Textbook of FORENSIC MEDICINE & TOXICOLOGY

Editor
V V Pillay

18th Edition

Paras Medical Publisher

India's #1 Bestseller in Forensic Medicine & Toxicology

TEXTBOOK OF FORENSIC MEDICINE & TOXICOLOGY

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Empowering Healthcare Professionals

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To

Every student who is passionate about
acquiring knowledge on all things forensic or toxic!

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PREFACE TO THE 18th EDITION

Yes, dear colleagues and students, I am back with a fresh serving of macabre snacks and tidbits! Fresh from the grisly oven of the Grim Reaper! Sooner perhaps than you would have thought. But then, when books fly off the shelves, they must be replaced, right? And since the 17th edition of this book did the vanishing act within months of its release in 2016, and readers began hollering for more, I had to rouse myself from the tranquil state I had slumped into and get back to the heat and sweat of the boiler room.

To tell the truth, I love being in the thick of action. Not for me, the lethargic life of a laid back professor ensconced in his armchair by the warm fire, sipping hot tomato soup and reading a Charles Dickens classic, while listening to the gentle strains of Beethoven in the background. No sir! I am all for stoking a raging fire at the mouth of a furnace, shoveling coal to fan the flames into a blazing conflagration, while death metal howls in the background, breaking now and then only to pause for a swig of a fiery swill. I need to be where the action is, where the hustle and bustle of work itself becomes music for the soul, and being idle even for a moment is to be dead and buried (pardon the ghastly pun).

The 18th edition that you are holding with curious anticipation in your hands is the product of restless hours of search and research for weeks and months stretching every other frenetic day into the dark and deadly watches of the night, while the whole world slept in bliss and peace. So, treat it with respect! Read it meticulously and scrupulously, savour every morsel of information, cogitate in focused concentration, switch yourself off from the maddening distractions around you, switch off your mobile phones and laptops and all such exasperating gizmos, and learn this harrowingly fascinating subject with the assiduous diligence that it deserves. There is no subject that is more gripping, more spellbinding, more awe inspiring than forensic medicine (including toxicology)!

And it is a speciality that has implications and ramifications across all other medical and surgical specialities, straddling the entire field of health sciences like a menacing behemoth that will wreak vengeful havoc if you do not pay due obeisance right from your undergraduate days to your high flying professional career. Almost every clinical speciality right from emergency medicine to paediatrics to orthopaedics to obstetrics to cardiovascular surgery is entwined inextricably with curling and twirling forensic-toxic tendrils that can suddenly tighten and strangle if one is not watchful or careful.

Now that I have got your pulse racing, your heart palpitating and your hands trembling, lock that door, get into that chair and do not move an inch until you have finished this entire book from cover to cover.

And then fire your salvos at me on drvvpillay@gmail.com.

Ciao!

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PROLOGUE

*Milestones in Forensic Medicine**

Forensic Medicine

Forensic Medicine is defined as a branch of medicine that deals with the application of principles and practice of medical and paramedical sciences for the purpose of administration of justice (mainly criminal).

The word 'forensic' is derived from the Latin word 'forensis' pertaining to forum. Forum is a term that refers to a marketplace in ancient Rome where civil and legal matters were discussed, and justice was dispensed.

Medical Jurisprudence

Juris - Law; Prudentia - Knowledge.

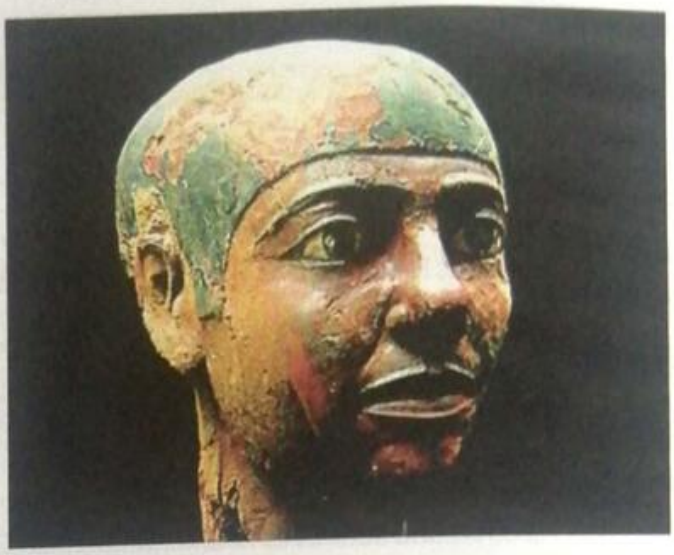
Medical Jurisprudence denotes the application of law in relation to the practice of medicine (legal duties and responsibilities of a doctor).

History

A. Outside India

3000 to 2000 BC

Imhotep (2655–2600 BC) **(Fig. 1)**, the Grand Vizir, Chief Justice and Chief Physician to King Zoser of Egypt is considered to be the first medicolegal expert. Egyptian doctors were aware of the different types of injuries inflicted on the body. The various aspects of law, judgement, crimes and punishments prevalent in those times can be deduced from ancient clay cuneiform tablets.



| Fig. 1 Imhotep |

2000 to 1000 BC

Hammurabi code – It is the oldest written code of law by the King of Babylon in 2200 BC, enumerating the responsibilities of a doctor while treating patients **(Fig. 2)**.

1000 to 50 BC

In Rome, around 600 years BC, Julius Caesar was delivered by a surgical operation practised to save the life of newborn babies, which later came to be called Caesarean section. It was also a solution to medical problems of inheritance.

Hippocrates (460–355 BC) **(Fig. 3)** – He is generally acknowledged as the Father of Medicine. His teachings included medicolegal aspects of wounds and medical ethics.

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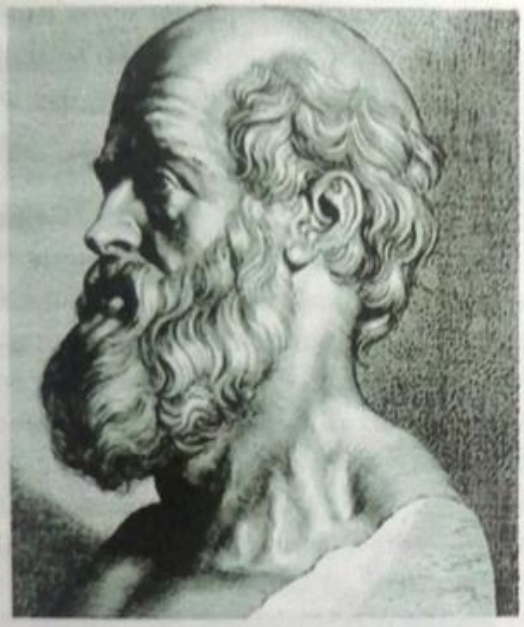
| Fig. 2 Hammurabi |

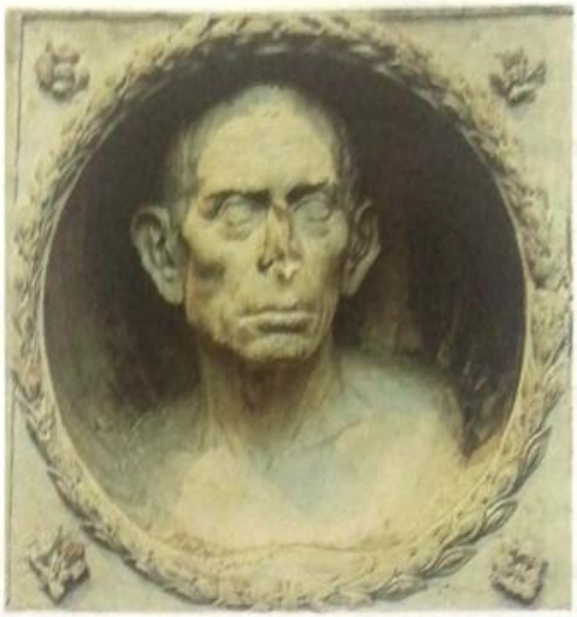


| Fig. 3 Hippocrates |

Antistius (about 30–10 BC) (Fig. 4) – This physician gave an opinion by externally examining the body of Julius Caesar that out of 23 injuries present on the body, the one that entered the chest between the first and second ribs was the fatal one.

Period of Christ

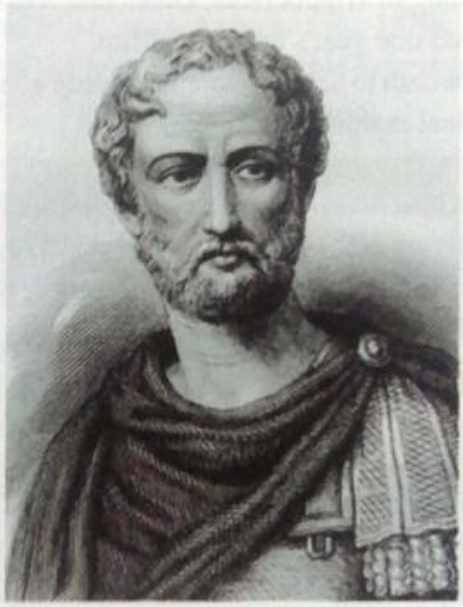
According to Jewish law of the olden days, a person who attempted suicide was said to be possessed by evil spirits, and hence deserved punishment. Similar ideology was shared by people in Rome and Greece during this period.



| Fig. 4 Marble Engraving of Antistius |

AD 100 to 500

Pliny the Elder (AD 23–79) (Fig. 5) a Roman naturalist and philosopher first made a mention about suspended animation, and sudden and natural deaths in his treatise, leading to the evolution of forensic literature from as early as 2nd and 3rd centuries.



| Fig. 5 Pliny the Elder |

Justinian Code (AD 529–564) prescribed regulations for medical practice and imposition of penalties for malpractice.

The Barbarians after overthrowing the Roman Empire, inserted a statute in the Court of Law that medical experts should be involved in awarding

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punishments after evaluating injuries caused by the accused.

AD 500 to 1000

Visigothic Code imposed restrictions on medical practice in line with Hammurabi code.

The Lex Alemanuorum gives detailed descriptions of wounds on body and makes mention of compulsory medicolegal examination of injuries by competent medical experts.

Bavarian Code prescribed punishment for administering abortifacients to cause criminal abortion.

AD 1100 to 1200

Frederick II (1194–1250), was one of the most powerful Holy Roman Emperors of the Middle Ages. He made it compulsory that in order for a person to practice medicine, he must fulfill the following criteria:

- Born legitimately.
- Aged 21 years.
- Studied philosophy for 3 years.
- Studied medicine for 5 years according to the teaching of Hippocrates, Galen and Avicenna.
- Served one year's apprenticeship.
- Taken oath to help the poor and needy after taking the final examination.

This was how State Medicine was born, which is even now reflected in the code of medical ethics to regulate the code and conduct of registered medical practitioners.

AD 1200 to 1500

The first written account of using medicine and entomology to solve criminal cases is attributed to the book 'Xi Yuan Ji Lu' (Collected Cases of Injustice Rectified), written in China by Sung Tzu (or Song Ci; 1186–1249) (Fig 6) in 1248, during the Song Dynasty. In one of the accounts, the case of a person murdered with a sickle was solved by an investigator who instructed everyone to bring his sickle to one location. (He realized it was a sickle by testing various blades on an animal carcass and comparing the wound.) Flies, attracted by the smell of blood, eventually gathered on a single sickle. In light of this, the murderer confessed.

| Fig. 6 Sung Tzu |

Doctors were appointed in Courts to give opinion in cases of injuries. In 1249, Hugo De Lucca, a surgeon, was appointed as "Medicolegal expert" in Italy. In 1374, the Pope sanctioned autopsy examinations.

AD 1600 to 1700

Emperor Charles V created a code called Constitutio Criminalis Carolina, which recognized the essentiality of medical testimony in deaths due to homicide, poisoning, abortion or infanticide. Thus the way was opened for the subject of Forensic Medicine to develop as a separate branch of medicine.

Ambroise Pare (a French army surgeon) (Fig 7) wrote a treatise on different medicolegal

| Fig. 7 Ambroise Pare |

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problems and how to differentiate antemortem injuries from postmortem injuries.

18th century

Two Italian surgeons, Fortunato Fidelis and Paolo Zacchia, laid the foundation of modern pathology by studying changes that occurred in the structure of the body as the result of disease.

Paulo Zacchia published *Questiones Medicolegales*. He is considered as the Father of Forensic Psychiatry and the Father of Legal Medicine. *Questiones Medicolegales* covers aspects of both forensic medicine and public health.

Later in 1701, Valentini published *Pandectae Medico-legalese*, which was a work challenging that of Paulo Zacchia.

In the late 18th century, writings on these topics began to appear. These included 'A Treatise on Forensic Medicine and Public Health' by the French physician Francois Immanuele Fodere and 'The Complete System of Police Medicine' by the German medical expert Johann Peter Frank. Henry Goddard at Scotland Yard pioneered the use of bullet comparison in 1835. He noticed a flaw in the bullet that killed the victim and was able to trace this back to the mold that was used in the manufacturing process.

19th century

In 1807, Andrew Duncan became the first Professor in this subject at Edinburgh.

Alfred Swaine Taylor (Fig 8) is the most famous name during this period. He became a Professor of Medical Jurisprudence at Guy's Hospital Medical School in 1834. His first edition of Principles and Practice of Medical Jurisprudence appeared in 1865. This book has stood the test of time, and is still revised regularly.

For mentally compromised criminals, the McNaughten's Rules were framed in 1843.

This marked the beginning of modern day Forensic Psychiatry.

Sir Robert Christison became Professor of Medical Jurisprudence at the age of 24 years in 1882, and was involved as medicolegal expert in the infamous case of Burke and Hare.

| Fig. 8 Alfred Swaine Taylor |

The French police officer Alphonse Bertillon (Fig 9) was the first to apply the anthropological technique of anthropometry to law enforcement, thereby creating an identification system based on physical measurements. Before that time, criminals could only be identified by name or photograph. Dissatisfied with the adhoc methods used to identify captured criminals in France in the 1870s, he began his work on developing a reliable system of anthropometrics for human classification.

| Fig. 9 Alphonse Bertillon - Self Portrait |

Bertillon created many other forensic techniques, including forensic document examination, the use of galvanoplastic compounds to preserve footprints, ballistics and the dynamometer, used to determine the degree of force used in breaking and entering.

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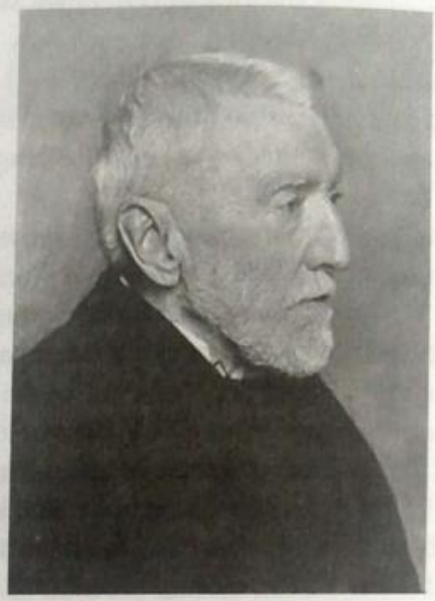
Although his central methods were soon to be supplanted by fingerprinting, his other contributions like the mug shot and the systematization of crime-scene photography remain in place to this day.

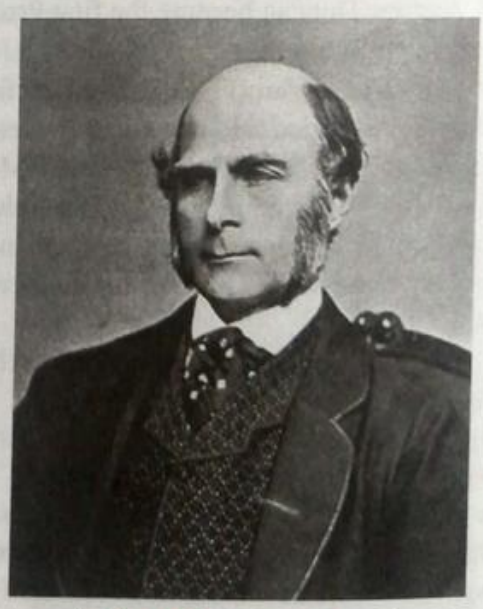
Sir William Herschel (Fig 10) was one of the first to advocate the use of fingerprinting in the identification of criminal suspects. While working for the Indian Civil Service, he began to use thumbprints on documents as a security measure to prevent the then-rampant repudiation of signatures in 1858.

| Fig. 10 Sir William Herschel |

In 1877 at Hooghly (near Calcutta), he instituted the use of fingerprints on contracts and deeds, and he registered government pensioners' fingerprints to prevent the collection of money by relatives after a pensioner's death. In 1880, Dr Henry Faulds (Fig 11), a Scottish surgeon in a Tokyo hospital, published his first paper on the subject in the scientific journal *Nature*, discussing the usefulness of fingerprints for identification and proposing a method to record them with printing ink. He established their first classification and was also the first to identify fingerprints left on a vial. Returning to the UK in 1886, he offered the concept to the Metropolitan Police in London, but it was dismissed at that time. Faulds wrote to Charles Darwin with a description of his method, but, too old and ill to work on it, Darwin gave the information to his cousin, Francis Galton (Fig 12), who was interested in anthropology. Having been thus inspired to study fingerprints for ten years, Galton published a detailed statistical model of fingerprint analysis and identification and encouraged its use in forensic science in his book 'Finger Prints.' He had calculated that the chance of a "false positive" (two different individuals having the same fingerprints) was about 1 in 64 billion.



| Fig. 11 Henry Faulds |



| Fig. 12 Francis Galton |

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Juan Vucetich, an Argentine chief police officer, created the first method of recording the fingerprints of individuals on file. In 1892, after studying Galton's pattern types, Vucetich set up the world's first fingerprint bureau.

The real impetus behind the modern science of solving crime using entomological evidence can be traced back to the works 'Faune des Tombeaux' (Fauna of the Tombs, 1887) and 'Les Faunes des Cadavres' (Fauna of Corpses, 1894) by French veterinarian and entomologist Jean Pierre Mégnin (Fig 13). These works made the concept of the process of insect ecological succession on a corpse understandable and interesting to an ordinary reader in a way that no other previous scientific work had done. It was after the publication of Megnin's work that the studies of forensic science and entomology became an established part of Western popular culture, which in turn inspired other scientists to continue and expand upon his research.

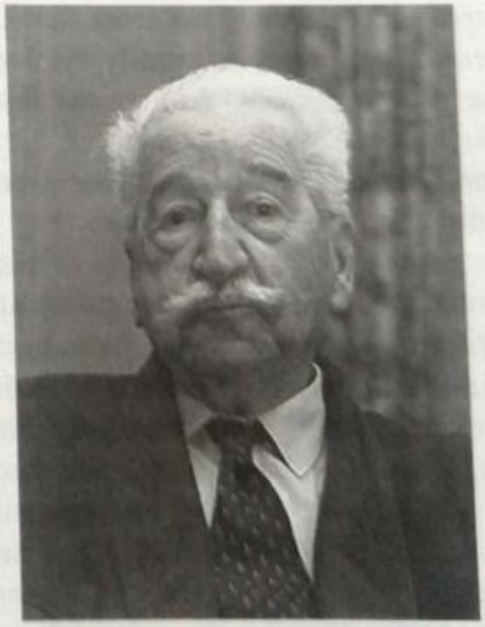
| Fig. 13 Jean Pierre Megnin |

Historically, there have been several accounts of applications for, and experimentation with, forensic entomology. The concept of forensic entomology dates back to at least the 14th century. However, only in the last 30 years has forensic entomology been systematically explored as a feasible source for evidence in criminal investigations. Through their own experiments and interest in arthropods and death, Sung Tzu (Song Ci), Francesco Redi, Bergeret d'Arbois, Jean Pierre Megnin and the German doctor Hermann Reinhard have helped to lay the foundations for today's modern forensic entomology.

20th century and beyond

By the turn of the 20th century, the science of forensics had become largely established in the sphere of criminal investigation. Scientific and surgical investigation was widely employed by the Metropolitan Police during their pursuit of the mysterious Jack the Ripper, who had killed a series of prostitutes in the 1880s. This case is a watershed in the application of forensic science. Large teams of policemen conducted house-to-house inquiries throughout Whitechapel. Forensic material was collected and examined. Suspects were identified, traced and either examined more closely or eliminated from the inquiry. Police work follows the same pattern today. Over 2000 people were interviewed, "upwards of 300" people were investigated and 80 people were detained.

In 1909, Archibald Reiss founded the Institut de police scientifique of the University of Lausanne (UNIL), the first school of forensic science in the world. Dr Edmond Locard (Fig 14), became known as the "Sherlock Holmes of France." He formulated the basic principle of forensic science: "Every contact leaves a trace," which became known as 'Locard's exchange principle.' In 1910, he founded



| Fig. 14 Dr Edmond Locard |

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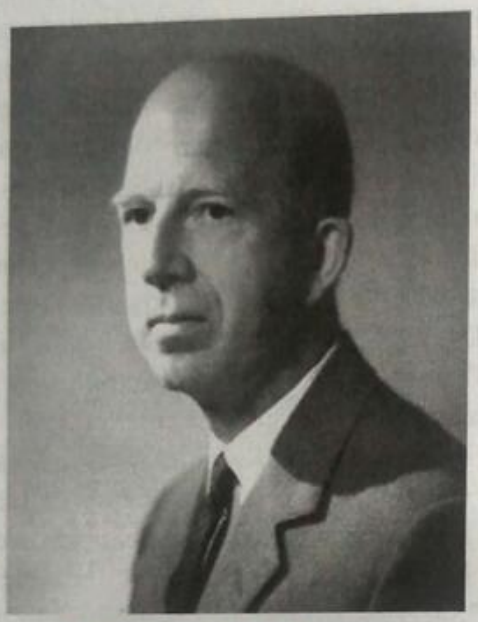
what may have been the first criminal laboratory in the world, after persuading the Police Department of Lyon (France) to give him two attic rooms and two assistants.

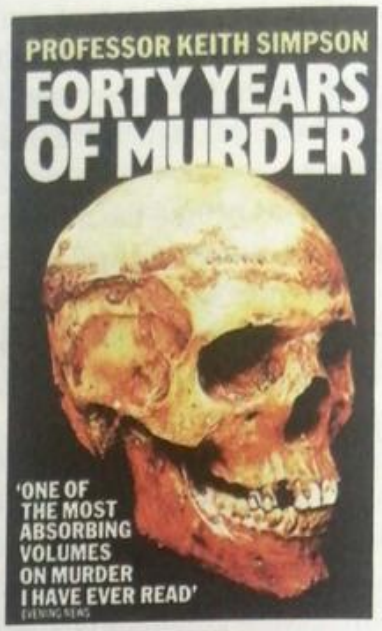
Later in the 20th century several British pathologists, Mikey Rochman, Francis Camps, Sydney Smith and Keith Simpson (Fig 15) pioneered new forensic science methods. The latter authored a hugely popular memoir in 1978 titled



| Fig. 15 Prof Keith Simpson |

'Forty Years of Murder - An Autobiography' (Fig 16) which recounted some of his most famous cases. Sir Bernard Spilsbury was actually the first British forensic pathologist who brought the fascinating speciality into the public domain, but his name is today unfortunately shrouded in controversy (Box 1). In the US, Prof Milton Helpern (Fig 17) was the most famous forensic pathologist of this period.

Forensic odontology is the study of dental applications in legal proceedings. The subject covers a variety of topics including individual identification, mass identification and bite mark analysis. There have been many cases throughout history, which have made use of bite marks as evidence. One of the first published accounts involving a conviction based on bite marks as evidence was the Gorringe case, in 1948, in which Keith Simpson used bite marks on the breast of the victim to seal a murder conviction against Robert Gorringe for the murder of his wife Phyllis.



| Fig. 16 Prof Keith Simpson's book |

| Fig. 17 Prof Milton Helpern |

Another early case was Doyle v. State, which occurred in Texas in 1954. The bite mark in this case was on a piece of cheese found at the crime scene of a burglary. The defendant was later asked to bite another piece of cheese for comparison. A firearms examiner and a dentist evaluated the bite marks independently and both concluded that the marks were made by the same set of teeth. The conviction in this case set the stage for bite marks found on objects and skin to be used as evidence in future cases.

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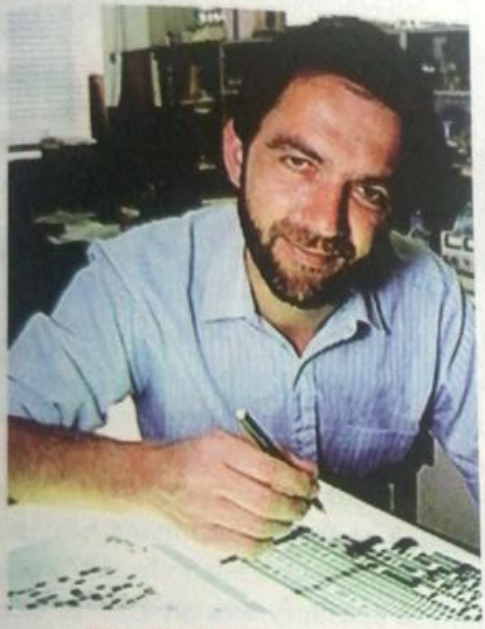
Prof Alec Jeffreys (Fig 18) pioneered the use of DNA profiling in forensic science in 1984. He realized the scope of DNA fingerprinting, which uses variations in the genetic code to identify individuals. The method has since become important in forensic science to assist police detective work, and it has also proved useful in resolving paternity and immigration disputes.



| Fig. 18 Sir Alec Jeffreys |

B. In India

Forensic Medicine in India has attained its present state of development by passing through several phases of evolution amidst superstition, religion and magic through the centuries, and subsequently imbibing Western concepts under the British regime. In ancient times, no person was safe from attacks on himself or his property, and a tooth for a tooth, an eye for an eye, and a life for a life was the rule of law.

Manu (3102 BC) in his famous treatise *Manu Smriti* prescribed various rules relating to minimum age of marriage, punishment for offences (sexual), and as to how a disease or intoxication could render one incapable of making a contract or depose in court.

During the Vedic Age (2000–1000 BC), *Rig Veda* was written, which mentions about how physicians successfully cured patients literally on the verge of death. Similarly, other Vedas mention crimes such as adultery, incest, abortion, murder, and prescribe punishments for the same. In *Atharva Veda* (1500 BC), there is mention of cures for injuries due to arrows, stab wounds, snake bites, etc.

Criminal abortion (*Brunahatya*) and suicide (*Atmahatya*) were specially mentioned as punishable under law in the Vedas. Even the nature of poison was attempted to be detected from the nature of flame and the sound of fire when the stomach or heart of the deceased (dead due to poisoning) was put in the fire.

Post-Vedic Period

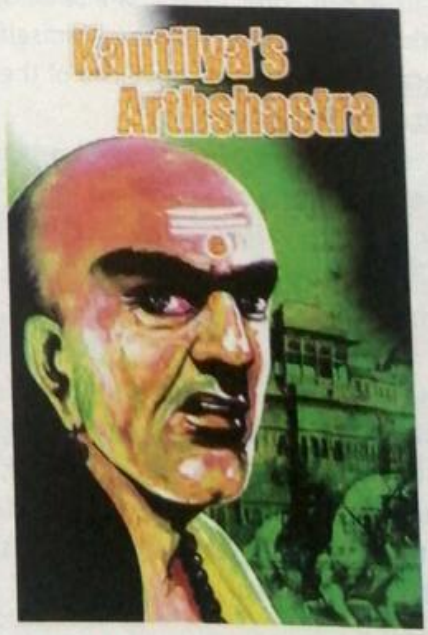
5th and 4th century BC (Buddha era)

King Ashoka established hospitals and roadside clinics and teaching institutions. Ayurvedic system of medicine was introduced.

4th & 3rd century BC (Mauryan Empire Period)

Kautilya's *Arthshastra* (Fig. 19) was written during this period. It is said to be the best treatise ever written in India on medicolegal investigation of crimes, and administration of law and justice. Kautilya advised medical examination in case of deaths due to assaults, poisoning and asphyxia, similar to the postmortem examinations conducted today.

Also, during this period it was stipulated that no one could practice medicine without the permission of the King, denoting a kind of medical registration system that we have now. Also, physicians were held responsible for negligence/carelessness in their treatment.



| Fig. 19 Kautilya's Arthshastra |

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Box 1 Sir Bernard Spilsbury – The Lethal Witness

Sir Bernard Spilsbury was an early-twentieth-century British forensic pathologist who gained fame by testifying in classic murder cases, beginning in 1910 with the Dr Hawley Harvey Crippen trial. His expert court testimony – he identified Crippen's victim by detailed microscopic study of a scar – convinced the lay jury of Crippen's guilt.

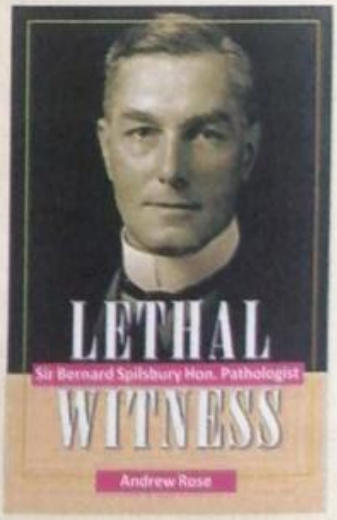
Considered the father of modern forensic pathology, Spilsbury became well known after he provided crucial prosecutorial evidence in the Brides in the Bath case (where a nurse nearly drowned in a laboratory experiment designed to prove his theories), the Blazing Car and Brighton Trunk murders, and the Hay-on-Wye arsenic poisoning trial. Knighted in 1923, Spilsbury performed 20,000 postmortem examinations and became the first and only "Honorary Pathologist to the Home Office."

Sir Bernard Spilsbury

The flamboyant Spilsbury became the best known pathologist of all time, rehabilitating the science and providing the crucial forensic evidence that condemned some of the most famous villains of the period. His findings led to Dr Crippen being hanged and helped to solve the infamous Brides in the Bath murder case.

Pushed to become a doctor by his chemist father, Bernard Spilsbury was an average student before spotting an opportunity to make his name in pathology, the least fashionable branch of medicine. He was immediately successful. His authoritarian manner and good looks made him one of the most popular figures of his age. He acted for the prosecution in more than 200 murders, becoming so notorious it was said that he had only to turn up at a mortuary for an accused man to be condemned.

Indeed, one of the many prisoners who hanged as a result of Spilsbury's evidence described himself as "a martyr to Spilsburyism," and several others were so convinced of their innocence they had to be dragged, drugged to the gallows.



Cover of the book Lethal Witness

The great pathologist, who was knighted for his efforts, was so successful that he regarded himself as beyond criticism. Yet, a new book ('Lethal Witness' by Andrew Rose) (Fig 2) recounting morbid details of the crimes of Edwardian England, and the slapdash way in which people could be convicted without appeal, shows that Spilsbury was worryingly fallible. With his enduring belief in capital punishment, he was a man of strong prejudices, whose grandiose murder theories were by no means watertight and were often invented on the spur of the moment. Above all, he frequently allowed his visceral conservatism and moral drive to convict criminals, to affect his clinical judgment. He smoked 50 cigarettes a day to counteract the ghastly smells in the dissecting rooms; he argued with his colleagues; and neglected his wife and children.

contd.

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Working in an age when there were few of the scientific aids and strict medical procedures employed today, there was much room for error. Bodies in storage pending the outcome of legal proceedings were not refrigerated and often had to be exhumed for proper pathological examination. In one case presided over by Spilsbury, a man had been shot dead during the night by his mistress. The police sent the victim's pyjamas, complete with bullet holes, to the laundry before the pathologist could study them, losing crucial evidence. Everything was so haphazard that many cases which ended with a hanging were, in fact, serious miscarriages of justice.

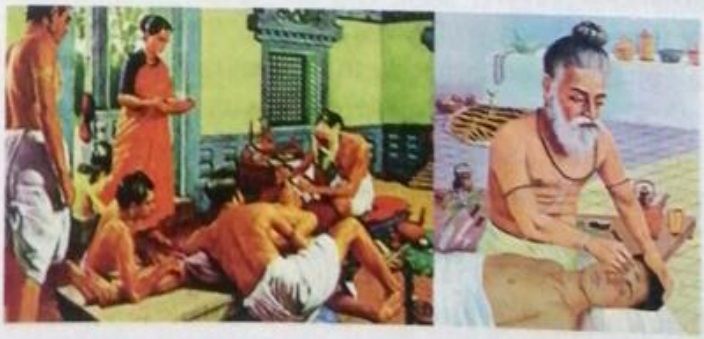
A deeply lonely figure, who had lost his mistress and was estranged from his wife, Spilsbury's professional enthusiasm began to wane towards the end of his career and he was starting to doubt his own evidence. He consoled himself with his glittering social life and his campaign for the establishment of special pathological facilities, which had been unavailable in his time. His efforts resulted in the setting up of the first police forensic laboratory, in Hendon, in 1934, and led to him being described as "the father of modern pathology." But the man himself, with his old fashioned prejudices, was becoming a pathetic figure. And his reputation was badly damaged in 1938 by his failure in a case involving a 14-year-old girl who became pregnant after being raped by two soldiers. Three doctors agreed that because she was too young to bear a child safely, she should be allowed an abortion, although terminations were illegal at the time. The operation was conducted by Aleck Bourne, one of Spilsbury's old adversaries, and when criminal proceedings were initiated against Bourne, Spilsbury was brought in to report on the case. Given his firm anti-abortion views, it was no surprise when he stated the doctors were wrong; there were no special risks to a young girl giving birth and that he knew a case of a 9-year-old who had given birth to a healthy, full-term baby. However, this time the jury ignored Spilsbury's testimony and took just 40 minutes to acquit Dr Bourne. It was a considerable blow to a man now in physical and mental decline, and when the only one of his three sons to follow him into medicine was killed, in 1940, by a Nazi bomb, which destroyed London's St Thomas's Hospital, he was overwhelmed by grief.

Drained and disillusioned - and perhaps tormented by the possibility of being exposed for his professional errors - Spilsbury committed suicide aged 70. In December 1947, Spilsbury gave Christmas gifts to his staff, ate alone at his club, then went to his rooms and turned on the gas tap of a Bunsen burner. Was it guilt that pursued him into the grave or simply the responsibilities of his profession? No longer capable of dissecting bodies properly due to arthritic hands and dementia, Spilsbury's loneliness was such that he lost the desire to continue working. It was a pathetic end to a highflying career, but even his greatest supporters were coming to the conclusion that a premature death was the only way he could preserve his legacy.

AD 200 to 300 (The Samhitas)

'Sushruta Samhita' compiled by Sushruta (Father of Indian Surgery) **(Fig. 20)** dealt not only with the management of surgical cases, but also detailed the good qualities of an ideal physician.

Charaka Samhita mentions about training and duties for physicians. Also, poisons were classified, as well as treatment measures for poisoning. The King was warned about poisoning effect on contact with Visha Kanyas.



| **Fig. 20** Sushruta Father of Indian Surgery |

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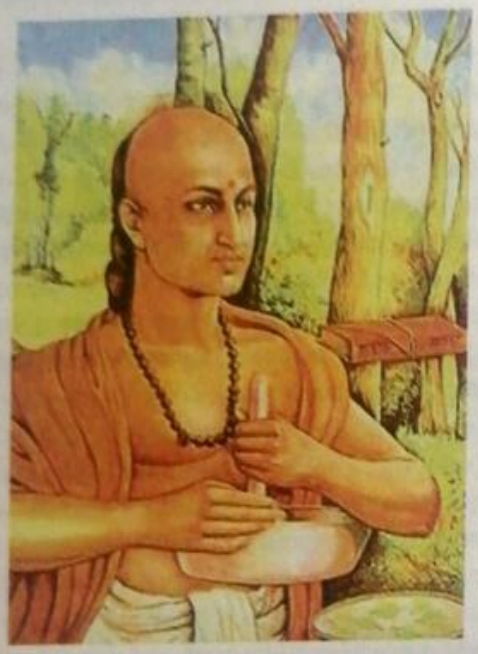
Charaka (Father of Indian Medicine) (Fig. 21) also laid down guidelines as to how a student should be trained to become a physician. Hence, he is also known as the Father of State Medicine. The physicians of those days were held in high esteem, both by the King and the general public.



| Fig. 21 Charaka Father of Indian Medicine |

AD 1000 to 1600

This period witnessed the invasion of India by foreign powers such as the Turks, Pathans and Moghuls. They came to plunder, spread religion and to rule the land. There were no improvements in teaching or training of physicians. Their law was based on the Koran, Hadis and Sara. Judiciary was based on Shari'ah rules, which included punishments like cutting of body parts, execution by trampling under elephant's feet, throwing to wild animals, etc.

Unani system of medicine was introduced during this period. Self-immolation practice (Sati) was practiced widely by Hindu females.

16th–19th centuries

The Portuguese, Dutch and French came and settled down and ruled the country. Later, the English East India Company was established, and the British conquered the country, thereby introducing a whole new system of medicine and legal procedures.

Coroner's system was introduced in Kolkata and Mumbai by the Coroner's Act 1871. However, the rest of the country followed the Police system.

The first medical college in the country was started in 1835 in Kolkata. Similar colleges were later set up in Chennai and Mumbai.

Dr CTO Woodford served as the first Professor of Medical Jurisprudence in the country in 1845.

Surgeon Edward Bulkley is credited with conducting the first postmortem examination in India. The case involved the death of James Wheeler in 1693, and the only previous such examination was in November 1680 when a soldier, Joshua Adams was killed by a strike on the head by Daniel Hughes. An examination of just the scalp was made, but in Bulkley's case he conducted a complete autopsy. James Wheeler was a member of the Council of Madras and had been treated by Samuel Browne (another surgeon), on whose advice he took a dose of medication prepared by the surgeon's assistant on the morning of 30 August 1693. Wheeler died before noon. The medicine had apparently been pounded by the assistant using a mortar that had previously contained arsenic. Browne took responsibility for the death, but was acquitted by the Grand Jury.

The Indian Penal Code was promulgated by Act XIV of 1860, codifying various crimes and punishments. It was drafted under the presidentship of Lord Macaulay. The Criminal Procedure Code was enacted by Act XXV of 1861 and Act VII of 1869, which streamlined the criminal procedures in the country. The Indian Evidence Act of 1872 codified laws with respect to evidence. In 1858, Sir William Herschel introduced the study of dactylography for the first time ever in the field of medicolegal investigation. Later in 1890, Sir Francis Galton of England refined and established the foundation for its systemic study and use in the field of identification. The first Fingerprint Bureau was established in Calcutta in 1897.

The Present Day

After 1947, many amendments were made to the above mentioned Acts. Medical Jurisprudence changed its nomenclature to Forensic Medicine.

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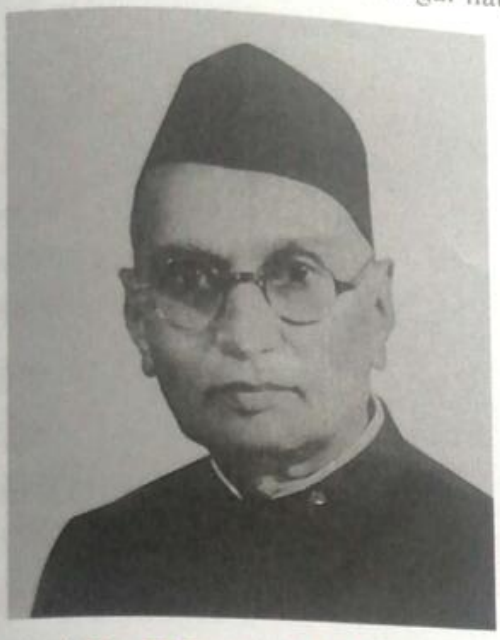
Dr Jaising P Modi (Fig. 22) became the first Indian physician to handle cases of medicolegal nature.



| Fig. 22 Dr Jaising P Modi |

Among the early forensic medical experts of India, two professors who contributed extensively to the growth of the speciality include Prof Bhooshana Rao and Prof ATS Iyengar.

Forensic Medicine together with Toxicology is now a part of the medical curriculum in all universities throughout the country (Graduate Medical Education-1997). The speciality is expected to be further strengthened after the release of the new MBBS curriculum, Graduate Medical Education-2012 by the Medical Council of India.

The entire field of Forensic Science has developed by leaps and bounds over the last few decades in India and every state of the country has well-equipped Forensic Science Laboratories, many of them with advanced biotechnology divisions attached, that undertake forensic DNA analysis. The first laboratory exclusively dedicated to DNA analysis in criminal cases was the Centre for DNA Fingerprinting and Diagnostics (CDFD), which was established in 1995 by Dr Lalji Singh, the pioneer of forensic DNA typing in India (Fig 23).

| Fig. 23 Dr Lalji Singh |

The field of Medical Toxicology has received a boost with the establishment of Poison Control Centres, one of which set up by the Editor of this book in 2003 in Amrita Institute of Medical Sciences (AIMS) in Cochin, Kerala is the most full-fledged centre with state of the art poison information and analytical services *(see page 504 for more details)*.

For an overview of the historical evolution of the specialities of Forensic Medicine and Toxicology in a pictorial manner comprising images of stalwarts who helped shape these two fascinating branches of medicine arranged in chronological order, every reader of this book is invited to visit the 'Corridor of Fame' established in the Department of Forensic Medicine & Toxicology in April 2016, in AIMS, Cochin (Fig 24).

| Fig. 24 Panoramic View of Corridor of Fame - FMT - AIMS, Cochin *(Pic : Dr Ajay B)* |

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Section I

Clinical Forensic Medicine

Chapters

1. Legal Procedure *2*
2. Medical Law and Ethics *25*
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5. Forensic Psychiatry *110*
6. Human Rights, Torture and the Medical Profession *130*

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CHAPTER 1

Legal Procedure

The net of law is spread so wide, no sinner from its sweep may hide.
Its meshes are so fine and strong, they take in every child of wrong.
O wondrous web of mystery! Big fish alone escape from thee!

—"The Net of Law", James Jeffrey Roche (1847-1908)

FORENSIC MEDICINE

Forensic medicine is a branch of medicine which deals with the application of medical knowledge in the administration of law and justice. A medical practitioner may have to on occasion, give evidence as an expert witness in a court of law to prove the innocence or guilt of an accused, or to authenticate or disprove a criminal charge of assault, rape, or murder brought against an individual.

- Forensic medicine is a vast subject, and requires a thorough knowledge of all branches of medicine. The medicolegal expert needs to take the help of various subjects to arrive at conclusions. He should be aware of the regulations, statutes, and acts relating to the practice and obligations of medical practice. A knowledge of legal procedure and some sections of the **Indian Penal Code** (IPC), **Criminal Procedure Code** (CrPC), and **Indian Evidence Act** (IEA), relating to various offences, is also desirable.

LEGAL PROCEDURE

- Whenever a person dies, the cause of death has to be determined. If the death is due to natural causes like cancer, pneumonia, heart failure, etc., no further investigation is necessary and the body can be handed over to the relatives for burial or cremation, or any kind of disposal as per their religious beliefs.
- If there is any suspicion of foul play, or if the mode of death seems to be unnatural, it must be reported to the authorities concerned. An immediate investigation (**inquest**) has to be conducted.

INQUEST

An inquest is a **legal inquiry into the circumstances and cause of death**, in cases of sudden, suspicious, or unnatural deaths.

Types of Inquest

1. Police Inquest
2. Magistrate's Inquest
3. Coroner's Inquest
4. Medical Examiner's System

Police Inquest

- Done all over India.
- Conducted by an officer in charge of a police station.
- On receipt of information of an unnatural death, the police officer informs the nearest magistrate, and proceeds to the place of death.
- He then conducts an inquest in the presence of two or more respectable inhabitants of the neighbourhood (***panchas***).
- After the necessary investigation, a report is drawn up on the apparent cause of death as judged by the state of the body, the injuries present on the body, hearsay evidence, circumstantial evidence, etc. This document is called **panchanama** or **inquest report** (Box 1.1). This is signed by the police officer and the persons present at the inquest.
- If any foul play or unnatural death is suspected, the police officer forwards the body for postmortem examination to the nearest medical officer, along with a written request and a copy of the

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Box 1.1 Inquest Report

Report of investigation under Section 174 CrPC on the body of a person found dead at ..... AM/PM ..... on the ..... day of .....(month) ..... (year)

1. Name, occupation and residence of persons composing the panchayat:
2. Name of the deceased, sex, age, occupation, father's name and residence:
3. By whom first found dead, when, and where?:
4. By whom last seen alive, where and when, and in whose company, and whether he carried any valuable property with him:
5. Height, colour and descriptive marks:
6. Married or single:
7. State of corpse, its posture and exact state of limbs, eyes, mouth, etc.:
8. If any wounds, particulars thereof, and list of all property found on the corpse:
9. Minute description of exact spot:
   a. Where corpse was found & if in water, depth thereof:
   b. When body is found in a well, information on the following points should be given:
      i. Is the well a public or private property?
      ii. If the latter, to whom does it belong?
      iii. Is it near a public road or pathway?
      iv. Does it have a parapet wall and float?
10. By which relative, body is recognized, and their statement given in short (blood relatives, such as parents, brothers, sisters always to be examined, if there are any):
11. Abstract of evidence of other persons examined:
12. Apparent cause of death:
13. If by violence, apparently, by what weapon:
    a. If any person is suspected, who and why?
    b. Was the deceased insured in any company?
14. If corpse is not sent for medical examination, why?
15. If corpse is sent, for what purpose and by whose order, and No. of Constable who went with it. (the date and hour when the body is sent should also be given here)
16. By whose order, corpse was buried or burnt?
17. Opinion of the panchayatdars as to cause and manner of death:
18. Signatures of such of the panchayatdars who concur with the above opinion:
19. Station house officer's signature:
20. If name and residence of deceased is unknown, state what steps have been taken to
    a. Ascertain the same, and secure identification.
    b. Have fingerprints of the deceased been taken and sent to the Fingerprint Bureau concerned?
21. Was the body warm or cold when first found?
22. Any reason to suspect foul play?
23. Duration of investigation:

Investigation commenced at ..... Investigation closed at .....

Signatures of witnesses .....

Signature of the Investigating Officer.....

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panchanama, to help him find out the probable cause of death. If the autopsy report confirms that the death is due to an unnatural cause, further enquiry and trial of the case is carried out in the usual manner by the magistrate concerned, to whom the entire records of the case are transferred by the police officer.

Magistrate's Inquest

A magistrate (usually an executive magistrate) conducts inquest in the following circumstances:

1. Dowry death
2. Death of a convict in prison
3. Death of a person in police custody
4. Death of a person as a result of police firing
5. Death in psychiatric hospital
6. Exhumation

It is done all over India.

Coroner's Inquest

- Conducted by a **coroner** who is either a medical professional with legal qualifications, or a graduate in law.
- Until recently, the coroner's inquest existed in the city of Mumbai, where it has now been abolished. Previously it was also conducted in various other cities such as Kolkata. **Today this system of inquest does not exist anywhere in India.** It is however the prevalent method of inquiry in the UK, (England, Wales, & Northern Ireland)*, Canada, Hong Kong, Australia, New Zealand, Sri Lanka and some states of the USA.
- A coroner holds an inquest on receipt of information of any unnatural, obscure, sudden, or suspicious death. He also investigates deaths of convicts in jail, deaths of persons in police custody, and deaths of patients in mental hospitals.
- The coroner's court is a court of enquiry, and not of trial. He is empowered to summon witnesses and record their evidence on oath. He can order for postmortem examination and exhumation whenever required.

Medical Examiner's System

- Medical examiner's system is a type of inquest which is **prevalent in most of the states of USA**.
- All sudden, unexpected, or unnatural deaths are analysed by a medical examiner who is a forensic pathologist.
- This type of inquest is considered **superior to all other types of inquest**, because it is conducted by a forensic pathologist with medical, scientific, and legal knowledge.

COURTS

Members of the medical profession may be required to attend court to give evidence in medicolegal cases. Therefore it is desirable that all medical practitioners possess some basic knowledge about criminal courts and court procedures.

Types of Courts

Table 1.1 gives the names, locations, and powers of the criminal courts in India.

Special Magistrates

- Appointed for special purposes, when the other regular magistrates cannot cope with a sudden and unexpected extra load of work, or when the enquiry has to be completed within a stipulated time.
- Special magistrates may be of any class.

Juvenile Magistrates

- Preside over juvenile courts, and try **juvenile offences**, i.e., those committed by individuals **below the age of 18 years (either sex)**.
- Juvenile magistrates are generally women.
- As per the Juvenile Justice (Care and Protection of Children) Act, 2000, amended as **The Juvenile Justice (Care and Protection of Children) Amendment Act, 2006**:
  - The Act known as 'The Reformatory Act' deals with two categories of children:

Scotland does not have Coroner system; inquest is conducted by an officer called "Procurator Fiscal"

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Table 1.1 Criminal Courts of India

No.	Court	Location	Powers
1.	**Supreme Court**	New Delhi	Highest judicial tribunal of the country. Can pass any sentence. Usually considers appeals from lower courts.
2.	**High Court**	Capital of every state (usually)	Highest judicial tribunal of the state. Can try any offence and pass any sentence.
3.	**Sessions Court** (District Sessions Court)	District headquarters	Highest judicial tribunal of the district. Can try only those offences which have been committed to it by a magistrate. Can pass any sentence, but death sentence must be confirmed by High Court.
4.	**Magistrate's Courts** are of two types:		
	I. **Judicial Magistrate**		
	a) i. Chief Metropolitan Magistrate	Metropolitan area	Can pass a sentence of imprisonment up to seven years; fine without limit.
	ii. Chief Judicial Magistrate	District (not being a metropolitan area)	
	b) i. Metropolitan Magistrate	Metropolitan area	Can pass a sentence of imprisonment up to three years; fine up to Rs. 10,000/-
	ii. Judicial Magistrate of I class	Subdivision of district	
	c) Judicial Magistrate of II class	Subdivision of district	Can pass a sentence of imprisonment up to 1 year and fine up to Rs. 5,000/-
	II. **Executive Magistrate**	I/c District, subdivision, or Taluk etc.	Appointed by the State Government; usually officers of Revenue dept., District Collector, Sub Collector or Tahasildar.

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Table 1.2 Special information relating to High Courts of India

States where High Court is located in city other than Capital

State	Capital	Location of High Court
Gujarat	Gandhinagar	Ahmedabad
Kerala	Thiruvananthapuram	Kochi
Madhya Pradesh	Bhopal	Jabalpur
Odisha	Bhubaneswar	Cuttack
Rajasthan	Jaipur	Jodhpur
Uttar Pradesh	Lucknow	Allahabad
Uttarakhand	Dehradun	Nainital
Assam	Dispur	Guwahati
Chhattisgarh	Raipur	Bilaspur

States and Union Territories which share High Courts	
Maharashtra, Goa, Dadra & Nagar Haveli, and Daman & Diu	Share High Court at Mumbai
West Bengal and Andaman & Nicobar Islands	Share High Court at Kolkata
Kerala and Lakshadweep	Share High Court at Kochi
Tamil Nadu and Puducherry	Share High Court at Chennai
Assam, Arunachal Pradesh, Mizoram and Nagaland	Share High Court at Guwahati

States which share Capital and High Court	
Andhra Pradesh and Telangana	Share Capital and High Court at Hyderabad
Punjab, Haryana and Chandigarh	Share Capital and High Court at Chandigarh

States with two High Courts	
Jammu & Kashmir	Jammu and Srinagar

- children in need of care and protection and
- children in conflict with the law.

- The competent authority to deal with children in need of care and protection is the Child Welfare Committee which constitutes a Chairperson and four other members, one of whom at least should be a woman.
- Every State Government has been authorised to constitute for a district or a group of districts, at least one Juvenile Board for exercising the powers and discharging the duties in relation to juveniles in conflict with the law under this act. The Board shall consist of a Metropolitan Magistrate or a Judicial Magistrate of the first class, and two social workers of whom at least one shall be a woman.
- When any juvenile is arrested, the officer in charge of the police station or the special juvenile police unit to which the juvenile is brought, has to inform the parent or guardian of the juvenile about his arrest and direct him to be present at the Board before which the juvenile will appear, and he has also to inform the probation officer of such arrest to enable him to obtain information regarding the family background of the juvenile.
- State Governments have been empowered to establish and maintain special homes in every district or a group of districts, for the reception and rehabilitation of juveniles in conflict with law.
  - Children's Home for the reception of child in need of care and protection.
  - Special Homes for the reception of child in conflict with law.
  - Observation Homes which are meant for the temporary reception of children during the pendency of any inquiry.

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- After-care Organizations which are meant for the purpose of taking care of children after they have been discharged from Children's Home or Special Homes.
- Newspapers, magazines, and visual media have been prohibited to disclose the name, address or school or any other particulars that can lead to the identification of the juvenile in conflict with law, nor they can publish any picture of such juvenile. Any person who contravenes this provision shall be punishable with fine up to one thousand rupees.

PROCEDURE OF CALLING A WITNESS TO A COURT

Subpoena

Subpoena or Summons is a document commanding the attendance of a witness in a court of law, under a penalty (*sub* – under, *poena* – penalty).

- A summons is issued by the court, in writing, signed by the presiding officer, and is served on the witness by a police officer or an officer of the court, or any other person specifically authorised for the purpose **(Box 1.2)**.
- It is issued in duplicate, one of which is to be returned after signing, while the other is retained by the witness.
- A summons must be implicitly obeyed, unless there are valid and urgent reasons. A witness who wilfully avoids to appear before a court after having been duly served a summons, is guilty of **contempt of court**. The penalty for non-compliance of summons is a **warrant of arrest** and a compulsory appearance before the court.
- In the matter of attending a court in response to a summons, it must be borne in mind that a witness must give **priority to a criminal case over a civil case**, if he is summoned to two courts at the same time, because criminal cases have priority over civil matters. Similarly, if he is summoned by two criminal courts on the same day, he is to give preference to the **higher court which takes precedence over a lower court**.

Box 1.2 Proforma of a Subpoena

Summons to a Witness
(CrPC Sections 61 & 244)

To Dr. .....

Whereas complaint has been made before me that Mr..... of ..... has committed, or is suspected to have committed the offence U/S .....IPC on ..... at ....., and it appears to me that you are likely to give material evidence, or to produce any document or other thing for the prosecution,

You are hereby summoned to appear before this Court on ..... at ....., to produce such document or thing to testify what you know concerning the matter of the said complaint, and not to depart thence without leave of court; and you are hereby warned that, if you neglect or refuse to appear on the said date, without just excuse, a warrant will be issued to compel your attendance.

Dated.....

Signature .....

(Seal of the Court)

(The Summons is issued in duplicate. The witness has to acknowledge the receipt of the summons by signing on the reverse side of the original. The signed original has to be returned to the court. The copy is to be retained with the witness)

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Conduct Money

In civil cases, the medical officer is usually paid money to meet his travelling expenses from his place of residence to the court, and back. This is called **conduct money**. This is paid to him at the time the summons is served on him. If this amount is not paid to him, he may ignore the summons, if he so desires. If he feels the sum is inadequate, he can inform the court accordingly and get it enhanced. In criminal cases however, no such fee is given usually, and it is the bounden duty of every citizen to attend the court whenever summoned.

PROCEDURE IN COURT

1. Oath

- Once the Medical Officer who is summoned makes his appearance in court, his evidence is recorded after administration of the oath.
- An **oath** is a declaration required by the law, to be made before the court by the witness. The oath is as follows: "I swear in the name of God, that the evidence I shall give to the court shall be the truth, the whole truth, and nothing but the truth. So help me God."
- If the witness is an atheist, he makes a **solemn affirmation** as follows: "I solemnly affirm that the evidence I shall give to the court shall be the truth, the whole truth, and nothing but the truth."
- Once a witness has been sworn, he is liable to be prosecuted for **perjury** (wilful utterance of falsehood) if he does not speak the truth, or willfully conceals the truth (punishable under Sec 193 IPC). A sensational case of murder (**Jessica Lal Case**) that occurred in 1999 in Delhi is an example of how justice can be subverted when crucial witnesses turn hostile and indulge in perjury **(Box 1.3)**.

2. Examination-in-Chief

- Examination-in-chief is the examination of the witness by the counsel (advocate) of the party which has called him. In government prosecution cases, the public prosecutor commences the examination-in-chief, the purpose of which is to apprise the court of all the facts of the case.
- Leading questions are not allowed in examination-in-chief, except when a hostile witness is being examined. A **leading question** is one which itself suggests the answer. For example, *"Doctor, was not the injury caused by a sharp weapon?"*, is a leading question. Normally, the question should be phrased in this manner: *"Doctor, by what weapon has this injury been caused?"*.

3. Cross Examination

- Cross examination follows examination-in-chief. It is the examination of the witness by the counsel (advocate) of the opposite party, namely, counsel for the accused.
- The purpose of cross examination is to highlight inaccuracies and contradictions in the statements of the witness, and thereby to prove to the court that this evidence is not valid.
- **Leading questions** are allowed during cross examination. The witness must therefore be very careful in answering the questions. He may be asked questions to test his truthfulness, skill, and character. A medical witness must not feel insulted, must avoid losing his temper, and must answer the questions with dignity and poise. He may sometimes be stumped for an answer, when asked an absurd question **(Box 1.4)**. After all, even lawyers are human!

4. Re-Examination

- Cross examination is followed by re-examination. It is conducted by the counsel who has conducted the examination-in-chief.
- The purpose of re-examination is to clear any doubts that may have arisen during cross examination.
- Leading questions are not allowed.
- No new matter may be introduced without the permission of the judge and the consent of the counsel of the opposing party. In the event of a new topic being introduced, the opposing party has the right to cross examine on the new matter.

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Box 1.3 **Jessica Lal Murder Case - Cesspool of Perjury**

On 29 April 1999, **Jessica Lal**, a young model was working at an unlicensed bar at a party in the Tamarind Court restaurant in Mehrauli (South-West Delhi). By midnight the bar had run out of liquor and it would, in any event, have ceased sales at 12.30 am. After midnight, a young man named Manu Sharma walked in with his friends and demanded to be served liquor. Lal refused to serve him though he was ready to offer Jessica Rs 1000 for it. Sharma then produced a .22 calibre pistol and fired it twice: the first bullet hit the ceiling which was to serve as a warning to Jessica not to refuse liquor, but when Jessica refused again, Sharma fired again and the second hit Jessica in the head and killed her. A mêlee followed the shooting, during which Sharma and his friends - Amardeep Singh Gill, Vikas Yadav, and Alok Khanna - left the scene. After eluding police for a few days, with the assistance of accomplices, Khanna and Gill were arrested on 4 May and Sharma on 6 May. The murder weapon was not recovered and was thought to have been passed on to a friend who had been visiting from the US and who may subsequently have returned there.

Jessica Lal
(Pic: BBC News, 18 Dec 2006)

The case by now involved several prominent people. Manu Sharma himself was the son of a former minister of the national government and by the time of the subsequent trial was a minister in the Haryana state government. Yadav was the son of another state politician. Bina Ramani, who had redeveloped the premises where the party took place, was a socialite and fashion designer who allegedly had contacts in high places and whose daughter knew Lal as a fellow-model. Singh managed the distribution of Coca-Cola in Chandigarh.

Amit Jhigan, an accomplice of Sharma, was arrested on 8 May and charged with conspiring to destroy evidence, as it was believed that he had retrieved the pistol from its original hiding place near the bar.

Charge sheets were filed with the court on 3 August 1999. Sharma was charged with murder, destruction of evidence and other offences, while Khanna, Gill and Yadav faced lesser charges, including destruction of evidence, conspiracy and harbouring a suspect. Seven years after the case was opened, on 21 February 2006, nine of the twelve accused were acquitted, including Sharma. The prosecution had been affected by 32 of their witnesses becoming "hostile". These included Shayan Munshi, a small time film actor, and two ballistics experts. Subsequently, in February 2011, it was announced that they would all face charges for perjury.

The reaction to the verdict was one of outcry. There were numerous protest campaigns, including ones involving SMS and email, seeking to obtain redress for the perceived miscarriage of justice. Rallies and marches took place, as well as candle light vigils.

The Delhi police commissioner announced an investigation to determine where things had gone wrong, and said that among other things it would examine whether there had been a conspiracy, including possibly by tampering with the evidence.

The police petitioned the High Court for a review of the case, and on 22 March 2006 the court issued warrants against the nine defendants who had stood trial. On 15 December 2006, the High Court ruled that Sharma was guilty based on existing evidence. The judgement said that the lower court had been lax in not considering the testimony of some witnesses such as Bina Ramani. In particular, the key witness Munshi came in for serious criticism. The judgement says, of his earlier repudiation of the First Information Report that "Munshi is now claiming that the said statement was recorded in Hindi while he had narrated the whole story in English as he did not know Hindi at all ... We do not find this explanation of Munshi to be convincing." Regarding Munshi's testimony that two guns were involved, the judgement says: "In court he has taken a somersault and came out with a version that there were two gentlemen at the bar counter. ... We have no manner of doubt that on this aspect he is telling a complete lie."

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On 20 December 2006, Sharma was punished with a sentence of life imprisonment and a fine. The other accused, Yadav and Gill, were fined and given four years' rigorous imprisonment. A plea for Sharma to be sentenced to death was rejected on the grounds that the murder, although intentional, was not premeditated and Sharma was not considered to be a threat to society.

On 19 April 2010, the Supreme Court of India approved the sentences and said that, "The evidence regarding the actual incident, the testimonies of witnesses, the evidence connecting the vehicles and cartridges to the accused - Manu Sharma, as well as his conduct after the incident prove his guilt beyond reasonable doubt. The High Court has analysed all the evidence and arrived at the correct conclusion."

In May 2013, Delhi High Court ordered prosecution of actor Shayan Munshi and a ballistic expert for turning hostile. The court cleared a further 17 people whose allegedly hostile position was under review. Ten other people had been discharged from claims of perjury in earlier hearings and three had died since the original trial.

Box 1.4 Some Wise Court Questions

The following are questions actually asked of witnesses by attorneys during trials:

1. "Now doctor, isn't it true that when a person dies in his sleep, he doesn't know about it until the next morning?"
2. "The youngest son, the twenty-year old, how old is he?"
3. "Were you present when your picture was taken?"
4. "Were you alone or by yourself?"
5. "Was it you or your younger brother who was killed in the war?"
6. "Did he kill you?"
7. "How far apart were the vehicles at the time of the collision?"
8. "You were there until the time you left, is that true?"
9. "How many times have you committed suicide?"
10. "Doctor, which human species do these skeletal remains belong to?"

All except the 10th entry: From the Massachusetts Bar Association Lawyers Journal.
10th entry: Question asked of the Editor of this book (V. V. Pillay) by the defense counsel in a Sessions Case at Mangalore, Karnataka.

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Court Questions: These are questions put forward by the presiding officer of the court. These questions are posed to clear doubts, if any, and can be asked at any stage of the trial proceedings.

MEDICAL EVIDENCE

The term "*Evidence*" means all information which the court permits, which is helpful in relation to matters of fact under enquiry. It may be **documentary** or **oral** or **circumstantial**. Evidence produced in the form of documents is called **documentary evidence**, while that which is stated orally is called **oral evidence**. Evidence obtained from the circumstances surrounding a case is called **circumstantial evidence**.

Documentary Evidence

This comprises documents produced before the court, and includes:

1. Medical certificate
2. Medicolegal report
3. Dying declaration

Medical Certificates

- These are certificates which pertain to sickness, insanity, death, etc.
- They are issued only by a registered medical practitioner and are admissible in court.
- It is however, an offence to issue a false certificate. When a medical practitioner is not sure of the cause of death or when he suspects foul play, he must refuse to issue a death certificate and must inform the police.

Death Certificate

- The Registration of Births and Deaths under Municipal Acts stipulates that notice must compulsorily be given by a doctor in attendance, at the time of the birth or death of an individual.
- Hence it becomes mandatory for a medical practitioner to issue a death certificate after inspecting the body and satisfying himself of the person's death, stating the cause of death.
- The medical certificate of the cause of death has a number of purposes, and the importance of these differs in the perception of those who make use of it.
  - Firstly, it helps the commencement of the **process of disposal of the dead**.
  - Secondly, it enables the collection of **national statistics**; and
  - Finally, it marks the **end of a pattern of care** and this, in the view of many doctors, is its overriding purpose. Accuracy in documentation is not considered to be a serious matter by many, compared with the need for accuracy, for example, in a prescription.
- The medical practitioner is not entitled to charge any fee for issuing a death certificate. He should not refuse, nor cause unnecessary delay in issuing a death certificate.

The recommended format of death certificate is mentioned in **Box 1.5**. The detailed proformas of death certification (institutional and non-institutional) are laid out under **Annexure 1** *(page 740)*.

Principles

1. It is the statutory responsibility of the person in charge of a medical institution to report all births and deaths occurring therein to the Registrar of Births & Deaths in the prescribed form within 21 days under the **Registration of Births & Deaths (RBD) Act, 1969**.
2. In the event of death of a person in the areas notified by the State Government, a medical practitioner who attended the deceased during his/her last illness is required to issue a certificate of cause of death in the prescribed form to\ accompany the death report.
3. The information on cause of death is to be kept confidential by law and must be used purely for statistical purposes.
4. Violations of these provisions are punishable under the RBD Act, 1969.

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Box 1.5 Form of Medical Certificate of Cause of Death

To: ..... I do hereby certify that I attended the deceased (full name) ..... aged about ..... residing at ..... during his last illness and that to the best of my belief, the cause of death at (time) ..... on (date) ..... was as stated below:

Approximate interval between onset and death Years: Months: Days:

Cause of death

I. **Immediate cause**

1. Disease or condition directly leading to death. a. ..... (due to or as a consequence of)
2. Antecedent cause: Morbid conditions, if any, giving rise to the above cause, stating the underlying condition last b. ..... (due to or as a consequence of)

II. **Contributory cause**

Other significant conditions contributing to the death but not related to the disease or condition causing it. c. .....

Address or rubber stamp of the institution

Signature, name, designation, qualifications, and registration number of the Medical Officer

Medicolegal Reports

Medicolegal reports are **documents prepared by a medical officer in compliance with a written requisition issued by a magistrate or police officer**.

- Medicolegal reports may pertain to **injury, sexual offence, death**, etc. They contain all the facts observed by the medical officer, and his opinion drawn therefrom. His opinion must be based upon the observations made by him, and not on hearsay evidence.

Dying Declaration

A dying declaration is a statement, written or oral, made by a person who is on the verge of dying as a result of unnatural causes.

- The statement should relate to the cause of his imminent death, or any of the circumstances of the transaction resulting in his present condition.
- Such a declaration is **admissible in court**, when the cause of that person's death is the subject of enquiry. It may provide useful information and help to obtain justice. A person who is accused of a crime cannot make a dying declaration, but only a person who is the victim of a crime. Statements unconnected with the actual crime are not admissible in a dying declaration.
- It is believed that a person who is about to die will speak only the truth. A dying declaration has the same measure of worth, as that of a statement made on oath, in the court. A dying declaration is valid even if the declarant lives for some days after making the declaration, but in that case, it may be relied on only as corroborative evidence.
- As soon as a doctor knows that the victim of a crime who is in danger of dying, has something of importance to say to the court, he must send

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for a magistrate. If the doctor feels that the declarant may die before the arrival of the magistrate, he can record the declaration himself. It is essential to certify that the declarant was in a state of sound mind (***compos mentis***) at the time of making the declaration. But a recent decision of the Supreme Court indicates that this is not mandatory.

- Although no oath is administered, a dying declaration is admissible in court as if this had been done, provided it is recorded as per the guidelines laid down for the purpose. It must be recorded in the presence of two witnesses. It is to be recorded verbatim, in the language in which the victim prefers to speak. No information must be elicited by asking leading questions. No prompting or suggestions should be made to the declarant, and undue influence must not be imposed on the declarant.
- **The investigating police officer should not be present when the declaration is being made.** If the dying person is unable to speak, but is able to make gestures in answer to questions, it can be recorded after deciphering the gestures. The medical officer recording the declaration should only mention the precise nature of the gestures so made, and not interpret them himself. Interpretation is done subsequently by the court.
- After the complete declaration has been recorded, it must be read over to the declarant, and must if possible, be signed by him. It must then be attested by the writer and the witnesses. If the declarant dies or becomes unconscious while the declaration is being made, the medical officer writing it must record as much information as he has obtained and sign it. It must then be **forwarded to the magistrate in a sealed envelope**.
- If a dying declaration is recorded by a magistrate, and in the presence of the accused who is given an opportunity to cross examine the declarant, it is called a **dying deposition**. This is however NOT prevalent in India. A dying deposition has greater value in court than dying declaration, for the reason that it is recorded by a magistrate, in the presence of the accused who is permitted to cross examine the declarant.

Oral Evidence

Oral evidence refers to **evidence which is tendered verbally**.

- Oral evidence, as far as possible, must be direct, i.e, if it refers to a fact which can be seen, heard or perceived, then it must be the evidence of a person who says he saw, heard, or perceived it. In other words, it must be the evidence of the actual witness. However, it is not always necessary that oral evidence must be direct.

  Exceptions to direct oral evidence include:
  1. Dying declaration
  2. Expert opinion expressed in a treatise, when the author is dead, or cannot be found, or is otherwise incapable of giving evidence
  3. Deposition of medical witness in a lower court
  4. Chemical examiner's report.
- **Oral evidence is superior to documentary evidence**, because it can be subjected to cross-examination.

Hearsay Evidence

Hearsay evidence is the evidence of one who has no personal knowledge of the facts of the case, but just repeats what he has heard others say. For example, if Mr A has seen Mr B shooting Mr X with a revolver, and if Mr A testifies that he has witnessed this incident, then it is **direct evidence**. But if Mr A has got this information from Mr Z that Mr B shot Mr X, then it is **hearsay evidence**, and it is not permissible in court, as the witness cannot be cross examined.

Circumstantial Evidence

It is the **evidence obtained from suspicious circumstances**. For example, the sudden disappearance of a person who is suspected to be the criminal. In some cases, circumstantial evidence is more reliable than eyewitness accounts.

WITNESSES

Witnesses are of two kinds, namely, **common witness** and **expert witness**.

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- A common or ordinary witness is one who testifies only to the facts observed by him. His evidence requires only common intelligence and knowledge. He is not capable of forming opinion or drawing conclusions from the facts observed by him.
- An expert witness, on the other hand, is one who is skilled in scientific, technical, or professional matters, and who on account of his professional training, experience, and ability, is capable of forming opinions, or drawing inferences, e.g., a doctor who conducts an autopsy.

Sometimes a witness deliberately conceals the truth or gives false evidence. After making a particular statement in court, he contradicts this subsequently. He is therefore presumed to have an interest or motive for concealing the truth, or giving false evidence. The court therefore declares him to be **hostile**. It is possible that a common witness or expert witness may turn hostile. When a hostile witness is being examined, leading questions are permissible even during examination-in-chief.

CONDUCT OF A DOCTOR IN THE COURT

1. Go to court well prepared with the details of the case. Take care to have answers ready for anticipated questions.
2. Be in possession of all relevant certificates, documents, and notes.
3. Do not attempt to memorise anything, since you are allowed to refresh your memory by consulting your report or notes.
4. Be well dressed and modest.
5. Speak audibly and clearly.
6. Use simple language, and avoid technical terms as far as possible.
7. Do not exaggerate anything. Avoid the use of superlatives, e.g., "It was the *biggest* wound I have ever seen...."
8. Do not fumble while referring to any case notes or records.
9. Do not discuss the case with anybody except the lawyer who has called you.
10. Address the Judge respectfully – "*Sir*" or "*Your Honour*". When entering the room, bow to him before taking your seat.
11. Avoid discrepancies between your earlier statements and your testimony to the court.
12. Do not evade any question. If a question is unclear, ask for it to be repeated or rephrased.
13. If you do not know the answer to a particular question, be frank and admit it.
14. Do not lose your temper. Always remain calm, composed, and courteous.
15. Do not argue. Disagree firmly with anything you are not convinced about. But do not give the impression of being dogmatic.
16. Do not give rambling, long winded answers. Try to be brief and precise.
17. As far as possible do not volunteer any statement on your own. However, if you feel that by not making some statement, injustice may result, do mention it.
18. Express opinions only on the basis of your own knowledge and experience. You can however utilise published opinion on scientific facts by qualified writers.
19. Be honest. If you have made some mistake, admit it. Do not attempt to cover up any lapses or errors.
20. Be absolutely impartial. Even though you may have been called by the prosecutor, present your facts objectively without taking sides. Remember the following quotation made by **Paul H Broussard**, Chair of Forensic Medicine, Sorbonne, 1897, an eminent French medicolegal expert:

    "***If the law has made you a witness, remain a man of science. You have no victim to avenge, no guilty man to convict, and no innocent man to save. You must bear testimony within the limits of science.***"

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Box 1.6 **Glossary of Common Legal Terms**

- **Accused**: One who is accused of/alleged to have committed a crime, but which has not yet been proved in a court of law.
- **Acquittal**: It means the accused has been absolved, i.e., he is not guilty, and therefore can be set free. Once an accused has been acquitted, he cannot be tried again for the same offence by the same court.
- **Affidavit**: Voluntary, written statement of facts made under oath before an officer of the court or before a notary public.
- **Appeal**: It is a complaint made to a superior court of an injustice done, or error committed by an inferior one, whose judgement or decision is requested to be corrected or reversed.
- **Appellant**: The person who files an appeal.
- **Arrest**: Apprehension of a person (usually an accused) by judicial authorities, resulting in deprivation of his liberty.
  - **Warrant of arrest** – It is a written order, which is signed, sealed, and issued by a magistrate, and addressed to a police officer or some other person specially named, commanding him to arrest the person named in it.
- **Assailant**: One who has committed an assault.
- **Bail**: It is defined as the security on behalf of an accused person, on giving which, he is released from custody, pending investigation or court trial.
  - **Anticipatory bail** – It is a direction granted by the Sessions or High Court to release a person on bail issued even before the person is arrested.
- **Case**: An action, cause of action, matter of dispute, or law suit.
  - **Warrant case** – A case relating to an offence punishable with death, imprisonment for life, or imprisonment for a term exceeding two years.
  - **Summons case** – A case relating to an offence which is not punishable by a term of imprisonment exceeding 2 years.
  - **Civil case** – It is a dispute between two private parties relating to wealth, property, etc.
  - **Criminal case** – It is a case between the Government (represented by the police) and a private party concerning matters of public interest and safety, e.g., assault, robbery, murder, rape, etc.
- **Case law**: Legal principles derived from judicial decisions. It is different from statutory law, which is enacted by the legislature.
- **Cause of action**: A set of facts which gives a person a right to file a proceeding in a civil court.
- **Charge**: A formal accusation in writing against a person that he has committed an offence.
- **Charge sheet**: It is a report alleging the commission of a crime by an accused person submitted to a magistrate by the police on completion of an investigation.
- **Common law**: Judge-made law as opposed to codified law.
- **Complaint**: A legal document that is the initial pleading on the part of the plaintiff in a civil suit. The purpose of this document is to give the defendant notice of the alleged facts. The complaint is usually attached to the summons.
- **Contempt of court**: It means intentional insult or interruption to a court in any stage of a judicial proceeding.
- **Conviction**: It means that an accused has been proved in a court of law, to be guilty of the crime alleged to have been committed by him. The "accused" is now termed a "convict."
- **Court of justice**: It denotes a judge who is empowered by law to act judicially alone, or a body of Judges which is empowered by law to act judicially as a body.
- **Culpability**: Being at fault, deserving punishment or reproach, for some act or cause of action.

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- **Damage**: Injury suffered by a party as a result of the action of another.
- **Damages**: Compensation (usually monetary) that is payable to a victim, as decided by the court.
- **Decree**: The document under the seal of the court setting out the relief granted to a party or parties.
- **Defendant**: The party against whom a complaint has been filed. He is the same as an "accused."
- **Defence counsel**: The legal practitioner who acts on behalf of the accused, and challenges the evidence of the prosecution. In other words, he defends the defendant.
- **Deposition**: The evidence given under oath by a person (usually a witness) in a court of law.
- **Document**: It describes any matter expressed or inscribed upon any substance by means of letters, figures, or marks, intended to be used, or which may be used as an evidence of that matter.
- **Evidence**: It means anything by which any alleged matter of fact is either established or disproved.
  - **Demonstrative or Real evidence** – The use of an article or object, rather than the statement of a witness, to prove a fact in question.
  - **Material evidence** – Proof of facts that directly affect an element of the cause of action.
  - **Prima facie evidence** – A level of proof which is sufficient to establish the fact, and if not rebutted, becomes conclusive of the fact.
- **Exhibit**: Any document or object produced for inspection before the court.
- **Good faith**: Nothing is said to be done or believed in good faith, which is done or believed without due care and attention.
- **Inquiry**: A procedure that is conducted by a magistrate or court as per the Criminal Procedure Code, which does not amount to a trial.
- **Investigation**: It is a procedure carried out by a police officer or other person (other than a magistrate) as per the Criminal Procedure Code, for the collection of evidence.
- **Judge**: It is a term that denotes not only those persons officially designated as a judge in a court of law, but also every person who is empowered by the law to give, in any judicial proceeding, civil or criminal, a definite judgement. It includes for instance, collectors of districts, and executive magistrates.
- **Jury**: A sworn body of people convened to render an impartial verdict officially submitted to them by a court, or to set a penalty or judgment. In criminal cases there are usually 12 members (jurors). Trial by jury does not exist in India.
- **Offence**: It is any act or omission made punishable by law.
  - **Cognisable offence** – It is an offence for which a police officer may arrest a person without a warrant, e.g., theft, rape, murder, etc.
  - **Non-cognisable offence** – It is an offence for which a police officer cannot arrest a person without a warrant, e.g., forgery, cheating, etc.
- **Offender**: One who has committed an offence.
- **Public Prosecutor**: A lawyer appointed by the Government for conducting prosecutions on behalf of the state in judicial proceedings of the High Court, Sessions Court, or Magistrate's Court.
- **Search warrant**: It is a written authority given to a police officer or any person by a competent magistrate or court for the search of any general or specified thing or document.
- **Statute**: The law passed by the legislature.
- **Statute of limitation**: The time period up to which a plaintiff may file a lawsuit.
- **Suit**: A civil proceeding in a court of law.
- **Trial**: It is a legal process in accordance with the law whereby the question of guilt or innocence of any person accused of an offence is determined.
  - **Court trial** – A trial without a jury, where a judge determines the facts as well as the law.
- **Verdict**: The formal decision or finding made by a judge or jury at the end of a trial. The verdict may be in favour of either the plaintiff or defendant.

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Box 1.7 **Some Important Sections of the Indian Penal Code**

Section	Offence
44	**Injury**: Any harm whatever illegally caused to any person, in body, mind, reputation or property.
82	**Act of a child under 7 years of age**: Nothing is an offence which is done by a child under 7 years of age.
83	**Act of a child above 7 and under 12 of immature understanding:** Nothing is an offence which is done by a child between 7 and 12 years, who has not attained sufficient maturity of understanding to judge the nature and consequences of his conduct on that occasion.
84	**Act of a person of unsound mind (McNaughten Rule)**: Nothing is an offence which is done by a person who, at the time of doing it, by reason of unsoundness of mind, is incapable of knowing the nature of the act, or that he is doing what is either wrong or contrary to law.
85	**Act of a person intoxicated involuntarily**: Nothing is an offence which is done by a person who, at the time of doing it, is, by reason of intoxication, incapable of knowing the nature of the act, or that he is doing what is either wrong, or contrary to law: provided that the thing which intoxicated him was administered to him without his knowledge or against his will.
86	**Act of a voluntarily intoxicated person**: A person who commits an offence in a state of intoxication shall be culpable if he had voluntarily consumed the thing which intoxicated him.
87	**Act not intended to cause death or grievous hurt, done by consent**: Nothing which is not intended to cause death, or grievous hurt, and which is not known by the doer to be likely to cause death or grievous hurt, is an offence by reason of any harm which it may cause to any person, above 18 years of age, who has given consent to suffer that harm. Example: taking part in a boxing match which results in the death of one of the participants.
88	**Act not intended to cause death, done by consent in good faith for person's benefit**: Nothing, which is not intended to cause death, is an offence by reason of any harm which it may cause to any person for whose benefit it is done in good faith, and who has given consent to suffer that harm, or to take the risk of that harm. Example: A surgeon, knowing that a particular operation can cause the death of his patient, conducts the procedure intending, in good faith, his patient's benefit, and performs it with the latter's consent, is not culpable if some harm or even death results.
89	**Act done in good faith for benefit of child or insane person**: Nothing which is done in good faith for the benefit of a person under 12 years of age, or of unsound mind, by consent of the guardian, is an offence by reason of any harm which it may cause to that person.
92	**Act done in good faith for benefit of a person without consent**: Nothing is an offence by reason of any harm which it may cause to a person for whose benefit it is done in good faith, even without that person's consent, if the circumstances are such that it is impossible for that person to signify consent. Example 1: A surgeon, sees a child suffer an accident which is likely to prove fatal unless an operation be immediately performed, and there is no time to apply to the child's guardian for consent, performs the operation intending, in good faith, the child's benefit, he has committed no offence. Example 2: A person is carried off by a tiger. Another person fires at the tiger knowing it to be likely that the shot may kill the victim, but not intending to kill him, in good faith intending his benefit, inflicts a mortal wound, he has committed no offence.
166B	**Punishment for non-treatment of victim**: Whoever, being in charge of a hospital, public or private, whether run by the Central Government or the State Government, contravenes the provisions of

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362	**Abduction**: Whoever by force or deceit compels any person to go from any place, is said to have committed the offence of abduction.
363	**Punishment for kidnapping**: Up to 7 years.
364	**Kidnapping or abducting in order to murder**: 10 years to life in prison.
364 A	**Kidnapping for ransom, etc**: If this is associated with threat of harm or death to the kidnapped person if ransom is not paid, it is punishable with life imprisonment or death sentence.
366	**Kidnapping or abducting a woman to compel her for marriage, etc**: 10 years.
366 A	**Procuration of minor girl**: Whoever induces any minor girl (under 18 years) to go from any place with intent that it is likely that she will be forced or seduced to illicit intercourse with another person shall be punishable with imprisonment which may extend to 10 years.
366B	**Importation of girl from foreign country**: Whoever imports into India from any country or from Jammu and Kashmir any girl (under 21 years) with intent that it is likely that she will be forced or seduced to illicit intercourse with another person shall be punishable with imprisonment which may extend to 10 years.
375	**Rape** *(page 408)*
376	**Punishment for rape**: 7 years to life in prison. If it is a case of custodial or statutory rape *(page 409, 416)*, or rape on a minor or pregnant woman or mentally unsound woman, or repeated rape on a woman, punishment is 10 years to life.
376A	**Punishment for causing death, or persistent vegetative state of victim**: In the course of rape, if the man inflicts an injury which causes the death of the woman or causes her to be in a persistent vegetative state, shall be punished with imprisonment of 20 years to life.
376B	**Sexual intercourse by husband upon his wife during separation**: 2 to 7 years.
376C	**Punishment for custodial rape**: Intercourse by a man in a position of authority over a woman, e.g., superintendent of jail, remand home, hospital, etc., by seducing or inducing or forcing her for sex. Punishment - 5 to 10 years.
376D	**Gang rape**: Where a woman is raped by one or more persons constituting a group, each of those persons shall be deemed to have committed the offence of gang rape, and shall be punished with imprisonment for a term not less than 20 years, but which may extend to life.
376E	**Punishment for repeat offenders of rape**: Whoever has been previously convicted of rape, and is subsequently convicted of the same offence, shall be punished with imprisonment for life, or with death.
377	**Unnatural offences** *(page 428)*.
497	**Adultery**: Whoever has sexual intercourse with a person who is the wife of another man, without the consent of that man, such sexual intercourse not amounting to rape, is guilty of the offence of adultery, and shall be punished with imprisonment up to 5 years, or with fine, or with both. In such case the wife shall not be punishable as an abettor.
498	**Enticing or taking away with criminal intent a married woman**: Whoever takes or entices away any woman who is the wife of another man, with intent that she may have illicit intercourse with any person, shall be punished with imprisonment which may extend to 2 years, or with fine, or with both.
498A	**Punishment for subjecting a married woman to cruelty**: Whoever, being the husband or the relative of the husband of a woman, subjects her to cruelty shall be punished with 3 years imprisonment.
509	**Word, gesture or act intended to insult the modesty of a woman**: up to 3 years.

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Box 1.8 **Some Important Sections of the Criminal Procedure Code (CrPC) and the Indian Evidence Act (IEA)**

I. CRIMINAL PROCEDURE CODE (CrPC)

1. **Section 53: Examination of accused by medical practitioner at the request of a police officer**
   - When a person arrested on a charge of committing an offence of such a nature and under such circumstances that there are reasonable grounds for believing that an examination of his person will offer some evidence, it shall be lawful for a registered medical practitioner, acting at the request of a police officer not below the rank of sub-inspector, to make such an examination of the person arrested as is reasonably necessary in order to ascertain the facts, and to use such force as reasonably necessary for that purpose.
   - Whenever the person of a female is to be examined under this section, the examination shall be made only by, or under the supervision of, a female registered medical practitioner.

   Explanation
   - The term "examination" shall include examination of blood, blood stain, semen, swabs in case of sexual offences, sputum and sweat, hair samples, and fingernail clippings by the use of modern and scientific techniques including DNA profiling, and such other tests which the registered medical practitioner thinks necessary in a particular case
2. **Section 53A: Examination of person accused of rape, by a medical practitioner**
   - When a person is arrested on a charge of committing an offence of rape, and there are reasonable grounds for believing that an examination of his person will afford evidence as to the commission of such offence, it shall be lawful for a registered medical practitioner acting at the request of a police officer not below the rank of a sub-inspector, to make such an examination of the arrested person, and to use such force as is reasonably necessary for that purpose.
   - The registered medical practitioner conducting such examination, shall without delay, examine such person and prepare a report of his examination, and forward the report to the investigating officer, who shall forward it to the magistrate.
3. **Section 161: Examination of witness by police**
   - Any police officer making an investigation under this section may examine orally any person supposed to be acquainted with the facts and circumstances of the case.
   - Such person shall be bound to answer truly all questions relating to such case put to him by such officer, other than questions the answers to which would have a tendency to expose him to a criminal charge or to a penalty or forfeiture.
   - The police officer may reduce into writing any statement made to him in the course of an examination under this section; and if he does so, he shall make a separate and true record of the statement of each such person whose statement he records.
4. **Section 174: Inquiry by police officer into cause of death**
   - When the officer in charge of a police station, receives information that a person has committed suicide, or has been killed by another, or by an animal, or by a machinery, or by an accident, or has died under circumstances raising a reasonable suspicion that some other person has committed an offence, he shall immediately give intimation thereof to the nearest Executive Magistrate empowered to hold inquest, and shall proceed to the place where the body of such deceased person is, and there, in the presence of two or more respectable inhabitants of the neighbourhood, make an investigation, and

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draw up a report of the apparent cause of death, describing such wounds, as may be found on the body, and stating in what manner, or by what weapon or instrument (if any), such wounds appear to have been inflicted.

- The report will be signed by such police officer and other persons, and shall be forthwith forwarded to the District Magistrate or the Sub-divisional Magistrate.
- When
  1. The case involves suicide by a woman within seven years of her marriage; or
  2. The case relates to the death of a woman within seven years of her marriage in any circumstances raising a reasonable suspicion that some other person committed an offence in relation to such woman; or
  3. The case relates to the death of a woman within seven years of her marriage and any relative of the woman has made a request in this behalf; or
  4. There is any doubt regarding the cause of death; or
  5. The police officer for any other reason considers it expedient so to do, he shall subject to such rules as the State Government may prescribe in this behalf, forward the body with a view to its being examined, to the nearest Civil Surgeon, or any other qualified medical man.

5. **Section 176: Inquiry by magistrate into cause of death**
   - When the case is of the nature referred to in sub-sections 1 to 3 of **Section 174**, the nearest Magistrate empowered to hold inquests shall hold an enquiry mentioned into the cause of death, either instead of, or in addition to, the investigation held by the police officer.
   - Where:
     a) any person dies or disappears while he is in the custody of the police, or in any other custody authorised by the Magistrate or the Court, or
     b) rape is alleged to have been committed on any woman, while such person or woman is in the custody of the police or in any other custody authorised by the Magistrate or the Court, either instead of, or in addition to the inquiry or investigation held by the police, an inquiry shall be held by the Judicial Magistrate or the Metropolitan Magistrate, as the case may be, within whose local jurisdiction the offence has been committed
   - The Magistrate holding such an inquiry shall record the evidence taken by him in connection therewith in any manner hereinafter prescribed according to the circumstances of the case.
   - Whenever such Magistrate considers it expedient to make an examination of the dead body of any person who has been already buried, in order to discover the cause of his death, the Magistrate may cause the body to be exhumed and examined.
   - The Judicial Magistrate or the Metropolitan Magistrate or the Executive Magistrate or police officer holding an inquiry or investigation, as the case may be shall, within twenty-four hours of the death of a person, forward the body with a view to its being examined to the nearest Civil Surgeon or other qualified medical man appointed in this behalf by the State Government, unless it is not possible to do so for reasons to be recorded in writing.

6. **Section 327 (Amended as per Code of Criminal Procedure [Amendment] Act, 2008)**
   The court examination of a survivor of sexual assault must be conducted **in camera** - which means that there will be no general public present there. The only people present will be the Judge, the Public Prosecutor, the defense lawyer, and the staff of the court.

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7. **Section 357C: Treatment of victims**

All hospitals, public or private, whether run by the Central Government, the State Government, local bodies or any other person, shall immediately provide first-aid or medical treatment, free of cost, to the victims of any offence covered under section 326A, 376, 376A, 376B, 376C, 376D or section 376E of the Indian Penal Code, and shall immediately inform the police of such incident.

II. INDIAN EVIDENCE ACT (IEA)

1. **Section 45: Opinion of experts**
   - When the court has to form an opinion upon a point of foreign law, or science or art, the opinion upon that point of persons specially skilled in such foreign law, science or art, are relevant facts. Such persons are called experts.
2. **Section 113 A: Presumption as to abetment of suicide by a married woman**
   - When the question is whether the commission of suicide by a woman had been abetted by her husband or any relative of her husband, and it is shown that she had committed suicide within a period of seven years from the date of her marriage, and that her husband or such relative or her husband had subjected her to cruelty, the court may presume, having regard to all other circumstances of the case, that such suicide had been abetted by her husband or by such relative or her husband.
3. **Section 113 B: Presumption as to dowry death**
   - When the question is whether a person has committed dowry death of a woman, and it is shown that soon before her death, such woman had been subjected by such person to cruelty or harassment for, or in connection with, any demand of dowry, the court shall presume that such person had caused the dowry death.
4. **Section 114 A: Presumption as to absence of consent in certain prosecutions for rape**
   - In a prosecution for rape under clause (a) or clause (b) or clause (d) or clause (e) or clause (g), or subsection (2), of Section 376 of the Indian Penal Code, where sexual intercourse by the accused is proved, and the question is whether it was without consent of the woman alleged to have been raped, and she states in her evidence before the court that she did not consent, the Court shall presume that she did not consent.
5. **Section 137: Procedures in examining witness in a court of law**
   - Examination-in-chief – The examination of a witness by the party who calls him shall be called his examination-in-chief.
   - Cross examination – The examination of witness by the adverse party shall be called cross examination
   - Re-examination – The examination of a witness by the party who called him, subsequent to the cross examination, shall be called his re-examination
6. **Section 138: Order of examinations**
   - Witnesses shall be first examined-in-chief, then (if the adverse party so desires) cross-examined, then (if the party calling him so desires) re-examined.
   - The chief examination and cross examination must relate to relevant facts, but the cross-examination need not be confined to the facts to which the witness testified on his examination-in-chief.
   - Direction of reexamination – The re-examination shall be directed to the explanation of matters referred to in cross examination; and, if new matter is, by permission of the Court, introduced in re-examination, the adverse party may further cross-examine upon that matter.

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7. **Section 141: Leading questions:** Any question suggesting the answer which the person putting it wishes or expects to receive, is called a leading question.
8. **Section 142: When leading questions must not be asked**
   - Leading questions must not, if objected to by the adverse party, be asked in an examination-in-chief.
9. **Section 143: When leading questions may be asked**
   - Leading questions may be asked in cross-examination.
10. **Section 146: Questions lawful in cross-examination**
    - When a witness is cross-examined, he may, in addition to the questions herein before referred to, be asked any questions which tend
      - to test his veracity
      - to discover who he is, and what is his position in life, or
      - to shake his credibility, although the answer to such question might
      - tend directly or indirectly to incriminate him, or might expose or tend
      - directly or indirectly to expose him to a penalty or forfeiture.
      - provided that in prosecution for rape or attempt to commit rape, it shall not be permissible to put questions in the cross examination of the prosecutrix as to her general immoral character
11. **Section 148: Court to decide when a witness is compelled to answer**
    - If any such question relates to a matter not relevant to the suit or proceeding, except in so far as it affects the credibility of the witness by injuring his character,
      the court shall decide whether or not the witness shall be compelled to answer it, and may, if it thinks fit, warn the witness he is not obliged to answer it.
12. **Section 151: Indecent and scandalous questions**
    - The court may forbid any questions or inquiries which are regarded as indecent or scandalous, although such questions or inquiries may have some bearing on the questions before the court, unless they relate to a fact in issue, or to matters necessary to be known, in order to determine whether or not the fact in issue existed.
13. **Section 159: Refreshing memory**
    - A witness, while under examination, can refresh his memory when he is questioned, or so soon afterwards that the Court considers it likely that the transaction was atthat time fresh in his memory.
    - The witness may also refer to any such writing made by another person, and read by witness within the time aforesaid, if when he read it he knew it to be correct.
    - When witness may use copy of document to refresh memory – Whenever a witness may refresh his memory by reference to any document, he may, with the permission of the Court, refer to a copy of such document, provided the court be satisfied that there is sufficient reason for the non-production of the original.
    - An expert may refresh his memory by reference to professional treatises.

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CHAPTER 2

Medical Law and Ethics

Ignorance of the law excuses no man. Not that all men know the law, but because it is an excuse every man can plead, and no one can refute him.

—John Selden (1584–1654); English Jurist

MEDICAL JURISPRUDENCE

('*Juris*' = law, and '*Prudence*' = knowledge)

Medical jurisprudence is the study of law in relation to medicine. In other words, *it deals with the legal aspects of medicine such as the legal rights, privileges, duties, and obligations of a medical practitioner.*

- Medical practitioners must be aware of legal implications of their medical practice. They should be familiar with the various statutes, rules and regulations that are in force, and which have been enacted by the Central or State government, as well as possess a working knowledge of the functioning of statutory bodies & Medical Councils.

Indian Medical Council

- The Indian Medical Council (IMC) or Medical Council of India (MCI) is a body that is intimately concerned with the medical profession, and is governed by the **Indian Medical Council Act (1956) (modified in 1964, 1993 and 2001, and amended in 2010, 2011, and 2012).**
- It consists of a number of members elected from various states and universities of India, and some members nominated by the Government of India.
  - These members hold office for a period of 5 yr.
  - They elect a President and a Vice-President from among themselves.
- The council also appoints a Registrar and a Secretary for day-to-day functioning.
- **The MCI was disbanded in 2010, and functioned under a Board of Governors until 2012, when a new council was formed.**

Functions of the Indian Medical Council

1. **Medical Register**
   - The Indian Medical Council (IMC) maintains a register. The register contains the names, addresses, and qualifications of all medical practitioners who have registered themselves with any state medical council.
   - When a medical graduate with a recognised medical qualification registers himself with any State Medical Council (SMC) after paying the prescribed fee, notification is sent to the IMC and his name gets registered in the Indian Medical Register also.
   - Similarly, if the name of a medical practitioner is erased from the State Medical Register for any reason, it is automatically deleted from the Indian Medical Register also.
2. **Medical Education**
   - The IMC regulates the standards of medical education. It appoints a committee for both undergraduate and postgraduate education.
     - The respective committee appoints inspectors to visit various institutions. The purpose of such a visit is to assess the facilities provided by the institutions, and to find out whether they are on par with the specifications prescribed by the IMC.
     - Inspectors are also required to visit these institutions during examinations, in order

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to assess the standard of such examinations.
- On the basis of the report made by the inspectors, the council recommends to the Government of India, recognition or de-recognition of a particular institution. Often, degrees are de-recognised only temporarily, and guidelines are given on ways and means of improving the standards in order to obtain recognition subsequently.
- The recommendation of the council is mandatory for the Central Government to act, either for recognising or de-recognising an institute, or a degree awarded by an institute.

3. **Recognition of Foreign Medical Qualifications:**
The IMC maintains **three schedules**:
- **First schedule** contains a list of medical degrees offered by different universities in India, which are recognised by the council.
- **Second schedule** contains a list of medical degrees offered by different universities outside India, which are recognised by the council.
- **Third schedule** has two parts:
  - ***Part 1*** contains a list of medical qualifications conferred by Indian universities or institutions which are not mentioned in the first schedule.
  - ***Part 2*** contains a list of medical qualifications of foreign universities, not mentioned in the second schedule.

These degrees may be recognised when Indian citizens obtain them, and apply to the council individually for recognition. A separate examination may be conducted by the council to assess the standard of knowledge possessed by such candidates, before recognizing their foreign degree.

4. **Apellate Tribunal**
The IMC acts as an appellate tribunal:
- If any registered medical practitioner who has been penalised by any SMC desires to appeal against such punishment, he can make a representation to the Central Government, which will subsequently consult the IMC.
- The IMC will examine the facts of the case, and then furnish its recommendations to the Central Government, which will be binding on the appealing party as well as the SMC concerned.

5. **Disciplinary Control**
- The IMC exercises disciplinary control over members of the medical profession. The council prescribes minimum standards of professional conduct, ethics, and etiquette.
- It issues a **warning notice** periodically, which is a list of offences constituting infamous conduct (professional misconduct). However, this list is not a complete one, and any other offence which is considered as dishonourable and disgraceful by professional colleagues of good repute, can also be brought under its purview.

State Medical Council

- Every state in India has a State Medical Council (SMC), located usually in the capital of that state.
- It is composed of members of the medical profession elected from among themselves, as well as those nominated by the State Government.
  - A President and a Vice President are elected by the members from amongst themselves.

Functions of the State Medical Council

1. **Medical Register**
- The SMC maintains a register containing the names, addresses, and qualifications of those medical practitioners who have registered with the council.
- It also contains the date on which a particular degree was obtained, and the name of the university which conferred it.
- This register is maintained by a Registrar who is appointed by the council. On receiving further qualifications, the medical practitioner concerned must inform the Registrar of the same.
- The Registrar is expected to inform the IMC without delay, all the additions and amendments made from time to time in the State Medical Register.

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2. **Disciplinary Control**
   - The council exercises disciplinary control over registered medical practitioners, and has the power to delete the names of those found guilty of professional misconduct. Such deletion may be temporary or permanent.
   - If an appeal is made by an aggrieved medical practitioner against the punishment awarded, and if the IMC makes a recommendation in favour of the appellant, his name will be restored in the State Medical Register.
3. **Warning Notice**

   The council makes clear disclosure of those practices it considers as constituting **infamous conduct** (Box 2.1). It issues a warning to the registered medical practitioners found indulging in unethical practice, and advises them to conduct themselves according to the ethical norms prescribed by the council.
   - It is important to note that a **warning notice** is different from a **warning**. The **warning notice** is a list of offences which are considered as infamous conduct (Box 2.1). This list is given to doctors at the time of registration with the State Medical Council, and later periodically.
   - On the other hand, a **warning** is a cautionary notice given by the SMC after judicial enquiry, on finding a doctor guilty of infamous conduct.

Procedure of Disciplinary Action

- The State Medical Council initiates disciplinary action in any of the following situations:
  i) When a complaint is made by a person or persons against a registered medical practitioner.
  ii) When a court of law convicts any registered medical practitioner for an offence involving moral turpitude.
- The complaint is received by the Registrar. He submits the complaint to the President who refers it to a subcommittee or an executive committee.
- The committee examines the complaint and decides whether it is necessary to take action against the medical practitioner concerned. If there is *prima facie* evidence of mis-demeanour, a notice is issued to the medical practitioner to be present on a specified day to face the charges.
- The defendant medical practitioner and his legal advisor should be present on the appointed day. First, the charges are read out with relevant details. The counsel for the complainant outlines the nature and substance of allegations with relevant evidentiary material. Then the defendant (registered practitioner) or his legal advisor rebuts the charges.
- After hearing both sides, the members of the council are asked to express their opinion. The judgement is based on the majority view.
- If the council finds *prima facie* evidence, and a majority of the members feel that the offence is proved, the guilty registered medical practitioner is punished in one of the following ways:
  i) **Warning**: A warning is issued to the medical practitioner to conduct himself according to the expectations of ethical standards prescribed by the council.
  ii) **Temporary erasure**: The name of the medical practitioner is erased from the register for a specified period after which it is restored.
  iii) **Penal erasure**: The name is permanently removed from the register. This is also known as *professional death sentence*.

Rights and Privileges of a Registered Medical Practitioner

There are certain rights and privileges that accrue to a medical practitioner as a result of registration in a medical council, and they are as follows:

1. Right to **practice the profession** anywhere in India
2. Right to **add professional titles** to his name.
3. Right to **choose patients**.
4. Right to **prescribe or dispense medicines**.
5. Right to **perform a surgical operation**.
6. Right to **seek government employment** as a doctor.

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Box 2.1 **List of Acts Mentioned in Warning Notice, Contravention of Which will Attract Disciplinary Action (Infamous Conduct, Professional Misconduct)**

1. ***Adultery or improper conduct or association with a patient***
2. ***Conviction by a court of law for offences involving moral turpitude***: Such offences include theft, perjury, bigamy, rape, etc.
3. ***Issuance of fraudulent professional certificates, reports, and other documents***

   Such documents include certificates and reports relating to:
   - Births, deaths, or disposal of the dead
   - Factory Acts
   - Workmen's Compensation Act
   - Employees' State Insurance Act
   - Mental Health Act
   - Public Health Act
   - Notifiable diseases
   - Sickness or fitness certificates

   Issuance of fraudulent certificates relating to any of the above will attract disciplinary action. A registered medical practitioner must maintain a Register of Medical Certificates in which all details must be entered of certificates issued. Whenever a medical certificate is issued, the identification marks of the patient must be mentioned, and his signature or thumb impression taken on the certificate or report.
4. ***Contravention of provisions of the Drugs Act***
5. ***Selling scheduled poisons or drugs*** to the public under the cover of his qualifications, except to his patients.
6. ***Association*** with unqualified person to perform abortion, or any illegal operation, or operations for which there is no medical or surgical indication.
7. ***Advertisement***
   - A physician should not contribute to the lay press articles, and give interviews regarding diseases and treatment which may have the effect of advertising himself or soliciting practice for himself. But there is no restriction on writing to the lay press under his own name on matters of public health and hygienic living, or to deliver public lectures, give talks on radio or public broadcast system for the same purpose, and send announcements of the same to the lay press.
   - An institution run by a physician for a particular purpose such as a maternity home, private hospital, etc., may be advertised in the lay press, but such advertisements should not contain anything more than the name of the institution, type of patients admitted, facilities offered, etc. Name of either the superintendent or the doctors attending to the patients should not appear in the advertisement.
   - It is improper for physicians to use a very large signboard, or write on a signboard anything other than his name, qualifications obtained from a university or statutory body, titles, and name of his specialty. It is improper to affix a signboard on a chemist's shop, or in places where he does not reside or work.
   - It is improper for a physician to exhibit publicly the scale of his fees. But there is no objection to the same being put up in the physician's waiting room or consultation chamber.
   - It is interesting to note that plastic surgeons in the US have moved out of the American Medical Association, and can freely and frequently advertise.
8. ***Contravention of professional secrecy***
   - A physician must not disclose the secrets of a patient that have been learnt in the exercise of his profession. Such matters can be disclosed only in a court of law under orders of the presiding judge.
   - A physician must not publish photographs or case reports of his patients in any medical or other journal in a manner by which their identity could be made out, without their permission. If the identity is not disclosed, consent is not necessary.

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9. *Refusal on religious grounds* to give assistance in matters relating to birth control, sterility, therapeutic abortion, etc., when there is medical indication.
10. *Failure to obtain consent* from husband, wife, parent, guardian, or patient himself, as the case may be, before performing a surgical operation. Consent of both husband and wife is mandatory for any operation that can result in sterility of either party.
11. *Employing touts or agents* to procure patients.
12. *False claims of specialist status*, unless the physician has undergone the requisite training programme in a recognized institute.

7. Right to **issue birth, sickness, insanity and other certificates** which will be held valid in a court of law.
8. Right to **give evidence as an expert witness** in a court of law.
9. Right to **possess, dispense, or prescribe drugs** listed in the **Dangerous Drugs Act**.
10. Right to **claim payment of fees** for professional services rendered.

What about Using the Red Cross Emblem?

- The objectives of the Red Cross Society are closely allied with those of the medical profession. This has led to the mistaken belief on the part of some medical practitioners, that they are entitled to use the Red Cross emblem. The Red Crescent emblem is used in 33 Islamic countries in place of the Red Cross, while Israel uses Red Crystal emblem (Fig. 2.1a, b & c).

| Fig. 2.1a Red Cross Emblem |

- This belief is erroneous, and in fact the law prohibits its misuse by medical practitioners.
- The right to display the Red Cross emblem (a red cross on a white background) can be exercised only by the members of the medical division of the armed forces of a country and the Red Cross Society.

| Fig. 2.1b Red Crescent Emblem |

| Fig. 2.1c Red Crystal Emblem |

- As per the **Geneva Convention Act 1960** (to which India is a signatory), *Sec. 12* prohibits the use of the Red Cross emblem and all other allied emblems for any purpose whatsoever, without approval of the Government of India, while *Sec 13* lays down the penalty for unauthorised use.
- The punishment may take the form of a fine (up to Rs.500), as well as forfeiture of the goods upon or in connection with which the emblem, designation, or wording was used by that person.

The Indian Medical Council Act, 1956 is set to be repealed shortly, and a new regulatory body is planned to be passed by the Indian Parliament, now referred to as the **National Medical Commission Bill**. When passed by both Houses of Parliament,

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it will be known as the **National Medical Commission Act, 2016**. Important provisions are mentioned in Box 2.2.

MEDICAL ETHICS

Medical ethics deals with moral principles which should guide the members of the medical profession in their dealings with each other, with their patients, and with the state.

A survey of the actual texts of the various 'Oaths' as applicable to medical practitioners, can serve as an introduction to medical ethics.

The general principles mentioned in the **Hippocratic Oath** were brought up-to-date by the World Medical Association several years ago. The modernised versions of the Hippocratic Oath comprise the **Declaration of Geneva** (as adopted by the third General Assembly of the World Medical Association at Geneva, Switzerland, in **September 1948**), and the **International Code of Medical Ethics** (as adopted by the fourth General Assembly of the World Medical Association held in London, in **October 1949**). Each country has its own code of ethics, usually modelled on the lines of the International Code. In fact, India can boast of an oath proposed by **Charaka**, roughly 4700 years ago!

*The reader is advised to consult the Annexures at the end for a detailed elaboration of the important 'Oaths' and 'Codes' in relation to the medical profession (**Annexure 2**, page 742). The full text of the **Indian Medical Council (Professional Conduct, Etiquette, and Ethics) Regulations 2002** has been incorporated as **Annexure 3** (page 745) at the end of the book. This was published in the Gazette of India dated **6th April 2002**, and has therefore come into effect from that date. It is imperative that every doctor familiarises himself with these regulations and abides by them scrupulously.*

The Indian Code of Medical Ethics is summarised below:

The Indian Code of Medical Ethics

(as framed by the Medical Council of India)

Declaration

1. I solemnly pledge myself to consecrate my life to the service of humanity.
2. Even under threat, I will not use my medical knowledge contrary to the laws of humanity.
3. I will maintain the utmost respect for human life from the time of conception.
4. I will not permit considerations of religion, nationality, race, party politics, or social standing to intervene between my duty and my patient.
5. I will practise my profession with conscience and dignity.
6. The health of my patient will be my first consideration.
7. I will respect the secrets which are confided in me.
8. I will give to my teachers the respect and gratitude which is their due.
9. I will maintain by all means, the honour and noble traditions of the medical profession.
10. I will treat my colleagues as my own brothers.

Code

General Principles

1. ***Character of the physician***
   - The prime objective of the medical profession is to render service to humanity; reward of financial gain is a subordinate consideration.
   - Whoever chooses this profession assumes the obligation to conduct himself in accordance with its ideals. He must keep himself pure in character and be diligent in caring for the sick.

2. ***The physician's responsibility***
   - Physicians should merit the confidence of patients entrusted to their care, rendering to each a full measure of service and devotion.
   - They should continuously try to improve medical knowledge, and should make available to their patients and colleagues the benefits of their professional attainments.

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Box 2.2 National Medical Commission Act, 2016

Constitution and Composition of the National Medical Commission

The Central Government shall constitute the National Medical Commission, which will comprise a Chairperson, a Member Secretary, 8 ex-officio members and 10 part time members. Of the ex-officio members, 4 shall be the Presidents of the Boards constituted under this Act; and the remaining 4 shall be nominees. Of the part-time members, 5 shall be persons to be appointed by the Central Government from diverse backgrounds including management, economics, law, consumer or patient rights advocacy, health research, science and technology. The remaining 5 part-time members shall be from amongst the nominees of the States and Union Territories in the Medical Advisory Council, who shall be appointed on a rotational basis for two-year terms by the Central Government.

There shall be a Secretariat for the Commission to be headed by the Member Secretary of an appropriate rank, who shall be the ex-officio Secretary to the Commission. The Member Secretary shall discharge such functions as may be specified under the regulations made by the Commission.

The Chairperson of the Commission or the part-time Members shall hold office for a term, not exceeding 4 years. The Presidents of the Boards shall also hold office for a term not exceeding 4 years. The Chairman, part-time Members and the President of the Boards shall be eligible for re-appointment for another term of 4 years. The maximum term of a person as the Chairperson, President of the Board and/ or Member shall not exceed 8 years in aggregate.

Power and Functions of National Medical Commission

1. Assess the changing requirements of the health care scenario, human resources for health, health care infrastructure and develop a road map for meeting these requirements.
2. Frame requisite policies for the governance of Medical Education.
3. Frame regulations for smooth working of the Commission and the Boards without undermining the autonomy of the Boards and within the provisions of this Act and Rules framed under it.
4. Provide overarching policy coordination among the Boards with due regard to their autonomy.
5. Ensure that State Councils effectively enforce the provisions of the Act and in event of inaction on their part, take such action as it deems fit to ensure compliance.
6. Exercise Appellate Authority with respect to decisions of the UGMEB, PGMEB and MARB *(see below)*.
7. Prescribe norms for determination of fees for a proportion of seats, not exceeding 40%, in the Private Medical Educational Institutions.

There shall be a uniform **National Eligibility-cum-Entrance Test (NEET)** for admission to under-graduate medical education under the purview of National Medical Commission through such designated authority in Hindi, English and such other languages and in such manner as may be prescribed and the designated authority shall ensure the conduct of uniform entrance examination in the aforesaid manner.

There shall be a **National Licentiate Examination** for the professionals graduating from the Medical Institutions under the purview of National Medical Commission through such designated authority in such manner as may be prescribed for granting the license to practice and enrolment into the Medical Register(s). The designated authority shall ensure the conduct of uniform licentiate examination in the aforesaid manner. The National Licentiate Examination shall also serve as a National Eligibility-cum-Entrance Test for admission into post-graduate courses in medical colleges/ institutions under the purview of National Medical Commission.

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Under-Graduate Medical Education Board (UGMEB)

The Central Government shall establish the Under-Graduate Medical Education Board (UGMEB), which shall be autonomous in its functioning subject only to the policies and regulations framed by the NMC. It will be headed by a full- time President who will be assisted by such other staff from the NMC Secretariat as may be sanctioned under the Rules.

Powers and Functions of UGMEB

1. Determine and prescribe standards and oversee all aspects of medical education at undergraduate level.
2. Develop a competency based dynamic curriculum (including assessment) at undergraduate level in consultation with stakeholders such that medical graduates have appropriate knowledge, skills, attitude, values and ethics for providing health care, as per the societal needs.
3. Prescribe guidelines for setting up medical institutions for imparting under-graduate courses in alignment with needs of the country while keeping in mind global norms.
4. Determine and prescribe the minimum requirements and standards for conduct of courses and examinations for under graduates in medical institutions
5. Determine and prescribe standards and norms for infrastructure, faculty and quality of education in institutions conducting under-graduate medical education.
6. Facilitate development/training for the faculty teaching undergraduate courses.

Post-Graduate Medical Education Board (PGMEB)

The Central Government shall establish the Post-Graduate Medical Education Board (PGMEB), which shall be autonomous in its functioning subject only to the policies and regulations framed by the NMC. It shall be headed by a full- time President who shall be assisted by such other staff from the NMC Secretariat as may be sanctioned under the Rules.

Powers and Functions of PGMEB

1. Determine and prescribe standards and oversee all aspects of medical education at the postgraduate and super-speciality levels.
2. Develop a competency based dynamic curriculum (including assessment) at post-graduate level in consultation with stakeholders such that postgraduates have appropriate knowledge, skills, attitude, values and ethics for providing health care, imparting medical education and conducting medical research.
3. Prescribe guidelines for setting up medical institutions for imparting postgraduate/ super-speciality courses as per the needs of the country while keeping in mind global norms.
4. Determine and prescribe the minimum requirements and standards for conduct of all post graduate and super specialty courses and their examinations in Medical Institutions.
5. Determine and prescribe standards and norms for infrastructure, faculty and quality of education in institutions conducting post-graduate and super-speciality medical education.
6. Facilitate development/training for the faculty of post-graduate courses.

Medical Assessment and Rating Board (MARB)

The Central Government shall establish the Medical Assessment and Rating Board (MARB). Subject only to the policies and the regulations framed by the NMC, the Board shall be autonomous in its functioning. It shall be headed by a full- time President who shall be assisted by such other staff from the NMC Secretariat as may be sanctioned under the Rules.

contd.

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Powers and Functions of MARB

1. Determine the process of Assessment and Rating of Medical Educational Institutions as per the standards laid down by the UGMEB or PGMEB, as the case may be.
2. Hire such credible third party agencies or to appoint such visitors and personnel as it may consider necessary to carry out inspections of the Medical Educational Institutions in order to discharge its Assessment and Rating Function.
3. Conduct an Assessment and Rating of all Medical Educational Institutions, within such period of their start, as may be prescribed, and every year thereafter, and to make it available in the public domain at regular intervals.
4. Levy monetary and other such penalties on Institutions which fail to maintain the minimum essential standards. In case a Medical Educational Institution fails to take the necessary corrective actions even after three monetary penalties, MARB shall recommend to the NMC to initiate proceedings for derecognizing the degree/ degrees awarded by the Institution.

Board for Medical Registration (BMR)

The Central Government shall establish the Board for Medical Registration (BMR). Subject to the policies and the regulations framed by the NMC, the Board shall be autonomous in its functioning. The Board shall comprise a President and two Part-time Members of the Commission nominated by the Chairperson of the Commission. The Board shall be assisted by such other staff from the NMC Secretariat as may be sanctioned under the Rules.

Powers and Functions of BMR

1. The BMR shall maintain a live National Register of all licensed medical practitioners to be known as the National Register. The register shall contain the name, address, date of birth, Aadhaar ID of and all qualifications recognized by UGMEB and PGMEB possessed by the licensed practitioner.
2. The National Register must be maintained in an electronic form as per prescribed rules. Such Register shall be made available in the public domain.
3. Every State Medical Council shall maintain and regularly update the State Register in an electronic format. It shall supply a physical copy of the same to the BMR at the commencement of this Act. Thereafter, the National and the State Register should be in Electronic synchronization so that a change in one is automatically reflected in the other.
4. Where the name of any person has been removed from a State Register on a ground other than non-possession of the requisite medical qualifications, he may appeal in the prescribed manner to the BMR, whose decision shall be binding on the State Council.
5. Prescribe the standards of professional conduct and frame a Code of Ethics for medical practitioners.
6. Ensure compliance to the Code of Ethics through the State Councils which shall take disciplinary action in cases of professional misconduct by medical practitioners and Organisations/ Associations of Doctors.
7. BMR will have an appellate jurisdiction over the orders passed by the State Councils, and such an order would be binding upon the State Council.

Please note that until such time that the National Medical Commission Act comes into force and the new Commission drafts its own regulations, the Indian Medical Council (Professional Conduct, Etiquette, and Ethics) Regulations 2002 will continue to be operational.

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3. ***Advertising***
   - Solicitation of patients either directly or indirectly by a physician, group of physicians, or institutions is unethical.
   - A physician shall not make use of lay channels so as to invite attention to himself or to his professional position, skill, qualifications, or achievements, that could result in his self-promotion. A medical practitioner is however permitted a formal announcement in press regarding the following:
     - When starting practice
     - Change of type of practice
     - Change of address
     - Temporary absence from duty
     - Resumption of practice
4. ***Payment for professional service***
   - Remuneration received for his service should be in the form and amount specifically announced to the patient at the time the service is rendered.
   - It is unethical to enter into a contract of "no cure, no payment."
5. ***Patents and copyrights***
   - A physician may patent surgical instruments, appliances, and medicines, or copyright applications, methods, and procedures. The use of such patents or copyright, or the receipt of remuneration from them which retards or inhibits research, or restricts the benefits derivable therefrom are unethical.
6. ***Running an open shop (dispensing drugs and appliances) by physicians***
   - A physician should not run an open shop for sale of medicines prescribed by physicians other than himself, or for sale of medical and surgical appliances.
7. ***Rebates and commissions***
   - A physician shall not give, solicit, or receive, nor shall he offer to give, solicit, or receive any gift, commission, or bonus with respect to referring, recommending, or procuring of any patient for medical, surgical or other treatment.
   - Nothing in this section however, shall prohibit payment of salaries by a qualified physician to other duly qualified person rendering medical care under his supervision.
8. ***Secret remedies***
   - The prescribing or dispensing by a physician of secret medicines or other secret remedial agents of which the composition is not revealed, or the manufacture or promotion of such products is unethical.
9. ***Evasion of legal restrictions***
   - The physician will observe the laws of the country in regulating the practice of medicine, and will not assist others to evade such laws.
   - He should be cooperative in the observance and enforcement of sanitary laws and regulations in the interests of public health. A physician should observe the provisions of State Acts such as Drugs Act, Rules, and Regulations made by the General Govt/State Govt, or local administrative bodies for the protection and promotion of public health.
10. ***Obligations to the sick***
    - Though a physician is not bound to treat each and everyone asking for his service except during emergencies, for the sake of humanity and the noble traditions of the profession, he should not only be ever ready to respond to the call of the sick and the injured, but should be mindful of the high character of his mission, and the responsibility he incurs in the discharge of his professional duties.
11. ***Patience, delicacy and secrecy***
    - Patience and delicacy should characterize the physician.
    - Confidence concerning individual or domestic life, entrusted by patients to the physician, and defects in the disposition or character of patients observed during medical attendance should never be revealed, unless their revelation is required by laws of the state.
12. ***Prognosis***
    - The physician should neither exaggerate nor minimize the gravity of a patient's condition. He should assure himself that the patient, his

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relatives, or his responsible friends have such knowledge of the patient's condition as will serve the best interests of the patient and his family.

13. ***Treatment rules***
   - Once having undertaken a case, the physician should not neglect the patient, nor withdraw from the case without giving notice to the patient or his relatives, sufficiently long in advance, of his withdrawal, to allow them to secure another medical attendant.

14. ***Upholding the profession***
   - All physicians are expected to uphold the dignity and honour of the profession.

15. ***Membership in societies***
   - For the advancement of his profession, a physician should affiliate with medical societies and contribute his time, energy, and means, so that these societies may represent the ideals of the profession.

16. ***Safeguarding the profession***
   - Every physician should aid in safeguarding the profession against admission to it of those who are deficient in moral character or education.
   - A physician should not employ in connection with his professional practice, any attendant who is neither registered nor enlisted under the Medical Act in force, and should not permit such persons to attend, treat, or perform operations upon patients in respect of matters regarding professional discretion or skill, as it is dangerous to public health.

17. ***Exposure of unethical conduct***
   - A physician should expose without fear or favour, incompetent or corrupt, dishonest, or unethical conduct on the part of members of the profession.

18. ***Dependence of physicians on each other***
   - Though there is no rule that a physician should not charge another physician for his services, he should cheerfully and without recompense give his professional services to other physicians or his dependents, if they are in his vicinity.

19. ***Compensation of expenses***
   - A physician should consider it a pleasure and privilege to render free service to all other physicians and their immediate family dependents.
   - When a physician is called from a distance to attend or advise another physician or his dependents, reimbursement should however be made of traveling and other incidental expenses.

20. ***Consultations:*** In case of serious illness, especially in doubtful or difficult conditions, the physician should request consultation.

   Rules relating to consultation:
   - In every consultation, the benefit to the patient must be of first importance.
   - Utmost punctuality must be observed in meetings for consultation.
   - With reference to consultations, no insincerity, rivalry, or envy should be indulged in. Due respect should be observed towards the physician in charge of the case, and no statement or remark be made which would impair the confidence reposed in him.
   - Difference in opinion should not be divulged unnecessarily, but should be expressed frankly and impartially.
   - When a physician has been called as a consultant, none but the rarest and most exceptional circumstances would justify that consultant taking charge of the case. He must not do so merely on the solicitation of the patient or his friends.
   - When a patient is referred to a specialist by the attending physician, a statement of the case should be given to the specialist who should communicate his opinion in writing in a closed cover directly to the attending physician.

21. ***Appointment of substitute***
   - Whenever a physician requests another physician to attend to his patients during his temporary absence from his practice, professional courtesy requires the acceptance of such appointment consistent with his other duties.
   - The physician acting under such an appointment should give the utmost consideration to

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the interests and reputation of the absent physician.

- All such patients should be restored to the care of the latter upon his return.

22. ***Visiting another physician's case:*** A physician called to visit a patient who has recently been under the care of another physician for the same illness should not take charge of, nor prescribe for such patient, except
    a) in case of emergency, when he should communicate to the former explaining the circumstances under which the patient was seen and treatment given,
    b) or when the physician has relinquished his case,
    c) or when the patient has notified such physician to discontinue his services.
23. ***Obstetric cases***
    - If a physician agrees to attend to a woman during her pregnancy, he must make himself available whenever necessary. Inability to do so on an excuse of any other engagement is not tenable, except when he is already engaged on a similar, or other serious case.
24. ***Physicians as citizens***
    - Physicians as good citizens possessed of special training should advise concerning the health of the community wherein they dwell.
    - They should operate especially with the proper authorities in the administration of sanitary laws and regulations.
25. ***Public health***
    - Physicians, especially those engaged in public health work, should enlighten the public concerning quarantine regulations, and measures for the prevention of epidemic and communicable diseases.
    - At all times, the physician should notify the public health authorities of every case of communicable disease in his care, in accordance with the laws, rules, and regulations of the health authorities.
    - When an epidemic occurs, a physician must continue his work without regard to the risk to his own health.
26. ***Relationship with pharmacists***
    - Physicians should recognize and promote the practice of pharmacy as a profession, and should recognize the cooperation of the pharmacist in education of the public concerning the practice of ethical and scientific medicine.

Professional Misconduct (Infamous Conduct)

Any act or behaviour of a doctor which is considered disgraceful or dishonourable by his professional colleagues of good repute, amounts to professional misconduct or infamous conduct.

Such cases, when brought to the notice of a State Medical Council, will be examined to determine if the doctor is guilty, and if so, to decide on the punishment. The procedure of enquiry is mentioned on page 27.

It is not possible to enumerate all the situations in which a doctor may be charged with professional misconduct, but the general categories of serious professional misconduct include the following (*many of which have already been described in the foregoing sections*):

1. **Abortion**
   Illegal termination of pregnancy is considered as an act of professional misconduct, i.e., contravention of the rules laid out in the *Medical Termination of Pregnancy Act 1971 (page 383)*
2. **Adultery**
   A medical practitioner must maintain the highest standards of moral integrity. He should not misuse his position to commit adultery with his patients, or their relatives or attendants.
3. **Alcohol**
   Attending to patients under the influence of alcohol is strictly prohibited.
4. **Addiction**
   By virtue of his profession, a medical practitioner has easy access to various kinds of drugs. He can be punished for professional misconduct if he resorts to drug abuse.
5. **Advertising**
   - The rigid attitude of the past towards advertisement of one's professional skills and

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ability is gradually being replaced by more liberal views. This change in attitude has become inevitable because of the increasing impact of the media on the community, increasing level of education, and heightened awareness of the lay public about medical matters.

- Compared to the past when anonymity was absolute, the participation of medically qualified people on radio and television programmes, and in newspaper articles has become an everyday occurrence.
- However, canvassing for patients is wrong and unacceptable, whether it is done by word of mouth, or in writing.
- It is also not correct on the part of a doctor to advertise a change of consulting hours through a public notice or in a newspaper. This should only be done by an individual notice to the existing patients, or by displaying a note at the doctor's office or consultation room.
- The scale of professional fees must never be disclosed in public.
- Name boards must be modest in size, colour, and lettering.
- Personal achievements in surgery or medical treatment must never be advertised.
- Plastic surgeons in the US have moved out of the American Medical Association, and can freely and frequently advertise, unlike their colleagues in other medical/surgical specialities.

6. **Association**
   - Association with unqualified persons to promote one's practice is perhaps still in vogue, but it undoubtedly amounts to professional misconduct.
   - Similarly, engaging unqualified persons in technical positions is undesirable and unethical.
   - ***Dichotomy*** or ***fee splitting*** is also considered highly unethical. Dichotomy refers to receiving or giving commission to colleagues, pharmacists, manufacturers of drugs, etc., for professional favours.
     - A doctor is expected to provide the best medical treatment available for his patients. If he is not competent or qualified to handle a particular case, then he should refer it to the specialist concerned.
     - It is objectionable to ask for a share in fees from the doctor to whom the case was referred. By fee-splitting, the doctor is receiving fees for work that he has not done, and hence it is unethical.

The examples cited above are sometimes referred to as the **6 A's** of professional misconduct.

Some other practices amounting to professional misconduct include:

- Ownership of a shop selling pharmaceutical drugs, or medical or surgical appliances.
- Assisting unqualified persons (i.e., without recognised qualifications) in the treatment of patients. This is referred to as ***covering***.
- Associating with bodies or societies comprising unqualified persons who are engaged in "training" health professionals.
- Violation of the provisions of the Drugs Acts in vogue.
- Performing surgical operations when they are not required or indicated.
- Issuing false or fraudulent medical certificates.
- Withholding information about notifiable diseases from public health authorities.
- Disclosure of professional secrets *(page 44)*.
- Refusal to render professional service on grounds of religion, nationality, language, or community.
- Violation of the provisions of *The Pre-Conception and Pre-Natal Diagnostic Techniques (Prohibition of Sex Selection) Act, 1994 (page 393)*.

MEDICAL ETIQUETTE

Medical etiquette refers to the conventional laws of courtesy observed between members of the medical profession.

Every medical practitioner should treat his colleagues in the same way as he would have them treat him, i.e., with courtesy and grace.

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CONSENT

Consent has been defined to mean "voluntary agreement, compliance, or permission for a specified act or purpose."

The Indian Contracts Act, *Section 13*, states "two or more persons are said to consent when they agree upon the same thing in the same sense."

- To be legally valid, the consent that is given must be intelligent and informed, i.e., the consent must be given after understanding what it is given for, and the knowledge of risks involved.
- Medical practitioners must always remember to obtain explicit consent from a patient before examining or treating him. If they treat or operate on a patient without express authority to do so, such treatment or operation will be deemed to be intentional interference with the patient's body without legal sanction. This in turn amounts to assault and battery for which the patient will be entitled to recover damages.
- Consent may be either **expressed** or **implied**.
  - Expressed consent may be ***written*** or ***verbal***.
  - Implied consent is indicated by the demeanour and behaviour of the patient, and is adequate for routine general examinations, but when special examinations such as vaginal examination, rectal examination, etc., are required, expressed consent must be obtained.
  - For more complicated diagnostic procedures like endoscopy, or for surgical procedures, written consent is essential. In hospitals, expressed consent (verbal or written) should preferably be obtained in the presence of a disinterested third party such as a nurse or a receptionist.
  - As far as possible, consent must be obtained after explaining the nature and consequences of the treatment procedure being contemplated. This is termed ***informed consent***.

Doctrine of Informed Consent

- Since every adult human being has the right to decide as to what is best for his own body, a doctor prescribing a particular diagnostic or therapeutic procedure must necessarily disclose all the risks associated with the procedure to the patient so as to enable him to decide whether to undergo the same or not. The following points must be borne in mind:
  - All relevant information about the ailment and treatment options must be outlined.
  - Significant risks associated with every medical procedure being contemplated must be disclosed.
  - The patient must be informed about all available alternative treatment options.
  - Everything that is told to the patient must be explained in simple language that is comprehensible to him.
  - Failure to take informed consent can expose a doctor to legal action if anything goes wrong during a particular procedure.
  - However, in some cases, a doctor is permitted to withhold some information if he is convinced that disclosure of the same can be counter-productive to the patient's own health, or that it can cause psychological harm. This is referred to as **therapeutic privilege**.
  - Even if informed consent has been obtained in a given case, it can be deemed invalid if the doctor exceeds his brief, for instance, carrying out a different procedure from what was originally contemplated, or extending the scope of operation beyond what was told to the patient.
  - However, the courts have invariably recognized the possibility that complete diagnosis of an internal ailment may not be certain until the incision has been made and the organ is laid bare. So when a surgeon is confronted with an un-anticipated condition for which immediate action is required, he is justified in extending the operation and doing whatever is necessary to save the life of the patient. This is referred to as the **extension doctrine**.

    Examples

    i) During the course of a caesarean section for placenta praevia there was uncontrollable bleeding, and an emergency hysterectomy had to be performed without the consent of the patient. The court did not hold

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the doctor liable (*MGK vs Dr AO, Kerala State Consumer Redressal Commission, 1990*).

ii) During the course of an appendectomy, the surgeon noticed the uterus was diseased and performed a hysterectomy. The court refused to apply the "extension doctrine" on the grounds that there did not exist a medical emergency for the hysterectomy (*R vs LMCC, 1994*).

- The consent given by any person must necessarily be voluntary and free. Consent obtained by force, fear, or fraud is invalid. Though for routine examinations and treatment, a broad-based consent (***blanket consent***) may suffice, for special operative procedures, specific informed consent in written form is necessary. Consent may not be deemed necessary in the following situations:
  - The patient is in coma and needs emergency treatment.
  - The patient is a child admitted as an emergency case, and the parents are not immediately accessible.
  - When a medicolegal case is referred by a court of law for examination.
- Consent is to be obtained from the following persons for examination and treatment:
  - Conscious, mentally sound adults.
  - Children above 12 years of age.
  - The spouse of a person who is to undergo sterilization, termination of pregnancy, etc. (not always essential legally).
  - The parent or guardian of a child who is less than 12 years of age.
  - Permission of *loco-parentis* (e.g., headmaster of a residential school) may be obtained when it is an emergency situation, and the consent of the parents concerned is not easily obtainable.
- Utmost care must be taken to preserve the sentiments of patients with regard to their religious beliefs, even if these appear to be a little unusual. A prime example is the religious group referred to as "Jehovah's Witnesses," which was founded in the late 19th century in Pennsylvania, USA, a few members of which exist in India also. These individuals believe that all hopes for eternal life will be forfeited if blood transfusion is accepted from another person. In fact, even autologous transfusion is not acceptable to strict adherents, since they believe that once the blood has left the body it is rendered unclean. While the courts have allowed such refusal of treatment on the part of adults, they have indicated in some cases that the policy may be different in the case of children.
- Mentally unsound persons are not capable of giving valid consent. The legal guardian must provide the same.
- Consent obtained for an illegal procedure is necessarily invalid.
- Before volunteering to participate in any research program or clinical trial, a person is entitled to know the exact methods of experimentation, aims of the experiment, and risks associated with it. It is also desirable for the person to know whether he is permitted to withdraw from the experiment at any stage.

PROFESSIONAL NEGLIGENCE (MEDICAL MALPRACTICE)

"Negligence" can be defined as doing something which a prudent and reasonable man would not do, or the omission to do something which a reasonable man would do.

- In the medical context, negligence may result either from the doctor's lack of knowledge and skill, or from failure by the doctor in exercising due care in the performance of a procedure.
- Every medical practitioner is required to possess reasonable medical knowledge, and to exercise reasonable skill and care in the treatment of his patients. It does not imply that he should possess the highest degree of skill or knowledge. He is only expected to possess such skill and knowledge as possessed by ordinary competent men practicing medicine at that time under similar circumstances and conditions.

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- He must therefore merely follow the prevalent standard procedures, and methods of diagnosis and treatment. No doctor is expected to possess all currently available medical knowledge, nor is he expected to be able to apply all known diagnostic and therapeutic techniques. But a doctor of a particular standing as regards grade and experience, is expected to have a standard knowledge and capability commensurate with his professional status. Thus a house surgeon is not expected to possess the same skills as a consultant surgeon, but at the same time he is expected to provide a level of medical care which is within his competence.
- The elements of a negligent action generally comprise the following:
  - Existence of a *duty* of care.
  - Failure to exercise such duty of care (*dereliction*).
  - Causation of *damage* to the patient on account of dereliction.
  - Reasonable foreseeability of damage.
- Professional negligence of doctors leading to death of the patient is punishable under ***Sec 304-A*** of the **Indian Penal Code**. According to this section, "*Whoever causes death of any person by any rash and negligent act not amounting to culpable homicide, shall be punished with imprisonment for a term which may extend to 2 years, with or without fine.*"

Let us examine each element of a negligent act in greater detail:

Duty of Care

- A doctor charged with negligence must be shown to have been under a **duty of care** to the person complaining of negligence. If the doctor was not under a duty of care to the complainant, he cannot be charged for the negligence even though his conduct has caused damage to the complaining party.
- This relationship may be formed easily, and by no means depends on any formal acceptance of a patient by a doctor. Even in an acute emergency, once a doctor approaches an ill or injured person with the object of assisting him, a completely valid relationship is built, notwithstanding the fact that the patient may be unconscious and quite unaware of the doctor's presence.
- The fact that no payment is offered or expected makes no difference to the duty of care.
- However, when a doctor acts as a "Good Samaritan" and helps an injured person in a roadside accident, he will not be bound by duty of care.
- Again, when a doctor examines a patient for some purpose other than providing advice and treatment, no contractual obligation is established, and therefore no duty of care exists, for example, medicolegal examination for disability, drunkenness, etc.

Dereliction of Duty

- Failure of a doctor to honour his duty that is owed to his patient is referred to as "**dereliction**."
- Such breach of duty may be an *act of commission* or an *act of omission*. For example,
  - mistaken ligation of ureter during hysterectomy constitutes an act of commission,
  - failure to give antitetanus prophylaxis when it is required, is an act of omission.
- Breach of duty of care and skill is said to occur whenever a doctor fails to reach a standard of proficiency expected from him, i.e., his action will be compared to that of others with the same qualifications and expertise. Thus, a fresh medical graduate is not expected to have the same proficiency of skill as a senior specialist.
- Again, a doctor will not be held guilty of negligence if he acts in accordance with accepted prevalent practice considered appropriate by a responsible body of medical opinion, even though other doctors adopt a different practice.
  - *Example:* A complaint was received by the State Consumer Disputes Redressal Commission, Delhi, that the modern management of acute pancreatitis (laparotomy, removal of necrotic pancreas, and intensive care) was not followed in a particular case resulting in serious harm. However, the Commission did not hold

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the doctor negligent as medical opinion on the management of acute pancreatitis varies, and there is a recognized school of thought which advocates conservative management of acute pancreatitis (*DPB vs SGR Hospital, Delhi*).

- However, with advances in knowledge, what is deemed negligent today may have been accepted practice yesterday. So, it is important for a doctor to constantly update his knowledge, failing which he may face litigation for negligence sooner or later.
- A doctor is not legally liable for genuine errors of judgement relating to either diagnosis or treatment, as long as he applies a reasonable standard of skill and care in arriving at that decision.

Damage

- **'Damage'** refers to the injury or disability suffered by the patient. The failure to exercise a duty of care must lead to actual damage in order to be actionable. However negligent the doctor might be, a patient cannot sue him for negligence if no damage has occurred.
- It should be proved that the breach of duty was the real cause of damage complained of, and such a damage was reasonably foreseeable.

  Examples
  - A patient was operated on for the delivery of a child. After being discharged, she complained of pain and distress. She was admitted to another clinic and an X-ray was taken which revealed a pair of forceps in the abdomen. Subsequent surgical intervention revealed a devitalised gut along with the pair of forceps. About three feet of the gut had to be resected. The intestine had entwined itself around the forceps and its blood supply was affected. The National Consumer Disputes Redressal Commission awarded a compensation of Rs.20,000/-in addition to the expenditure incurred for the second operation.
  - An employee of a company fell ill suddenly, and the company medical officer treated him, though he was not able to make a correct diagnosis. The patient later died of small pox. The Bombay High Court did not consider the doctor negligent, as the duty cast on the company doctor was not higher or lower than the duty of an average doctor towards his patient. The doctor in this case had exercised the ordinary degree of professional skill expected of him.
- Errors of judgement either in diagnosis or treatment, will not constitute negligence as long as it is proved that the doctor had exercised minimum reasonable standards of skill and care.
- The term **'damages'** refers to monetary compensation that is intended to restore the injured patient as far as possible, to the state he was in before he suffered from a negligent act. Though money cannot be expected to restore a wrongly amputated limb, it could help to compensate for the loss of wages in the case of a patient who can no longer pursue his trade. Damages are categorised into the following types:
  - *General:* Awarded for more subjective effects of injury, such as pain and suffering, loss of enjoyment of life, loss of function, etc.
  - *Special:* Those which can be more exactly computed, for example, cost of treatment, loss of future income, expense of care for a badly disabled person, etc.

Reasonable Foreseeability of Damage

- It is not every failure to exercise a duty of care that renders the doctor liable. The damage has to be foreseeable. One would have to take into consideration whether a reasonably competent doctor under the same circumstances would have foreseen the injury or not. If not, the doctor would not be liable for negligence.
  - For example, dyspepsia (impaired digestion) may be an early symptom of serious illness such as gall bladder disease, peptic ulcer, or stomach carcinoma, but often no organic lesion is found in the early stages. Before the doctor orders special (and expensive) investigations such as sonography, barium studies, endoscopy, mucosal biopsy etc., he may

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advise a detailed study of stool to exclude parasitic infestation. It is possible that stomach cancer may be missed or diagnosed late, but is certainly not negligence in this case, as the doctor's approach is based on sound judgement.

- A doctor will be considered negligent in the following circumstances:
  - If the doctor's professional performance falls below the standard of a reasonably competent medical practitioner.
  - If there is overt evidence of negligence in diagnosis, treatment procedure (including administration of medicines), surgical operation, etc.
  - Evidence of failure in undertaking all reasonable precautions.

Box 2.3 outlines a case of professional negligence that led to the Supreme Court of India awarding the highest ever compensation given in any case so far, to the husband of a victim of medical negligence.

Calculated Risk Doctrine

- In certain medical procedures, there may be a certain amount of inevitable risk. For example, amniocentesis is associated with a 1 per cent risk of abortion. In a caesarean section, there is 0.1 percent chance of maternal mortality. In such cases, a charge of negligence will not stand against a doctor if proper care has been taken to avoid the risk.

Novus Actus Interveniens (An Unrelated Action Intervening)

- This usually applies to cases of assault and accidental injury.
- It is applicable in a situation where the cause of disability or death passes from the original incident for which the doctor was responsible, to the later negligent action of some other person.
- However, it would be difficult to prove in cases of disability or death, whether it was the result of the original negligent act, or due to the subsequent incident.

Res Ipsa Loquitur (The Thing Speaks For Itself)

- It is a situation where the facts of the case themselves are sufficient to justify the conclusion that most probably the defendant (doctor) was negligent, and the negligence caused the injury. In other words, it is a reasonable conclusion from the circumstances, that it was undoubtedly the doctor's fault.
- The plaintiff (patient) does not have to prove that the act was negligent as it could be nothing else. It is for the doctor to prove if he can, that the negligence was not his doing.

  Examples:
  - Amputation of wrong limb or digit
  - Leaving a swab or instrument in the patient after operation
  - Operating on the wrong part

Contributory Negligence

- Contributory negligence refers to any unreasonable conduct or negligence on the part of the patient which has contributed to the causation of damage alleged, although the doctor has also been negligent.
- This may occur when, for example, the patient interferes with his dressings and induces infection, or removes a plaster cast or bandage, or more commonly, fails to attend the follow-up clinic.
- In claiming that there was contributory negligence, the burden of proof will be on the doctor to show that it has happened.
- If it is proved, the compensation payable will be reduced.

Corporate Negligence

- Sometimes a patient's care is affected by malfunctioning equipment, inadequate accommodation, incompetent staff, etc. In these cases, if harm results to the patient, the hospital becomes liable for negligence. This is referred to as corporate negligence.

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Box 2.3 **Dr Anuradha Saha Case**

Dr Anuradha Saha, a 36-year-old Ohio (US)-based child psychologist who was visiting India, approached Dr Sukumar Mukherjee, a doctor at Nightingale Diagnostic Centre in Kolkata, on 7 May 1998 complaining of acute pain, fever and rashes. The doctor decided to administer the steroid Depomedrol. But a higher-than-recommended dose was given. According to Dr Kunal Saha (Anuradha Saha's doctor husband), his wife was administered 80 mg of Depomedrol straightaway and prescribed two injections daily for three days. The maximum recommended dose of the drug for any clinical condition is said to be 40-120 mg, at a minimum interval of 1-2 weeks between the doses.

When Dr Anuradha's condition did not improve, she was admitted to AMRI Hospitals, Kolkata on 11 May. This is incidentally the same hospital that was shut down on grounds of negligence in 2011 after a fire gutted one of its buildings, killing 93 people, mostly patients and nurses. At AMRI Hospitals, Anuradha was administered another steroid, Prednisolone, in a tapering dose-continuing the treatment for allergic vasculitis, which is an extreme reaction to a drug, leading to inflammation and damage to blood vessels of the skin. Dr Mukherjee then left for US on a pre-arranged visit, leaving Dr Anuradha in the care of dermatologist Dr Balram Haldar and physician Dr Abani Roychowdhury.

The court documents state that while handing over the patient, "most culpably, he (Dr Mukherjee) did not even prescribe I.V. (intravenous) fluids and adequate nutritional support which was mandatory in that condition". By 12 May, Dr Anuradha had been correctly diagnosed by Dr Haldar as suffering from toxic epidermal necrolysis (TEN), but there was no drastic shift in the treatment regimen. TEN is a rare skin condition caused by a reaction to drugs, where the top layer of skin detaches from the lower layer all over the body.

With no sign of improvement, Dr Anuradha was taken to Breach Candy Hospital in Mumbai, where she died on 28 May 1998.

In March 1999, Dr Kunal Saha launched what would be a 15-year-long battle to pin responsibility of negligence on the doctors. He issued legal notices to as many as 26 people who had treated his wife, alleging negligence, and filed a complaint at the National Consumer Disputes Redressal Commission (NCDRC). Dr Saha initially lost his fight as the West Bengal Medical Council and Calcutta High Court both dismissed his case against AMRI Hospitals. The NCDRC, however, found the hospital and its doctors guilty of medical negligence and fixed a compensation amount of Rs. 1.7 crore. At this point in 2009, Kunal moved the Supreme Court, claiming that the compensation amount, along with interest since 1998, should be fixed at Rs. 200 crore. Dr Saha filed a criminal as well as civil case against the doctors and the hospitals. In 2009, the apex court cleared the accused of criminal liability for medical negligence, but held them culpable of civil liabilities. In establishing civil liability and dereliction of duty by the doctors, the Supreme Court minced no words.

On 24 October 2013, the Supreme Court ordered a compensation of Rs. 5.96 crore, which with interest crossed Rs. 11 crore. It marked the highest compensation ever ordered in a case of medical negligence in India. Justices S.J. Mukhopadhaya and V. Gopala Gowda held out their 210-page verdict as a "deterrent and a reminder" to the medical community-a first in a medical negligence case in India.

On the method of calculating compensation, earlier for the purpose of compensation for the loss of a life, the courts and tribunals used to calculate the deceased's net annual income and multiplied the same with 10-18 years of loss-even if the victim was expected to work and earn for a longer period. In the present case, the deceased's annual net income was multiplied by 30 years of loss. Dr Anuradha Saha was 36 when she died and 30 years loss of income was calculated on the assumption that she would have worked at least till 66 if the negligence had not cut off her life. Thus, the victim's expected remaining working years was taken as the criterion for calculation of compensation without any arbitrary limits. Apart from this, the time-consuming judicial process was also a factor in the compensation.

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Products Liability

- Sometimes, injury or death of a patient may result from
  - The use of faulty, defective, or negligently designed medical or surgical equipment
  - The use of a drug that is adulterated, contaminated, or of inferior quality
  - The lack of accurate guidelines in the use of any equipment or drug
- In such cases, the manufacturer concerned becomes liable for harm resulting to the patient. This is referred to as products liability.
- However, the manufacturer will not be liable in the following situations:
  - If the doctor or hospital misused an equipment or medical product
  - If the instrument was functioning well at the time of supply, and was not defective
  - If the instrument malfunctioned due to improper use, or due to wear and tear, and was not serviced regularly, or replaced in time.

Therapeutic Misadventure

- This is applicable in those situations where a diagnostic procedure or treatment carries inherent risks of complications.
- The employment of some investigative procedures or therapeutic measures by a doctor involving considerable risk and compulsion, in the absence of an alternative option (e.g., use of anticancer drugs), will not provide grounds for medical negligence, unless the doctor failed to draw the attention of the patient to the risk at the time of obtaining consent.

Differences between Civil Negligence and Criminal Negligence (Table 2.1)

Vicarious Liability

As per law, a man may become liable to pay damages for an act of negligence committed by his servants or agents in the course of their employment or agency. This is called vicarious responsibility or vicarious liability, or as the Latin phrase goes **"respondeat superior"**, meaning *let the superior be responsible*, or *let the master answer.*

For a person to become vicariously liable for the act of another, it must be proved that

- The negligent act was done in the course of carrying out his duties.
- The person was his servant or agent.

Examples

- A surgeon may be vicariously liable for the negligent act of his assistant when he is in charge and directing the operation.
- A medical officer may be vicariously liable if a house surgeon posted under him commits a negligent act under his supervision.
- However, the action of an anaesthetist is not imputed to the surgeon, unless the surgeon issues specific orders to the anaesthetist.

Professional Secrecy

- During the course of treatment, a patient may reveal matters of a personal nature to his doctor. The doctor is obliged to maintain the secrecy of all such information, except when he is required by law to divulge it, or when the patient has consented for the disclosure.
- The doctor is liable for damages if he discloses without valid grounds, any such information which the patient may reasonably claim as secret or confidential.
- The following examples can serve as guidelines:
  - A doctor should not disclose any secret information about his patient or his private life which he learns in the course of his examination, to a third party.
  - Without the consent of the patient, no information about his illness, or any matter about his family can be disclosed, even to the patient's spouse or employer.
  - In the case of domestic servants, even if the master pays the fees of the doctor towards the treatment of the servant, the doctor should not disclose any information to the master about the nature of the illness, without the patient's consent.

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Table 2.1 Differences Between Civil Negligence and Criminal Negligence

Civil negligence	Criminal negligence
1. Simple absence of care and skill	Gross carelessness and scant regard for patient's welfare
2. No special violation of law	Willful, wanton, or even culpable negligence
3. Consent of patient amounts to a good defence	Consent of patient not adequate defence
4. Tried by civil court	Tried by criminal court
5. Contributory negligence can be cited as a defence in court	Contributory negligence does not constitute defence in court
6. Liable to pay damages	In the event of death, punishable under Section 304(A) of the IPC

- Information about the nature of illness of a minor child, insane person, or intoxicated patient, may be disclosed to the guardian of the patient. But in the case of a mentally sound major patient, nothing should be disclosed to his parents or any other relative without his consent.
- While treating a minor inmate of a hostel or a boarding house, the doctor may disclose relevant information about the patient to the warden or superintendent. But if the patient is a major, he cannot do so without the consent of the patient, unless the matter poses risk to the other inmates of the hostel.
- In the course of treatment of a **convicted prisoner** in a jail, the matter relating to his illness may be conveyed to the jailor or the superintendent of the jail. But in the case of a **prisoner under trial**, or a **person in police custody**, this cannot be done without his consent.
- When a person approaches a medical practitioner for a medical certificate or a report, it may be taken as implied that he has given consent for the disclosure of all information about his illness. Hence, in such a situation, disclosure of relevant information about the person, will not amount to breach of trust.
- While reporting a case in any scientific journal, the doctor should take care that the identity of the patient is not disclosed.

Privileged Communication

- From the foregoing it is clear that every doctor must observe professional secrecy as far as possible. However, there are certain circumstances in which a doctor is bound by law to divulge information, even if it is of a confidential nature. This is referred to as **privileged communication**. In other words, it is an exception to the usual policy of professional secrecy.
- A privileged communication is therefore defined as **a statement made by a person who has an interest to protect, or a legal, social, or moral duty to perform, to another person having a corresponding interest, even though such communication may under normal conditions, amount to defamation or slander.**
- For instance, a medical practitioner cannot withhold professional secrets in those cases where he has a statutory duty to notify births, deaths, infectious diseases, etc., to the public health authorities.
- On certain occasions, he has a moral duty to protect the interests of the community or the public, and in doing so, if he divulges the secrets of

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his patient obtained in the course of his professional examination and treatment, he will be absolved from legal liabilities.

- In all such cases, the communication (if made bonafide and without malice), will be deemed to be privileged by the circumstances. However, it should be made only to persons directly concerned, otherwise he may be penalised.
- The following examples are self-explanatory:
  - A medical practitioner has a duty to inform the warden of a hostel, if any boarder is suffering from venereal or other communicable or infectious disease.
  - He must inform the railway authority if he finds that a particular engine driver is colour blind, and he does not wish to change his employment, although he is persuaded to do so.

ORGAN TRANSPLANTATION

- Transplantation of organs in the human body represents a notable advance in medical science, and has tremendous life-saving potential (see Box 2.4 for a fascinating historical timeline of organ transplantations). Unfortunately it has leapt into prominence in recent years because of some controversial issues, not only medical and legal, but also ethical, and even religious issues. There has been sensational reportage in the lay press of alleged gross violations of ethics, and kidneys are said to have been 'stolen' while patients were on the operation table for appendectomy or hysterectomy! Reports of body snatching, and persons being kidnapped for removal of kidneys have also appeared.
- This situation of lawlessness in the field of organ transplantation in our country compelled the government to enact some stringent laws, of which one of the most important is the **Transplantation of Human Organs Act 1994**. It came into force in 1995, and deals with the regulation of removal, storage, and transplantation of human organs for therapeutic purposes, and for the prevention of commercial trade in human organs.
- As per the Act (THOA), the organs that can be donated include the kidneys, heart, lungs, liver, pancreas, eyes (cornea), eardrums, and ear bones.
- THOA limits live transplants to three categories: relatives by blood, spouses, and those who donated "out of affection". State authorisation committees are meant to scrutinize all applications for unrelated transplants. Hospitals conducting transplants are supposed to be registered with committees which are also supposed to monitor their functioning.
- In the last few years, 35 hospitals in India from various regions have undertaken cadaver transplants. Chennai has done the maximum number of cadaver transplants in the country. A major center Sri Ramachandra Medical College and Research Center, undertaking cadaver transplants in the last several years has had a brain death conversion rate of 19% (30/159). In this institution, the ICU staff have been sensitized to the issue of brain death and organ donation.
- The Act defines human organ as any part of the human body consisting of a structured arrangement of tissues, which if wholly removed cannot be replicated, by the body. Bone marrow transplant is therefore outside the purview of the Act.
- Any person between 1 year and 60 years can become a potential donor. However, to donate a kidney during life, the donor has to be not less than 18 years of age.
- Normally, the right of possession of a dead body lies with the surviving spouse or the next of kin. In case of death in a hospital, the hospital is the legal possessor until someone with a better claim to possess it turns up. If nobody turns up to claim the body for 48 hours after death, the body may be disposed of by the hospital authorities. If the deceased had left any directions about the manner in which the body is to be disposed of, or the manner in which the tissues are to be used, such directions must be respected.
- Any transplant must be effective in its own right to be useful. A donation from a living person is more likely to succeed than that from a dead donor, and in the latter case, success will be

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Box 2.4 **Timeline of successful organ transplants around the world**

1823 : First skin autograft-transplantation of skin tissue from one location on an individual's body to another location (Germany).
1905 : First successful cornea transplant by Eduard Zirm (Czech Republic).
1908 : First skin allograft-transplantation of skin from a donor to a recipient (Switzerland).
1933 : First successful cadaveric AB-0 incompatible kidney transplant by Yuriu Yu. Voronoy (USSR)
1950 : First successful kidney transplant by Dr. Richard H. Lawler (Chicago, USA).
1954 : First living related kidney transplant (identical twins) (USA).
1955 : First heart valve allograft into descending aorta (Canada).
1962 : First kidney transplant from a deceased donor (USA).
1965 : Australia's first successful (living) kidney transplant (Queen Elizabeth Hospital, SA, Australia).
1966 : First successful pancreas transplant by Richard Lillehei and William Kelly (Minnesota, USA).
1967 : First successful liver transplant by Thomas Starzl (Denver, USA).
1967 : First successful heart transplant by Christian Barnard (Cape Town, South Africa).
1981 : First successful heart/lung transplant by Bruce Reitz (Stanford, USA).
1983 : First successful lung lobe transplant by Joel Cooper at the Toronto General Hospital (Canada).
1984 : First successful double organ transplant by Thomas Starzl and Henry T. Bahnson (Pittsburgh, USA).
1986 : First successful double-lung transplant by Joel Cooper at the Toronto General Hospital (Canada).
1995 : First successful laparoscopic live-donor nephrectomy by Lloyd Ratner and Louis Kavoussi (Baltimore, USA)
1997 : First successful allogeneic vascularized transplantation of a fresh and perfused human knee joint by Gunther O. Hofmann
1998 : First successful live-donor partial pancreas transplant by David Sutherland (Minnesota, USA)
1998 : First successful hand transplant by Dr. Jean-Michel Dubernard (Lyon, France)
1998 : United States' first adult-to-adult living donor liver transplant University of Illinois Medical Center
1999 : First successful tissue engineered bladder transplanted by Anthony Atala (Boston Children's Hospital, USA)
2004 : First liver and small bowel transplants from same living donor into same recipient in the world (University of Illinois Medical Center, USA).
2005 : First successful ovarian transplant by Dr. P. N. Mhatre (Wadia Hospital, Mumbai, India)
2005 : First successful partial face transplant (France).
2005 : First robotic hepatectomy in the United States (University of Illinois Medical Center).
2006 : First jaw transplant to combine donor jaw with bone marrow from the patient, by Eric M. Genden (Mount Sinai Hospital, New York City, USA)
2006 : First successful human penis transplant (later reversed after 15 days due to 44-year-old recipient's wife's psychological rejection) (Guangzhou, China).
2008 : First successful complete full double arm transplant by Edgar Biemer, Christoph Höhnke and Manfred Stangl (Technical University of Munich, Germany).

contd.

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2008 : First baby born from transplanted ovary. The transplant was carried out by Dr Sherman Silber at the Infertility Centre of St Louis in Missouri. The donor was her twin sister.

2008 : First transplant of a human windpipe using a patient's own stem cells, by Paolo Macchiarini (Barcelona, Spain).

2008 : First successful transplantation of near total area (80%) of face, (including palate, nose, cheeks, and eyelid) by Maria Siemionow (Cleveland Clinic, USA)

2009 : Worlds' first robotic kidney transplant in an obese patient (University of Illinois Medical Center, USA).

2010 : First full facial transplant by Dr. Joan Pere Barret and team (Hospital Universitari Vall d'Hebron, Barcelona, Spain)

2011 : First double leg transplant by Dr. Cavadas and team (Valencia's Hospital, La Fe, Spain).

2012 : First robotic alloparathyroid transplant (University of Illinois, Chicago, USA).

2013 : First successful entire face transplantation as an urgent life-saving surgery at Maria Skodowska-Curie Institute of Oncology branch in Gliwice, Poland.

2014 : First successful uterine transplant resulting in live birth (Sweden).

2015 : India's first successful double hand transplant by Dr Subramania Iyer and team (Amrita Institute of Medical Sciences & Research, Cochin, Kerala).

inversely proportional to the length of time between death and donation.

- **Potential donations** are of three types:
  - Donations of tissues that are readily replaceable (e.g., blood). These do not cause any serious problems.
  - Donations of organs that are not essential to the life of the donor.
  - Donations of one of the paired organs, the other one being capable of maintaining life, as long as it is healthy (e.g., kidney).

  Consent to such donations should be properly obtained, after giving a complete explanation.
- During the course of his lifetime, a donor can give his consent for the removal of organs from his body after his death. However, such a consent becomes invalid if the next of kin refuses to allow organs to be removed for transplantation. On the other hand, the legal heir can direct the removal of organs from the dead body, even if the person, while alive, had not made any such commitment.
- The ultimate success of a transplantation rests on the quality of the donated organ, and this depends on the ***warm anoxic time*** to which it is subjected. This is the time between the cessation of arterial oxygen supply and the refrigeration of the isolated organ.
- Living donations offer two major advantages. Firstly, sufficient time is available for a full appraisal of the case, and secondly, the warm anoxic time can be reduced almost to zero. However, in the case of cadaver donation, the kidney must be removed from the dead body within 30 to 60 minutes of circulatory cessation, and in general must not be stored for more than 12 hours.
- The dramatic improvement in the success of transplant surgery that has taken place in recent years has been largely due to the approximation of the cadaver to the living donor through the medium of ***beating heart donor***. This concept has become possible with the use of sophisticated machines for keeping the respiration and circulation going on in a person after he is declared dead. There are functional regions in the brain that vary in their resistance to lack of oxygen, the most sensitive being the cortex, followed by the thalamus, and finally the brainstem which regulates the basic functions of the body and in particular, the respiratory and vasomotor centres. There may be varying degrees of 'brain death'

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ranging from intellectual deterioration to suppression of all functions (except the capacity to remain alive). This is known as ***persistent vegetative state (PVS)***.

- In any discussion of death, it is essential to appreciate that death is an absolute concept; the body is not dead unless the whole brain is dead. The brainstem is not only the controller of life, but also the most important part of the brain which is relatively resistant to hypoxia. For this reason, the common expression '*brain death*' has now been replaced by the unambiguous term '***brainstem death***'. It is now generally accepted that brainstem death can be diagnosed while the heart is still beating. However, some stringent criteria are laid down.
- They are called the ***Harvard Criteria***.
  - These include the exclusion of drug overdose, hypothermia, or metabolic disorder as a cause of deep coma, and
  - Establishing that the cause for the coma is irremediable structural brain damage.
  - This is followed by tests to confirm that all brainstem reflexes are absent, and in particular to establish under very standardised conditions that no respiratory movements occur, when the patient is disconnected from the mechanical ventilator.
  - It is recommended that the tests be repeated after a reasonable interval (usually 6 hours).
  - The standard practice is that the diagnosis should be made by a minimum of two doctors, and it is mandatory that they do not form part of the team concerned with transplant operation.
  - If brainstem death is declared after all the conditions have been met, the patient is considered unequivocally dead, and the decision as to stop or continue ventilation rests upon whether the body is to be used as an organ donor.
- **Punishment for commercial dealing in human organs**: Any person found guilty of commercial trade in human organs shall be punishable with imprisonment for a term which shall not be less than two years, but which may extend to seven years, and shall be liable to fine which shall not be less than ten thousand rupees, but may extend to twenty thousand rupees.
- Every year, almost two lakh people in India need kidney transplants and there are only 4,000 people donating them, reveals the Indian Medical Association. And this discrepancy in demand and supply leads to cases like the deeds of "Dr Horror" Amit Kumar, accused of running an illegal kidney racket out of Gurgaon (Box 2.5). The incident has raised many questions, including the efficacy of the Transplantation of Human Organs Act, 1994.
- The medical fraternity in India, however, says the law is too stringent for transplantation to be carried out legally all the time. According to many doctors, the section mentioning that only close relatives can donate kidneys is too restrictive and needs to be widened. Also the provision for non relatives to donate kidneys for attachment or emotional reasons could be misused by any individual who could sell a kidney illegally.
- The government is now mooting the idea of amending the Transplantation of Human Organs Act. Among the changes being considered are mandatory declaration that patients are brain dead by all intensive care units (ICU) of hospitals to help address the shortage of organs for donation in the country.
- The High Court of Delhi in its order dated 6.9.2004 set up a Committee to examine the provisions of Transplantation of Human Organs Act, 1994 and the Transplantation of Human Organs Rules, 1995. The report was submitted on 25 May 2005. A National Consultation was held on 18 May 2007 and the report was submitted in the second fortnight of August, 2007. The recommended changes required amendments in the Transplantation of Human Organs Act, 1994 and the Rules framed there under. These changes are intended to facilitate genuine cases, increase transparency in transplantation procedures and to provide deterrent penalties for violation of the law.

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Box 2.5 **The Gurgaon Kidney Scandal**

The horrifying multi-billion rupee Gurgaon kidney scandal came to light in January 2008 when police arrested several people for running a kidney transplant racket in Gurgaon, an industrial township near New Delhi, India. On January 24, 2008, police teams from Haryana and Uttar Pradesh raided a residential building and a guest house owned by one Dr Amit Kumar. According to the Gurgaon police, the scandal at the local clinic was going on for six to seven years. Donors were lured with offerings of about Rs. 30,000 for kidney removal. First, they were lured to the clinic on the pretext of job opportunities. They were instead asked to donate their kidneys for the fee and all those who resisted this were drugged against their will and subsequently operated upon. Kidneys from most of the victims, who were poor people hailing from the nearby western Uttar Pradesh, were transplanted into clients from United States, United Kingdom, Canada, Saudi Arabia and Greece. The Haryana police, under whose jurisdiction the scandal happened, issued arrest warrants against Dr Upendra Aggarwal, a general physician and an associate of Dr Amit Kumar, for his involvement in the scandal. However, at the time of the police raid, Dr Kumar and his other accomplices escaped after the knowledge of possible arrests. The raid helped rescue five people who were shifted to a Gurgaon hospital.

The police subsequently revealed that Dr. Amit Kumar and his accomplices had performed 600 kidney transplants in the past decade. Additionally, at least two hospitals were involved in the after care of patients. Police, through the technology of fingerprinting, determined that Dr Kumar went by many aliases and had been previously arrested at least four different times for illegal organ trade operations.

The Haryana police further uncovered 2 hospitals and 10 laboratories in Greater Noida and Meerut, cities near New Delhi for their alleged involvement in the scandal.

In the meanwhile, a Gurgaon court issued arrest warrants for Dr Amit Kumar and his brother. With growing suspicions that Kumar might have fled the country, the Haryana police requested the CBI to alert the Interpol. Thereafter, Red corner notices were issued for the Kumar siblings.

On February 7, 2008, Dr Amit Kumar was arrested in the neighbouring country of Nepal. He was hiding in a wildlife resort, about 35 miles from the Indo-Nepal border. He had a bank draft worth Rs.936,000 along with a total of •145,000 and $18,900 in cash. At the resort he made an unsuccessful attempt to bribe the Nepali policemen to let him go.

In March 2013, a CBI special court convicted five of the accused, while acquitting another five in the case. Dr Amit Kumar, who was termed a "quack" in no uncertain terms by the court, got seven-year rigorous imprisonment (RI) besides a fine of over Rs. 60 lakh.

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- **In so far as the Act is concerned, the following amendments have been proposed**:
  - To empower Union Territories, specially Government of NCT of Delhi to have their own appropriate authority instead of DGHS and /or Additional DG (Hospitals).
  - To make the punishments under the Act harsh and cognizable for the illegal transplantation activities to deter offenders from committing this crime.
  - To provide for registration of the centers for removal of organs from the cadavers and brain stem dead patients for harvesting of organs instead of registration of centers for transplantations only.

  (**"Organ Transplantation" & "Brainstem Death"** have also been discussed in **Chapter 7**).

CONSUMER PROTECTION ACT 1986

- **The Consumer Protection Act** received the consent of the President of India on **24th December 1986**. It has undergone two amendments, one on **18th June 1993** and another on **27th August 1993**.
- A revised Act was brought into force in 2002: **Consumer Protection (Amendment) Act 2002**
- The purpose of the Act is to make sure that business and industrial organisations are obliged to satisfy the needs of consumers by producing quality goods and services at reasonable prices.
- In the corporate sector, which is a form of organisation producing goods and services, the emphasis is also to give proper after-sales service, and provide a mechanism for satisfactory response to grievances and problems of the consumer.
- The Act seeks to provide a cheap and speedy remedy to the ordinary consumer who is unable to get involved in a costly and time-consuming litigation in a court of law in search of redressal for his problems.
- The Act covers all private sector, corporate sector and public sector enterprises. The service rendered by doctors has been explicitly brought under the purview of the Consumer Protection Act in **1995**. However, services offered by Government hospitals which provide absolutely free treatment are not covered by the Act.
- The District Consumer Forum, the State Consumer Redressal Commission, and the National Consumer Redressal Commission (all courts of law, with certain modifications established for the purposes of the Act), are agencies for redressal of disputes in consumer related cases and matters connected therewith.
- The **consumer court** is a *three tier* structure:
  - The *lowest tier* is the District Forum. It is established by the State Government with prior approval of the Central Government in each district of a state. The district forum has three members. One among them is the President, who must be a district judge or a retired district judge, while the other two are eminent citizens, one of whom should be a lady. These fora have a jurisdiction to entetain claims for compensation up to Rs. 20 lakhs (2 million).
  - Te *second tier* is the State Consumer Disputes Redressal Commission (State Commission). It comprises three members. The President has to be a High Court Judge or a retired High Court Judge. Two other members are eminent citizens, one of whom has to be a lady. The State Commission hears appeals from district forum and has jurisdiction for consumer compensation claims between Rs. 20 lakhs (2 million) and 1 crore (10 million).
  - The *topmost tier* comprises the Natonal Consumer Disputes Redressal Commission (National Commission) presided over by a retired judge of the Supreme Court with four other members, one of whom has to be a lady member. The National Commission hears appeals from State Commissions, as well as consumer complaints seeking compensation of over Rs. 1 crore (10 million).

Procedure

- The procedure under the Consumer Protection Act is very simple:

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- There is no court fee However, this is not entirely true. For instance, a fee is payable in the District Forum based on the compensation claimed (Table 2.2).
- The complainant (consumer) has to submit his complaint to the members of the concerned consumer court.
- The consumer court issues notice to the opponent by sending copies of the complaint, and asks for a reply within 30 days.
- If the opposite party disputes the complaint or fails to represent his case, a hearing is held.
- It is not necessary for the parties to be represented by lawyers.
- The Act allows only one adjournment.
- Within 90 days an order is to be given, unless the goods in question are to be sent to an approved testing laboratory, in which case the period is extended to 150 days.
- The complaint has to be filed within two years of the cause of action, unless the court condones the delay for special reasons.

Criticism

- The Consumer Protection Act has shattered the age-old relationship between doctor and patient, which is based on mutual trust and faith. Nowadays, the doctor is forced to be cautious, and feels compelled to practise defensive medicine, because of the possibility of litigation if chances are taken, even though they may be based on sound judgement.
- The consequent increase in the requests for examinations (to protect doctors from accusations of ignorance of any unusual condition) leads directly to overload, exhaustion, and loss of time in hospital laboratories, prolongation of hospitalization and the consequent lengthening of waiting list; and inability to hospitalize many patients promptly. The increase in hospital costs could become unbearable for the hospital, financial organization, and insurance organization concerned.
- Consequently, technology wears out and is not replaced, new technology is not provided, and new clinics and laboratories are not developed. Thus, the level of hospitalization declines.
- This burdens the already altered relationship in trust between the doctor and the patient, which is the cornerstone of medicine and treatment.
- The introduction of medical malpractice insurance certainly has helped protect doctors, but not medicine. This insurance requires great expenditure, which often is difficult for the doctor to bear, and it is the unfortunate patient who in the end will have to pay for it.
- The Consumer Fora which try such cases, do not have a medical practitioner on their panel who can screen medical complaints. Without expert guidance, these consumer courts raise the possibility of jeopardising the principles of justice.

SOME RECENT DEVELOPMENTS

- In a major ruling on August 5, 2005, the Supreme Court directed law enforcement agencies not to proceed against doctors accused of rash or negligent act or omission, without obtaining an independent and competent medical opinion to support the charges. Noting that cases of doctors being subjected to criminal prosecution were on an increase, the Supreme Court held that a private

Table 2.2 Fees to be paid in District Forum

Sl.No.	Value of goods or services and the compensation claimed	Amount of fee payable
1.	Up to one lakh rupees	Rs. 100
2.	1–5 lakhs	Rs. 200
3.	5–10 lakhs	Rs. 400
4.	10–20 lakhs	Rs. 500

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complaint alleging negligence against a doctor should not be entertained unless the complainant produces before the court a credible opinion by another competent doctor supporting the charge.

- It has now held that to fix criminal liability on a doctor or surgeon, the standard of negligence required to be proved should be so high that it can be described as gross negligence or recklessness, and not merely lack of necessary care, attention and skill. Every careless act of a medical person cannot be termed 'criminal'. It can be termed 'criminal' only when doctors exhibit gross lack of competence or inaction, and wanton indifference to their patients' safety, as a result of gross ignorance or gross negligence.
- When a patient's death results merely from an error of judgment or an accident, no criminal liability should be attached to it. Mere inadvertence or some degree of want of adequate care and caution might create civil liability; but not criminal liability.

PREVENTIVE MEASURES AGAINST NEGLIGENCE

1. **Do not criticise another doctor**

   A physician must remember that one of the most common causes of negligence arises out of criticising adversely the professional conduct of another physician, without knowing the full facts. It has been observed that quite often patients go from doctor to doctor asking for an opinion regarding investigations or treatment adopted by another who is either a family physician or the medical officer at the place of work. The patient is perhaps just seeking psychological reassurance, but a casual remark by any doctor can create complications by shaking the patient's confidence in the doctor whom he has originally consulted.

2. **Employ qualified staff and associate with good partners**

   The doctor must always remember that he is responsible for the acts of omission/commission of his assistants, non-technical staff, and partners in profession during the course of treating the patient. Therefore selection must be done very carefully, and only those who are properly qualified should be employed.

3. **Update your knowledge**

   A doctor must keep abreast with the latest developments with regard to his profession and its practice.

4. **Keep accurate and complete records**

   Human memory can fail, but accurate and detailed medical records will never fail a physician in his hour of need, even after a considerable lapse of time. The doctor must keep up-to-date records, complete, with respect to

   a) History – including negative and positive information.
   b) Present illness – in the patient's own words as far as possible.
   c) Physical examination – both subjective complaints and objective findings.
   d) Course of investigations – advised, executed, and their results.
   e) Impressions about the case – before and after diagnostic procedures, and the diagnosis.
   f) Treatment adopted – a complete day-to-day record.
   g) Any consultation advised or references made to specialists.
   h) Any refusal on the part of the patient regarding treatment, or diagnostic investigations, etc., or discontinuing treatment against the physician's advice, should be recorded and the signature of the patient obtained against the statements.

5. **Take valid consent**

   Consent of the patient must be obtained before starting an examination, diagnostic or investigative procedure, or the treatment. Failure to obtain valid consent before commencing such measures may make a doctor liable for assault and battery. For the consent to be valid, it must be *informed*, with the patient being informed of the relevant facts regarding the procedures being adopted or to be adopted, including the risks involved. It is better to obtain written consent for

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certain special procedures of diagnostic and therapeutic value.

6. **Ensure reasonable skill and care**

A doctor should take all due care, and use reasonable skill within his knowledge. When in doubt, it is good to take a second opinion or consult a specialist, and adopt the necessary diagnostic procedures available. While ensuring reasonable skill and care, do not guarantee results even in an implied manner.

A doctor must ensure that all the instruments used by him are maintained well, and sterilized whenever necessary. He should treat his patient as long as it is necessary, and not withdraw from the case without prior notice to the patient.

If more than one doctor is involved in treating a case, good communication is essential and of benefit, both to the patient and to the doctor.

It is of crucial importance in surgical procedures to ensure that the surgeon does not confuse the case record of one patient with that of another, or in the case of the same patient, the affected part of the body to be operated upon with another normal part! The distressing case of famous Bollywood actress Sridevi's mother is a case in point. In May 1995, Rajeswari Ayyappan, 59, the mother of Sridevi (Fig 2.2), one of India's most popular film stars, came to New York City to be treated for brain cancer at the renowned Memorial Sloan-Kettering Cancer Center. There the neurosurgeon brought another patient's X-rays into surgery and operated on the wrong side of Mrs Ayyappan's brain, damaging healthy tissue. During the operation on May 26, Dr Ehud Arbit, Chief Neurosurgeon, who was to have removed the tumour from the left lobe of Mrs Ayyappan's brain, operated on the healthy right lobe. He was later dismissed from the hospital. Mrs Ayyappan was subsequently treated in Cornell Medical Center (New York) for her cancer and returned to India.

| Fig. 2.2 Sridevi |

7. **Guard against therapeutic hazards**

Before commencement of treatment, the doctor should enquire about the past history of the patient for any adverse drug reactions. Though he may have taken enough precautions to inject a test dose, he should be prepared in advance to handle a case of adverse drug reaction.

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CHAPTER 3

Euthanasia

Dying is not a crime.

—**Dr Jack Kevorkian** (1928–2011; American physican)

You matter because you are you. You matter to the last moment of your life, and we will do all we can, not only to help you die peacefully, but also to live until you die.

—**Dame Cicely Saunders** (1918–2005; Founder of hospice care movement)

ORIGIN

The word **euthanasia** is derived from the Greek, and means a "good death", though it has undergone considerable distortion over a period of time to assume its present day meaning of "mercy killing". As far back as **300–400 BC**, both **Socrates** and **Plato** accorded moral sanction to euthanasia and suggested that it was permissible in certain circumstances. But today there is a raging controversy all over the world as to its legal standing (evident from the quotations mentioned above), aside from the moral and ethical issues involved.

SYNONYMS

Mercy killing, Assisted suicide, Physician-assisted suicide, Aid-in-dying, Self deliverance

MEANING

Euthanasia refers to the **infliction of a painless death on an individual suffering from severe, intractable pain or discomfort, arising out of a terminal illness or condition**.

CLASSIFICATION

1. *Voluntary:* The dying individual consents to the act.
2. *Non-voluntary:* The dying individual is incapable of giving or refusing consent, e.g., an irreversibly comatose patient.
3. *Compulsory (Involuntary):* Decision by society to terminate the life of an individual.
4. *Active:* Inflicting painless death by an act of commission, e.g., injection of a lethal dose of barbiturates.
5. *Passive:* Inflicting painless death by an act of omission, e.g., withdrawal of life support to a comatose patient.
6. *Paediatric:* Euthanasia administered to seriously sick or deformed infants.
7. *Geriatric:* Euthanasia administered to seriously sick, aged individuals.
8. *Battlefield:* Euthanasia administered to severely wounded or handicapped individual.

ARGUMENTS IN FAVOUR OF EUTHANASIA

- The medical ethos of the "sanctity of life" implying the unqualified duty to preserve life at all costs, has come under increasing challenge.
- There is a perceptibly growing movement away from a rigid obligation on the part of a doctor to preserve life "at all costs", towards a more flexible duty to provide good palliative terminal care. Terminal illness is considered best treated by providing optimum conditions for death rather than by the use of increasingly invasive techniques to prolong some sort of existence. A conscious, dying patient can make his own decision, since

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patient's autonomy is today considered to be the cornerstone of ethical medical practice. To continue to treat in the face of contrary instructions can attract legal liabilities, though the exact position is still not clear-cut in India *(page 58)*.

- In many Western countries, it is generally accepted that there is no moral obligation on the part of a doctor to preserve life at the expense of suffering, and if in the course of good terminal care, the use of drugs inadvertently hastens death, this is ethically acceptable within the concept of "**double effect**," i.e., an ill effect is morally acceptable as long as there is a greater, intended good effect from an action. This concept was first given legal sanction in relation to euthanasia by **Justice Devlin** in the *Bodkin Adams case* (**1957**), when he remarked, "The doctor is entitled to relieve pain and suffering even if the measures he takes may incidentally shorten life." (Box 3.1).
- The possibility of maintaining "physiological life," i.e., the continuation of the body functions by artificial means, while the patient remains unconscious over a period of months or years, has introduced a new dimension into the debate – "quality of life." Clearly, the sustaining of physiological functions with no prospect of recovery of consciousness or contact with the patient's environment has led to considerable debate as to whether or not such support systems should be continued, and who should be responsible for the decision to turn off such systems.
- Views vary widely, but there is a substantial proportion of population in countries such as the USA which favours the view that support systems can be switched off by attending doctors with consent from the victim's relatives, in certain cases.
  - The case of *Karen Ann Quinlan* is representative of this. Karen (Fig. 3.1), a 21-year-old girl, fell into a coma after imbibing an overdose of alcohol and drugs on 15 April 1975. She passed into "persistent vegetative state" from which recovery was extremely remote. Her parents, both devout Roman Catholics, were initially hopeful of a miracle, but as the months passed by they realised that this was only wishful thinking, and that their daughter was never going to come back to meaningful existence. They requested that life support systems prolonging the futile ordeal be switched off. The doctors attending on the case refused, and the issue was taken to court. In 1976, the New Jersey Supreme Court delivered a verdict in favour of Karen's parents. However, while the support systems were subsequently switched off, artificial feeding was not stopped, and Karen continued to "live" for nearly 10 years before her heart finally stopped in 1985. The case however served to focus medical attention on a topic that had for decades been considered taboo.

| **Fig. 3.1** Karen Ann Quinlan |

- Today, not only in the case of terminally unconscious patients, but also in conscious patients (who are suffering from an intractable, painful, terminal illness), euthanasia is being increasingly considered as applicable, provided the patient concerned makes the request, and he is judged to be of sound and rational mind. Withdrawing treatment and allowing a patient to die (passive euthanasia) is therefore not perceived as repugnant anymore in certain situations. In fact in several Western countries, adult individuals over a specified age can execute a ***living will*** or ***advance directive*** which entitles him to refuse treatment any time in future in the event of a catastrophic accident or natural disease.

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Box 3.1 **The Bodkin Adams Case**

John Bodkin Adams (21st January 1899 – 4th July 1983) was an Irish-born British general practitioner. Between the years 1946 and 1956, more than 160 of his patients died under suspicious circumstances. Of these, 132 left him money or items in their will. He was tried and acquitted for the murder of one patient in 1957. Another count of murder was withdrawn by the prosecution in what was later described as "an abuse of process" by the presiding judge Patrick Devlin, causing questions to be asked in Parliament about the prosecution's handling of events.

During the course of this sensational trial, a humorous poem became quite popular that takes a jibe at Bodkin Adams and his alleged crimes:

"It's the mortuary chapel
If they touch an Adam's apple
After parting with a Bentley as a fee
So to liquidate your odd kin
By the needle of Bodkin
Send them down to sunny Eastbourne by the sea!"

The trial had several important legal ramifications:

- It established the principle of "double effect", whereby a doctor giving treatment with the aim of relieving pain may, as an unintentional result, shorten life.
- Secondly, due to the publicity surrounding Adams' committal hearing, the law was changed to allow defendants to ask for such hearings to be held in private.
- Finally, though a defendant had never been required to give evidence in his own defence, the judge underlined in his summing-up that no prejudice should be attached by the jury to Adams not doing so.

Adams was found guilty in a subsequent trial of 13 offences of prescription fraud, falsifying cremation forms, obstructing a police search, and failing to keep a dangerous drugs register. He was removed from the Medical Register in 1957, but was reinstated in 1961.

- While passive euthanasia has been accorded some semblance of acceptance in certain situations by most people, active euthanasia is in the centre of a heated (and often bitter) debate, with vociferous sections of the population in India and elsewhere either strongly advocating or condemning its practice. Despite its unresolved status, active euthanasia is being employed without serious legal difficulties in some countries, e.g., USA, Sweden, etc. Some countries have virtually legalised active euthanasia if performed by a physician under strict guidelines (**physician-assisted suicide**), e.g., Holland, Belgium, and Luxembourg. Some parts of the world have enacted legal statutes, e.g., **The Death with Dignity Act (1994)** of the State of Oregon, USA, and The Northern Territory of Australia, which was however overturned by the Australian Senate in 1997. Holland practices physician-assisted suicide openly ever since the Royal Dutch Medical Association officially endorsed it in 1984, and the parliament approved the practice, provided it was done within a framework of specified guidelines.
- Countries that have legalized voluntary, active euthanasia (in some cases, physician-assisted suicide): Netherlands (Holland), Belgium, Luxembourg, Switzerland, Estonia, Albania, and

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the US states of Oregon, Vermont, Texas, Washington and Montana.

- Switzerland and death tourism: Hundreds of Europeans travel to Zurich to end their lives because of 'Dignitas', an organization set up in 1998 to help people with terminal illnesses. They are provided with a lethal dose of barbiturates which they have to take themselves.
- In fact, in several other European countries, assisted suicide is not illegal and can have the involvement of non-physicians.

ARGUMENTS AGAINST EUTHANASIA

- The opponents of euthanasia (particularly *active euthanasia*) state that there are moral, religious, and ethical objections which cannot be ignored. They argue that no one has the right to take away the life of an individual, not even the individual himself. The concept of "sanctity of life" is inviolable and doctors having taken an oath (the Hippocratic Oath) "to preserve life at all costs", cannot justify allowing a patient to die either through active or passive means.
- It is also true that doctors are not omniscient; there have been several cases where a patient certified as terminally ill, has survived and led a reasonably fulfilling existence for several years with good palliative care. The classical example is that of renowned physicist Stephen Hawking who was diagnosed with motor neurone disease when he was in his twenties and given two years to live. He went on to live for decades and contributed significantly to our understanding of cosmic physics (Box 3.2). However, Right to Die activists argue that he must not be held up as an example to encourage doctors to prolong life at all costs, as his is an exceptional case. Besides, they go on to state that just as Hawking has been given the right to live in spite of a debilitating illness that has no known cure, another individual in the same situation should be given the choice of whether he would like to live (right to life) or die (right to die). There should not be compulsion either way.
- Even if a patient does have only a few months to live, adequate medical care can in most cases serve to make him reasonably comfortable for the remaining period till natural death supervenes. The emphasis therefore should be on improving palliative care, rather than improving methods of terminating life.
- A disturbing feature that has come to light in those countries where physician-assisted euthanasia has been accorded legal sanction, is the impatience (and sometimes greed) of the relatives of a dying patient who happens to be affluent, in pressing ahead with "euthanasia" for their own selfish ends. In such cases the patient's "right to die" is subtly converted to a "duty to die," pressure being brought on the hapless victim to accede to the infliction of "painless death."

EVOLUTION OF EUTHANASIA

Table 3.1 lists some of the important personalities around the world who have been campaigning for the legal acceptance and validation of euthanasia.

A 20th century chronology of important events relating to voluntary euthanasia and physician-assisted suicide is presented in Table 3.2.

CURRENT LEGAL STATUS IN INDIA

- While euthanasia is not explicitly stated as a criminal offence in the **Indian Penal Code**, it is generally accepted that it is covered under either the offence of attempted suicide (**S.309**), or abetment of suicide (**S.306**).
- However, judicial opinion acknowledges that euthanasia is a "grey area" in Indian criminal law. This unsettled status has been brought into stark focus in several cases, e.g., *P. Rathinam v. Union of India* (**1994**), *Smt. Gian Kaur v. State of Punjab* (**1996**), etc. As per the Supreme Court's view, passive voluntary euthanasia can be visualised as a fundamental right protected by Article 21, which assures the right to privacy, since such right to privacy can be said to encompass the right of a patient to refuse life-saving medical treatment. In other words, the right to

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Box 3.2 **The Extraordinary Story of Stephen Hawking**

Stephen William Hawking (born 8 January 1942) is an English theoretical physicist, cosmologist, author and Director of Research at the Centre for Theoretical Cosmology within the University of Cambridge. His scientific works include a collaboration with Roger Penrose on gravitational singularity theorems in the framework of general relativity, and the theoretical prediction that black holes emit radiation, often called Hawking radiation. Hawking was the first to set forth a cosmology explained by a union of the general theory of relativity and quantum mechanics. He is a vigorous supporter of the many-worlds interpretation of quantum mechanics. Hawking is an Honorary Fellow of the Royal Society of Arts, a lifetime member of the Pontifical Academy of Sciences, and a recipient of the Presidential Medal of Freedom, the highest civilian award in the United States. Hawking was the Lucasian Professor of Mathematics at the University of Cambridge between 1979 and 2009.

Hawking has also achieved success with works of popular science in which he discusses his own theories and cosmology in general; his book 'A Brief History of Time' stayed on the British Sunday Times best-seller list for a record-breaking 237 weeks.

Hawking suffers from a rare early-onset slow-progressing form of amyotrophic lateral sclerosis (ALS), also known as motor neurone disease or Lou Gehrig's disease, that has gradually paralysed him over the decades. He communicates using a single cheek muscle attached to a speech-generating device. Hawking had experienced increasing clumsiness during his final year at Oxford, including a fall on some stairs and difficulties when rowing. The problems worsened, and his speech became slightly slurred; his family noticed the changes when he returned home for Christmas and medical investigations were begun. The diagnosis of motor neurone disease came when Hawking was 21, in 1963. At the time, doctors gave him a life expectancy of two years. After his diagnosis, Hawking fell into a depression; though his doctors advised that he continue with his studies, he felt there was little point. However, two years slipped away quickly, and he was still breathing. Miraculously, the disease's progression had slowed. Although Hawking had difficulty walking without support, and his speech was almost unintelligible, disability and death is still far away. With the encouragement of several doctors and friends, he returned to his work with a new perspective on life-it is precious and why not make it meaningful.

Hawking married twice and has three children. His wives (Jane Wilde, and later Elaine Mason) have been a source of great strength and support to him. He had married Jane Wilde in July 1965, but later divorced her and married Elaine in September 1995 after a slightly strained relationship with the former. However, he divorced Elaine for unknown reasons in 2006, following which he resumed closer relation-

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ships with Jane, his children, and grandchildren. Reflecting this happier period, a revised version of Jane's earlier controversial biographical book now re-titled 'Travelling to Infinity: My Life with Stephen' was published in 2007. It was made into an award winning Hollywood film in 2014 - 'The Theory of Everything'.

Table 3.1 Some Prominent Right-to-Die Activists

Name	Country
Pieter Admiraal	*Netherlands*
John Beloff	*Scotland*
Buji Colabawalla	*India*
Pinki Virani	*India*
Lynda Cracknell	*Australia*
Derek Humphry	*USA*
Ludovic Kennedy	*England*
Jack Kevorkian	*USA*
Jeanne Marchig	*Switzerland*
Philip Nitschke	*Australia*
Marion Rookhuizen	*Netherlands*
Clemencia Uribe	*Columbia*
Barbara Coombs Lee	*USA*

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"personal liberty" as guaranteed by Art.21 of the constitution includes the freedom to die with dignity.

- Active euthanasia (voluntary or otherwise) is of course unambiguously viewed as a crime, though convictions have not been brought so far against any individual in India for the commission of such an "offence."
- In 2008, The Law Commission of India, Ministry of Law and Justice decided to recommend to the Indian Government to allow terminally ill to end their lives. The Commission also proposes another radical reform: decriminalize attempt to suicide.
- In 2009, Pinki Virani, a journalist and euthanasia activist, filed a petition in the Supreme Court to stop doctors of KEM hospital (Mumbai) from force feeding Aruna Shanbaug (Box 3.3), and allow her to finally die a dignified natural death. On 07 March 2011, the Supreme Court of India turned down the plea of Pinki. Strangely, while the Supreme Court disallowed withdrawal of life support for Aruna, it laid down guidelines for passive euthanasia!
- On 10 December 2014, the Minister of State for Home Affairs, stated that "it has been decided to delete Section 309 of IPC from the Statute book." However, right up to the date of the current edition of this book, Section 309 of the Indian Penal Code is yet to be limited or repealed.
- It is interesting to note that while Indians in general seem opposed to the concept of euthanasia (even though the Supreme Court has now legalized passive euthanasia), Jains and Hindus have the traditional rituals ***Santhara*** and ***Prayopavesa*** respectively, wherein one can end one's life by starvation, when one feels their life is complete (Box 3.4). There appears to be no controversy here (probably because it is sanctioned by religion)!

Table 3.2 Chronology of Euthanasia (Summary of Important Events from Early 20th Century)

Year	Developments
1906	First euthanasia bill drafted in the USA (Ohio), but it does not succeed.
1935	World's first euthanasia society is founded in London.
1938	The Euthanasia Society of America is founded in New York
1967	The first "living will" is written by American attorney Louis Kutner.
1973	The American Hospital Association creates Patient Bill of Rights, which includes the right to refuse treatment.
1974	The Euthanasia Society in New York is renamed the Society for the Right to Die.
1976	The California Natural Death Act is passed which protects physicians from being sued for failing to treat incurable illnesses. Several other states of the USA follow suit with similar legislation.
1976	First international meeting of Right to Die groups.
1978	A Broadway play *Whose Life is it Anyway?* about a quadriplegic wanting to die is staged for the first time. It goes on to become a massive hit and is followed by its movie version in 1982.
1980	Pope John Paul II issues "Declaration in Euthanasia" opposing mercy killing, but permitting the right to refuse extraordinary means for sustaining life.
1980	Hemlock Society (advocating euthanasia) is founded in California by journalist Derek Humphry.
1980	World Federation of Right to Die Societies is formed in Oxford, England.
1984	The Netherlands Supreme Court approves voluntary euthanasia under certain conditions
1990	American Medical Association permits physicians to withhold or withdraw treatment from patients who are close to death.

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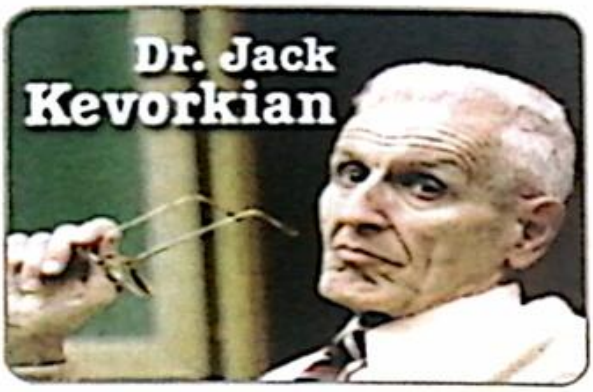
Year	Developments
1990	Dr Jack Kevorkian (Michigan, USA), assists for the first time, in the death of a patient. Over the next 9 years he assists in a total of 130 deaths. He would be tried 4 times before finally being convicted in his 5th trial in April 1999 for 2nd degree murder, and sentenced to 10 to 25 years in prison.
1991	Derek Humphry publishes "Final Exit", a how-to book on self deliverance. It quickly tops the US best-seller list, and is subsequently translated into 12 languages.
1993	A political action committee Oregon Right to Die is founded to write and subsequently pass the Oregon Death with Dignity Act. The Act takes effect only from October 1997 after several unsuccessful attempts to scuttle it.
1996	The Northern Territory of Australia passes voluntary euthanasia law which was drafted the previous year. However, nine months later the Federal Parliament quashes it.
1999	Dr Kevorkian is sentenced to 10–25 years in prison for 2nd degree murder of Thomas Youk suffering from motor neurone disease. The videotape of Youk's death had been telecast on national television, provoking public outrage.
2000	The Netherlands becomes the first country in the world to legalize physician-assisted suicide.
2000	The Switzerland-based Dignitas, a legal euthanasia center, begins its operations under the lax euthanasia laws of the country, and as of 2008 has assisted nearly 900 deaths. However, a clear-cut law legalizing physician-assisted suicide has so far not been passed in Switzerland.
2002	Belgium becomes the second country to legalize physician-assisted suicide.
2005	Terri Schiavo collapses in her St. Petersburg, Florida, home in full cardiac arrest on February 25, 1990. She suffers massive brain damage due to lack of oxygen and, after 2½ months in a coma, her diagnosis is changed to vegetative state. For the next two years doctors attempt speech and physical therapy and other experimental therapy, hoping to return her to a state of awareness. In 1998 Schiavo's husband, Michael, petitions the Sixth Circuit Court of Florida (Pinellas County), to remove her feeding tube. He is opposed by Terri's parents, Robert and Mary Schindler, who argue that she is conscious. The court determines that she would not wish to continue life-prolonging measures, and on April 24, 2001, her feeding tube is removed for the first time, only to be reinserted several days later. On February 25, 2005, a County judge orders the removal of Terri Schiavo's feeding tube. Several appeals and federal government intervention follow. After all attempts at appeals fail, staff at the hospice facility where Terri was being cared for disconnect the feeding tube on March 18, 2005. Terri dies on March 31, 2005.
2006	The Peaceful Pill Handbook a book setting out information on assisted suicide and voluntary euthanasia is



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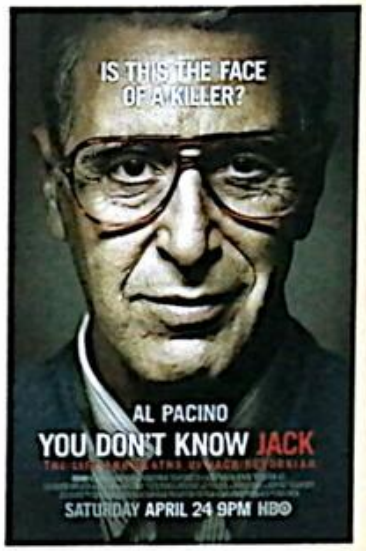
Year	Developments
	published in the US in 2006, written by the Australian doctors Philip Nitschke and Fiona Stewart. In 2008 the on-line handbook was launched. Called The Peaceful Pill eHandbook, it contains video clips on assisted suicide and voluntary euthanasia methods and related issues, but does not provide "how-to" instructions. The eHandbook is updated six times a year.
2007	Dr Jack Kevorkian is released from prison after serving 8 years.
2008	Luxembourg becomes the third country to legalize physician-assisted suicide.
2008	The Washington Initiative 1000 makes Washington the second US state to legalize physician-assisted suicide.
2009	Luxembourg becomes the third European Union country, after the Netherlands and Belgium, to decriminalise euthanasia.
2009	Pinki Virani, a journalist and euthanasia activist in India, files a petition in the Supreme Court to stop doctors of KEM hospital (Mumbai) from force feeding Aruna Shanbaug, and allow her to finally die a dignified natural death.
2010	The Federal Court of Justice of Germany legalises passive euthanasia with patient's consent.
2010	Al Pacino plays Jack Kevorkian in the HBO Film "You Don't Know Jack". He wins the Emmy for Outstanding Lead Actor in a Miniseries or Movie, along with the Golden Globe and Screen Actors Guild award in 2011 for his role as Kevorkian.
2011	Jack Kevorkian dies at the age of 83 (from natural causes).
2011	The Supreme Court of India turns down the plea of Pinki Virani to stop doctors of KEM hospital (Mumbai) from force feeding Aruna Shanbaug. Strangely, while the Supreme Court disallows withdrawal of life support for Aruna, it lays down guidelines for passive euthanasia!
2014	On December 23, 2014, the Govt of India endorsed the Passive Euthanasia judgement-law in a press release, after stating in the Rajya Sabha as follows: The Honble Supreme Court of India in its judgment dated 7-3-2011, while dismissing the plea for mercy killing in a particular case, laid down comprehensive guidelines to process cases relating to passive euthanasia. Thereafter, the matter of mercy killing was examined in consultation with the Ministry of Law and Justice and it has been decided that since the Honble Supreme Court has already laid down the guidelines, these should be followed and treated as law in such cases. At present, there is no proposal to enact legislation on this subject and the judgment of the Honble Supreme Court is binding on all.
2015	Aruna Shanbaug passes away in hospital without ever regaining full control of her mental faculties.
2016	Canada legalizes euthanasia as "medically assisted dying" in June 2016 to relieve the suffering of grievously ill adults whose "natural death is reasonably foreseeable".



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Box 3.3 **The Aruna Shanbaug Case**

Aruna Shanbaug (Shanbhag) was a former nurse from Haldipur, Uttara Kannada, Karnataka in India. In 1973, while working as a junior nurse at King Edward Memorial Hospital, Parel, Mumbai, she was sexually assaulted by a ward boy, Sohanlal Bhartha Walmiki and was in a vegetative state for 4 decades after the assault. Aruna was planning to get married to a young doctor in the hospital.

On the night of 27 November 1973, Shanbaug was sexually assaulted by Sohanlal, a sweeper on contract at the King Edward Memorial Hospital. He attacked her while she was changing clothes in the hospital basement. The assailant choked her with a dog chain and sodomized her. The asphyxiation cut off oxygen supply to her brain, resulting in brain stem contusion injury and cervical cord injury apart from leaving her cortically blind.

The police case was registered as a case of robbery and attempted murder on account of the concealment of anal rape (sodomy) by the doctors under the instructions of the Dean of KEM, perhaps to avoid the social rejection of the victim, and her impending marriage.

Sohanlal was caught and convicted, and served two concurrent seven-year sentences for assault and robbery, neither for rape or sexual molestation, nor for the "unnatural sexual offence" (which could have got him a ten-year sentence by itself).

Since the assault in 1973, Aruna was in a vegetative state right until 18 May 2015 when she passed away (a period of about 42 years).

On December 17, 2010, the Supreme Court of India while admitting the plea to end her life made by activist-journalist Pinki Virani, sought a report on Shanbaug's medical condition from the hospital in Mumbai and the government of Maharashtra. On 24 January 2011, the Supreme Court asked for the setting up of a medical panel to examine her. The three-member medical committee subsequently set up under the Court's directive, checked upon Aruna and concluded that she met "most of the criteria of being in a permanent vegetative state".

But the Supreme Court turned down the mercy killing petition on 7 March 2011. The court, in its landmark judgement, however allowed passive euthanasia in India and laid out guidelines for the same. According to these guidelines, passive euthanasia involves the withdrawing of treatment or food that would allow the patient to live. Pinki Virani's lawyer, Shubhangi Tulli ruled out filing an appeal stating "the two-judge ruling is final till the SC decides to constitute a larger bench to re-examine the issue". Pinki Virani herself stated, "Because of this woman who has never received justice, no other person in a similar

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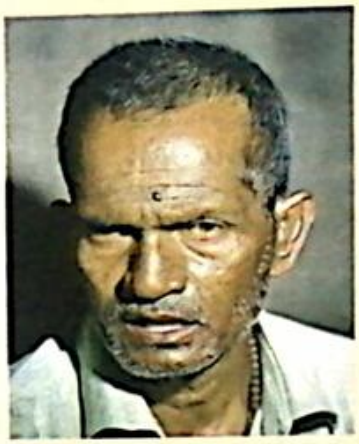
position will have to suffer for more than three-and-a-half decades".

Aruna passed away in hospital on 18 May 2015. On 22 May, because of media frenzy surrounding her death, her attacker (Sohanlal Valmiki) was finally traced to a small village in Uttar Pradesh, not very far from Delhi. In some interviews he granted to a few news agencies, he expressed deep remorse at what he had done and said, "I heard when she died. How couldn't I? I had been praying for her recovery. *Bahot taklif hua. Aisa sunne se sabhi ko dard hoga*. I fully realise what I have done. I don't wish to live anymore."



Box 3.4 **Euthanasia in Religion**

While there are no clear indications that Christianity, Islam, or the other major religions of the world sanction the concept of euthanasia in any form, there is very clear evidence that Hinduism and Jainism do advocate passive euthanasia in the form of 'Prayopavesa' and 'Santhara' respectively.

Prayopavesa: Prayopavesa *(Sanskrit: literally 'resolving to die through fasting')* is a practice in Hinduism that denotes the suicide by fasting of a person, who has no desire or ambition left, and no responsibilities remaining in life. It is also allowed in cases of terminal disease or great disability. Committing Prayopavesa is bound by very strict regulations. Only a person who has no desire or ambition left, and no responsibilities remaining in life is entitled to perform it. The decision to do so must be publicly declared well in advance. Ancient lawmakers stipulated the conditions that allow Prayopavesa. They are: one's inability to perform normal bodily purification, death appears imminent or the condition is so bad that life's pleasures are nil, and the action is done under community regulation.

Actual Cases

Vinayak Damodar Savarkar, after 21 days fast, died on 26 February 1966. He thought that his duties were ful filled and thus had no purpose left to live.

In November 2001, Satguru Sivaya Subramuniyaswami subjected himself to Prayopavesa. He was diagnosed to be suffering from terminal intestinal cancer. He later died on the 32nd day of his fast.

Sallekhana (Santhara, Samadhi-marana, Sanyasana-marana): is the last vow prescribed by the Jain ethical code of conduct. The vow of Sallekhana is observed by the Jain ascetics and lay votaries at the end of their life by gradually reducing the intake of food and liquids. It is allowed when normal life according to religion is not possible due to old age, incurable disease, or when a person is nearing his end. It is a highly respected practice among the members of the Jain community. According to Jain texts, Sallekhana leads to ahimsa (non-violence or non-injury), as a person observing Sallekhana subjugates the passions, which are the root cause of himsa (injury or violence). In 2015, the Rajasthan High Court banned the practice, calling it suicide. On 31 August 2015, the Supreme Court of India stayed the decision of the Rajasthan High Court and lifted the ban on Sallekhana.The Supreme court stated that Santhara (Sallekhana) is a component of non-violence ('ahimsa'), and hence cannot be called illegal.

contd.

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According to the Jain text, Purushartha Siddhyupaya, "Sallekhana enables a person to carry with him his wealth of piety". Sallekhana is treated as a supplementary to the twelve vows taken by Jains. However, some Jain Acharyas such as Kundakunda, Devasena, Padmanandin and Vasunandin have included it under the last vow, siksa-vrata.

According to Tattvartha Sutra (a compendium of Jain principles): "A person can willingly or voluntarily adopt Sallekhana when death is very near." According to the famous Jain text, Ratnakaranda sravakacara, Sallekhana can be observed only "on the arrival of unavoidable calamity, distress, senescence and disease." The duration of the practice could be up to twelve years or more. The sixth part of the Jain text, Ratnakaranda sravakacara is on Sallekhana and its procedure. The procedure expounded is as follows- "Giving up solid food by degrees, one should take to milk and whey, then giving them up, to hot or spiced water. [Subsequently] giving up hot water also, and observing fasting with full determination, he should give up his body, trying in every possible way to keep in mind the pancha-namaskara mantra (Namokar Mantra)".

—**Ratna Karanda Sravakachara** (127–128)

Due to the prolonged nature of Sallekhana, the individual is given ample time to reflect on his or her life. The purpose is to purge old karmas and prevent the creation of new ones. The vow of Sallekhana cannot be taken by a lay person on his own without being permitted by a monk. According to a survey conducted in 2006, on an average 200 Jains practice Sallekhana until death each year in India. Statistically, Sallekhana is undertaken both by men and women of all economic classes, and among the educationally forward Jains. It is considered to be a display of utmost piety, purification and expiation. In 1999, Acharya Vidyanand, a prominent Digambara monk took a twelve year-long vow of Sallekhana.

Fig 1 : Badni Devi Daga

In a recent case, an 83-year-old woman passed away in Rajasthan on Sept 05, 2015, 50 days after opting for Santhara, the first such death after a legal battle over the Jain community's right to follow the ritual of voluntarily starving to death. Badni Devi Daga (Fig 1) of Gangashahar in Bikaner, more than 300 km from capital Jaipur, died at around 8 am. Though Devi had started her fast many weeks before, family members announced her Santhara decision only after the Supreme Court's order declaring the ritual as legal.

In 2013, a highly acclaimed film titled 'Ship of Theseus' (Fig 2) written and directed by Anand Gandhi, was released that explored the concept of Sallekhana as one of three intertwined stories, in a sensitive and realistic manner.

Fig 2 : Film poster of "Ship of Theseus"

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CHAPTER 4

Identification

So God created man in his own image. In the image of God created he him.

—**Old Testament**, Genesis 1:27

INTRODUCTION

Identification in the medicolegal sense refers to the determination of individuality of a person.

- It may be **complete** or **partial**.
  - In the case of living persons, as well as dead bodies recovered before the process of putrefaction has set in, identity can be fixed with respect to their name, age, sex, occupation, address etc., with the help of their unique features. This is termed **complete identification**. Establishing complete identification is usually the responsibility of the police.
  - But in cases of mutilated and highly putrefied bodies, as well as in skeletal remains, the police may require the help of a medical officer, or a forensic expert, who with his knowledge of anatomy can help provide certain information such as race, age, sex, stature, etc., by studying the morphology of the body parts. This is termed **partial identification**. Partial identification by a medical officer can provide some clues to the police for further investigation leading to complete identification.

FACTORS HELPFUL IN FIXING IDENTITY

The following factors can help in establishing the complete identity of a person, either living or dead:

- Race
- Sex
- Age
- Hair
- Anthropometry
- Dactylography
- Poroscopy
- Footprints
- Cheiloscopy
- Rugoscopy
- Tattoo marks
- Scars
- Occupational stigmata
- Complexion & physical features
- Miscellaneous factors

RACE

Definition

Race can be defined as "A biological grouping within the human species classified according to genetically transmitted differences."

Classification

The scientific classification of human racial types is based on certain combinations of fixed, inherited, measurable, and visually identifiable traits such as shape of the head, facial features, nose shape, eye shape and colour, skin colour, blood groups, hereditary characteristics, etc. Although difference of opinion exists regarding terminology and exact classification, the following divisions are generally accepted:

- **Major groups** – Caucasian, Negro, Mongolian
- **Minor groups** – Indian, Australian, American Indian, Polynesian

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Characteristic Features of Major Races

Caucasian

- These include European, Semitic (Arabs and Jews), and Indo-Aryan people.
- Skin colour varies from very fair as in the case of North European people, to brown in the case of Indian and South West Asian people.
- Hair is straight or wavy (sometimes frizzy), and may be blonde, brown, or black.
- Face is narrow to medium broad.
- The nose is generally long and narrow.

Negroid

- They inhabit Africa to the south of the Sahara, though some minor groups include the Negrito people of India and South East Asia, as well as the Melanesians of the South West Pacific.
- Their skin colour varies from black to brown.
- These people have broad, rather flat noses.
- Their stature varies widely. The Pygmies of Central Africa are the shortest people in the world, while the Negroes of Sudan and Central Africa are among the tallest people in the world.
- Face is narrow to medium-broad with prognathism.
- Hair appears woolly, the colour is brown-black, and texture is coarse.

Mongoloids

- They are inhabitants of Northern, Eastern or South Eastern Asia. In fact, some of these groups were the original inhabitants of America.
- The groups include Chinese, Japanese, Burmese, Thais, Vietnamese, Malays, Eskimos, Red Indians, and American Indians of South America.
- Their eyes have a characteristic fold of skin on the upper lid (epicanthic fold).
- Hair is lank and straight.
- Stature varies from short to medium.

Identification of Race

- Race determination is mainly the domain of physical anthropologists. Due to global shrink age and increasing incidence of mass disasters such as airplane crashes, etc., their help in identifying victims has become vital in many cases, which has led to the development of a specialised field, **Forensic Anthropology**.
- Race can be determined by studying
  - Variations in morphology
  - **Osteometry**, i.e., measurement of various bones and studying the proportionalities to each other, and
  - Multivariate discrimination function analysis.
- **Krogman** studied the morphological traits of the skull and outlined the essential descriptive morphology of the three main races. He further subdivided the Caucasians into: Nordic, Alpine, and Mediterranean groups on the basis of his findings.
- Attempts were also made by **Todd and Lindala (1928)**, **Cobb (1934, 1942)**, and **Lewis (1942)**, to differentiate the races on the basis of measurements of different body parts. Due to wide standard deviation, there is considerable overlap in the actual dimensions of various bones among the races, and hence the proportionality of different parameters were studied. This has led to the calculation of various indices such as *cephalic index, brachial index, crural index, intermembral index, intra-membral index*, etc. (Table 4.1 a & b). The values of some of these indices for the three races – Asiatic Indians, Europeans, & Negroes – are mentioned in Table 4.2.
- **Scalp hair** also demonstrates characteristic features helpful in the determination of race (Table 4.3).
- Certain **dental characteristics** are also helpful in the determination of race. The most distinctive feature is the 'shovel-shaped' incisor seen among American Indians, Chinese, and Palestinian Arab populations. Other features like *cusp of Carabelli*, protostylid, cusp six & cusp seven, arrangement of groove patterns of molars, ac-*

**The cusp of Carabelli, or Carabelli's tubercle, or tuberculum anomalum of Georg Carabelli is a small additional cusp at the mesiopalatal line angle of maxillary first molars. Carabelli's cusp is most common among Europeans (75-85% of individuals).*

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Table 4.1a Various Indices

Race Indices	
Cephalic Index	$\frac{\text{Max. Breadth of Skull}}{\text{Max. Antero-posterior Length of Skull}} \times 100$
Brachial Index	$\frac{\text{Length of Radius}}{\text{Length of Humerus}} \times 100$
Crural Index	$\frac{\text{Length of Tibia}}{\text{Length of Femur}} \times 100$
Inter-membral Index	$\frac{\text{(Length of Humerus + Length of Radius)}}{\text{(Length of Femur + Length of Tibia)}} \times 100$
Intra-membral Index	$\frac{\text{Length of Humerus}}{\text{Length of Femur}} \times 100$

Table 4.1b Cephalic Index

Type of skull	Cephalic index	Race
Dolico-cephalic (long-headed)	70 to 75	Pure Aryans, Aborigines & Negroes
Mesati-cephalic (medium-headed)	75 to 80	European and Chinese
Brachy-cephalic (short-headed)	80 to 85	Mongolian

Table 4.2 Racial Differences from Osteometry

Index	Asiatic Indians	Europeans	Negroes
Brachial index	76.49	75.5	78.5
Crural index	86.49	83.3	86.2
Inter-membral index	67.27	70.4	70.3
Intra-membral index	71.11	69.0	72.4

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Table 4.3 Racial Differences from Hair Analysis

Feature	Negro	Caucasian	Mongolian
Diameter	60–90 mm	70–100 mm	90–120 mm
Cross-section	Kidney shaped	Oval	Round
Pigmentation	Dense & clumped towards the periphery	Evenly distributed towards the periphery	Dense auburn through the cross-section
Cuticle	—	Medium	Thick
Undulation	Prevalent	Uncommon	Rare

cessory ridges on canines, longitudinal tubercles in anterior teeth, etc., have also been studied for the discrimination of race.

- The anterior curvature of the femur is said to be distinctive for the negroid race.

SEX

Situations Where Sex Determination is Needed

1. For the purpose of simple identification in the living, where the individual of one sex carries the features of the opposite sex.
2. When a person appears to possess the primary sex organs of both the sexes.
3. For the purpose of deciding whether an individual can exercise certain civil rights reserved to one sex only.
4. For deciding questions relating to legitimacy, divorce, paternity, affiliation, and also to some criminal offences.
5. Simple identification of dead individuals in an advanced state of decay where primary sex organs are lost due to decomposition.

Determination of Sex in the Living

1. **Presumptive evidence of sex**
   It is based on the outward appearance of the individual, taking into account the clothing, general appearance of the face, the body contour, distribution of hairs including evidence of shaving, the habits, the voice, etc. It becomes unreliable when a person of one sex tries to conceal his own sex (*concealed sex*), and behaves like a person of the opposite sex.
2. **Probable evidence of sex**
   It is based upon the possession of secondary sexual characteristics such as breast development, distribution of body hairs, muscular development, and presence of vagina in females and penis in males. Difficulty arises in the case of intersex states when there is intermingling of sexes.
3. **Positive evidence of sex**
   This is done by confirming the presence of ovaries in females, and testes in males, and by the presence of Barr bodies and Davidson bodies.
   - **Barr body** or **sex chromatin** (Fig. 4.1) is a distinctive basophilic, intranuclear structure usually located near the inner surface of nuclear membrane of the somatic cells of females, which is absent in males. It is presumed that this is due to the inactivation of an extra X chromosome, and the number of Barr bodies present is correlated with the number of X chromosomes as follows:

     $B = X - 1$, (B = number of Barr bodies, X = Number of X chromosomes)

     This is sometimes helpful in clarifying certain chromosomal aberrations. A recent study

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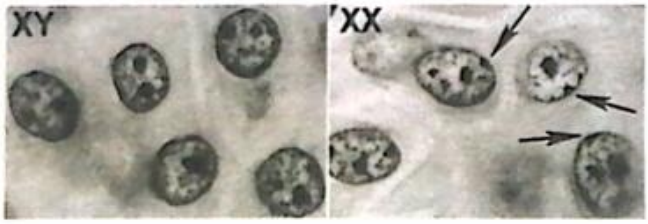
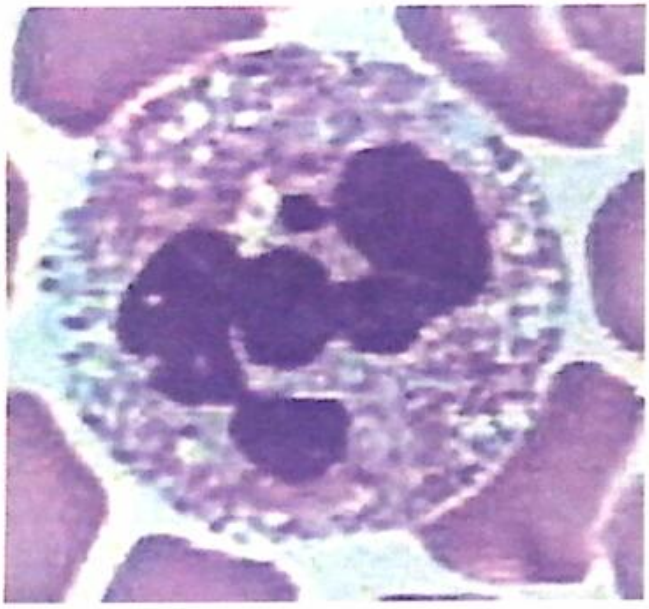
on the frequency of Barr bodies in females of different Asian racial groups produced the following results: Indian (34%), Malaysian (33%), and Chinese (22%).



| Fig. 4.1 Barr body |

- **Davidson and Smith** observed a sex difference in the morphology of polymorpho-nuclear leukocytes in females. Some polymorph nuclei demonstrate an additional lobe ("drumstick") which is rarely found in males. This has come to be called the "**Davidson body**" (Fig. 4.2).



| Fig. 4.2 Davidson body |

- The Y chromosome present in some cells demonstrates fluorescence when stained with quinacrine.

Intersex (Disorders of Sexual Differentiation)

- Sexual differentiation is a sequential and ordered process. Chromosomal sex, established at the moment of fertilization determines the gonadal sex, which in turn causes the development of phenotypic sex, in which male and female urogenital sex is formed.
- A disturbance in any process during embryogenesis may impair sexual differentiation. No matter how many X-chromosomes are present (47XXY, 49XXXY), a testis will develop as long as a normal Y chromosome is present. A normal testis is essential for the development of masculine characteristics. The absence of testes, as seen in females (and males in whom castration is done before puberty), will make a person feminine.
- Though there are many ways of classifying intersex states, it can be conveniently classified as follows for a better understanding:

Classification of disorders of sexual development

1. ***Disorders of chromosomal sex***
   - Klinefelter syndrome
   - XX male
   - Gonadal dysgenesis (Turner syndrome)
   - Mixed gonadal dysgenesis
   - True hermaphroditism
2. ***Disorders of gonadal sex***
   - Pure gonadal dysgenesis
   - Dysgenetic testis
   - Absent testis syndrome
3. ***Disorders of phenotypic sex***
   - Female pseudohermaphroditism
   - Congenital adrenal hyperplasia
   - Non-adrenal female pseudohermaphroditism
   - Developmental disorders of mullerian duct
   - Male pseudohermaphroditism
   - Abnormalities in androgen synthesis
   - Abnormalities in androgen action
   - Persistent mullerian duct syndrome
   - Developmental defect of male genitalia

Some important disorders will be discussed here:

Klinefelter Syndrome (Fig. 4.3)

- It is best defined as male hypogonadism that occurs when there are two or more X chromosomes and one or more Y chromosomes.

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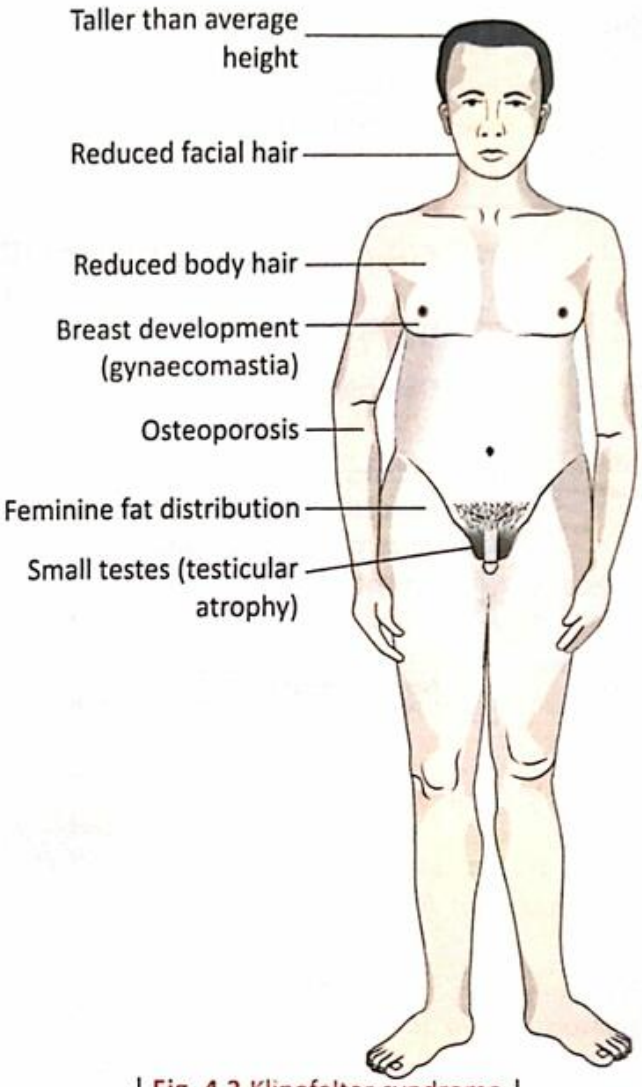

| Fig. 4.3 Klinefelter syndrome |

- This is the most common cause of hypogonadism in males. The incidence is 1 in 850 live male births.
- The classical pattern is associated with 47 XXY karyotype.
- Characteristic features include eunuchoid body with abnormally long legs; small atrophic testes often associated with a small penis, and lack of such secondary sex characteristics as deep voice, beard, and male distribution of pubic hair. Gynaecomastia is a usual finding.
- It is the principal cause of male infertility.

Turner Syndrome (Fig. 4.4)

- This results from complete or partial monosomy of the X-chromosome, and is characterised primarily by hypogonadism in phenotypic females.
- It is the most common sex chromosome abnormality in females.
- Usual karyotype is 45 XO.
- Characteristic features include short stature, low posterior hairline, webbing of neck, broad chest with widely spaced nipples, cubitus valgus, pigmented naevi, and peripheral lymphoedema at birth. Coarctation of aorta is a common finding.
- It is the single most important cause of primary amenorrhoea.

Hermaphroditism

- The term "true hermaphrodite" implies the presence of both ovarian and testicular tissue. In contrast, a pseudo-hermaphrodite represents a disagreement between the phenotypic and gonadal sex. Therefore, a female pseudo-hermaphrodite has ovaries but male external genitalia, and a male pseudo-hermaphrodite has testicular tissue but female type genitalia.
  - ***True hermaphroditism***
    - It is an extremely rare condition.
    - In some cases, there is a testis on one side and an ovary on the other; whereas in other cases, there may be combined ovarian and testicular tissue known as ovotestes.
    - Karyotype: 46 XX in 50% of cases, and 46 XY in 25% of cases.
  - ***Female pseudo-hermaphroditism***
    - Karyotype is 46 XX in all cases, and the development of gonads (ovaries) and internal genitalia are normal.
    - Only the external genitalia are ambiguous or virilized.
    - The basis of this disorder is excessive and inappropriate exposure to androgenic steroids during early foetal life.
  - ***Male pseudo-hermaphroditism***
    - Karyotype is 46 XY.
    - Their gonads are exclusively testes, but the

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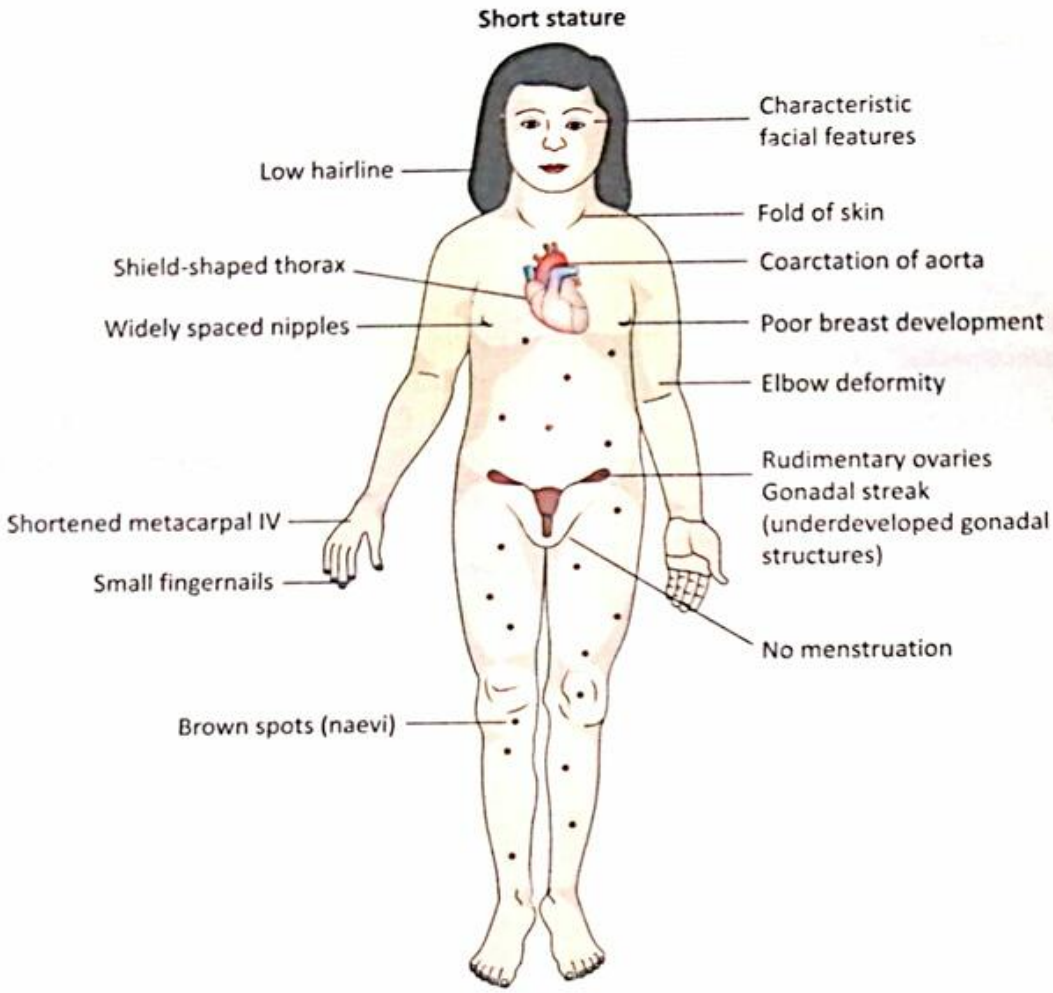

| Fig. 4.4 Turner syndrome |

Table 4.4 Sex Determination in Intersex

Intersex	Anatomical Sex	Nuclear Sex
Gonadal Agenesis	—	—
Gonadal Dysgenesis		
Turner's Syndrome	Female	—
Klinefelter's Syndrome	Male	Female
True Hermaphroditism	Bisexual	Female
Pseudo-Hermaphroditism		
Male	Female	Male
Female	Male	Female

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external genitalia are either ambiguous or completely feminine.

- Commonest cause is defective virilization of male embryo, resulting from genetically determined defects in androgen synthesis or action, or both.

Determination of Sex in the Dead

1. **In a decomposed body**
   a) Putrefaction starts early in the external genitalia altering their appearance.
   b) Deliberate mutilation of external genitalia, as seen in sex crimes and destruction by carrion feeders (scavenging animals) soon after death, poses problems for identification.
   c) In such circumstances, one must make a search for the ovaries.
   d) A non-pregnant uterus, and uterus containing non-degenerative myomas are significantly resistant to putrefaction.
   e) Prostate is also among the organs to putrefy last.
   f) But when the primary sex organs are totally unidentifiable, one has to look for sexual characteristics in the skeleton.
2. **From skeletal remains**
   a) For a trained pathologist, it seldom poses a problem to determine sex from skeletal remains. The accuracy of estimating sex from skeletal remains depends upon the number of bones available. According to Krogman, when the entire skeleton is available, sex can be determined with 100% certainty, from pelvis alone 95%, from skull alone 90%, from both skull and pelvis 98%, and from long bones it can be done with 80% certainty.
   b) Sex differences in the morphology of skull and mandible (Fig. 4.5) are considered quite reliable, and have been used extensively for sex determination. While the female skull retains the gracile attributes seen in pre-pubescent skull, the male cranium becomes markedly rougher in adulthood at the site of muscle attachments. The important differentiating features include prominence of supraorbital ridges, glabella, mastoid process, digastric groove, muscular markings in the occipital area, and frontal and parietal eminences (Table 4.5).
   c) The pelvis is generally agreed to be the part of the skeleton best suited for sex determination as it is associated with female structural capability to bear children. The morphological features that are important for sex determination (Fig. 4.6 & 4.7) include greater sciatic notch, sub-pubic angle, pre-auricular sulcus, shape of pubis, etc. The shape of the greater sciatic notch is an important differentiating feature even in early foetal life. The other features become more pronounced after puberty due to the effect of hormones. The important differentiating features are given in Table 4.6.
   d) Because the differentiating features become more prominent after puberty, it is easier to sex an adult skeleton than to sex infant remains. Again towards old age, there occurs blurring of sexually dimorphic traits. So the determination of sex from bones should ideally be limited to 15–55 years of age.
   e) Although other bones (long bones, sternum, and ribs) have also been investigated for their accuracy and reliability for sex determination, they are only used when the skull and the pelvis are not available for examination.
   f) In addition to the qualitative assessment of sex from the skeleton, a quantitative approach can be used to "calculate" sex. Some important indices devised for this purpose are as follows:

      i) **Sciatic notch index**

      $$\frac{\text{Width of notch (mm)}}{\text{Depth of notch (mm)}} \times 100$$

      Male: 4 to 5; Female: 5 to 6

      ii) **Washburn ischiopubic index**

      $$\frac{\text{Pubic length (mm)}}{\text{Ischial length (mm)}} \times 100$$

      Male: 73 to 94; Female: 91 to 115

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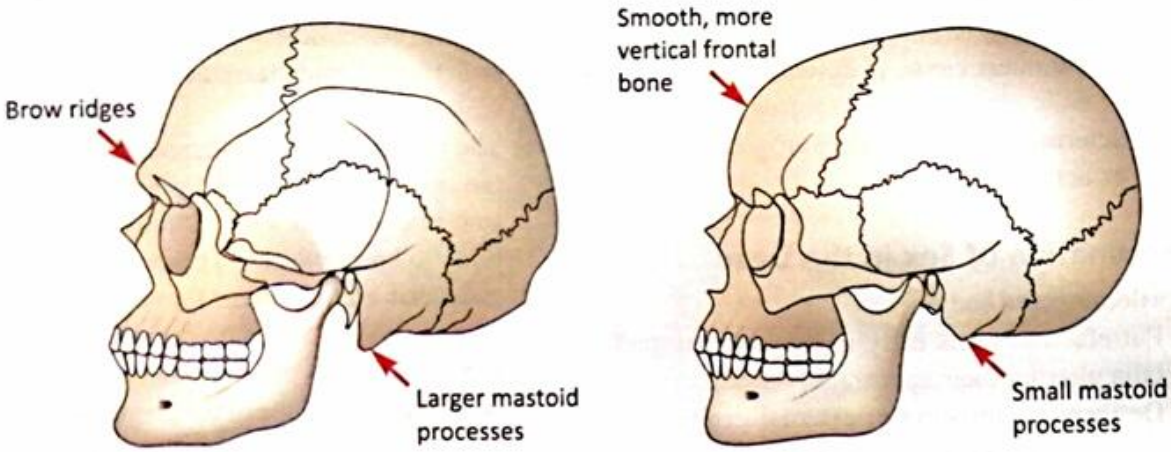
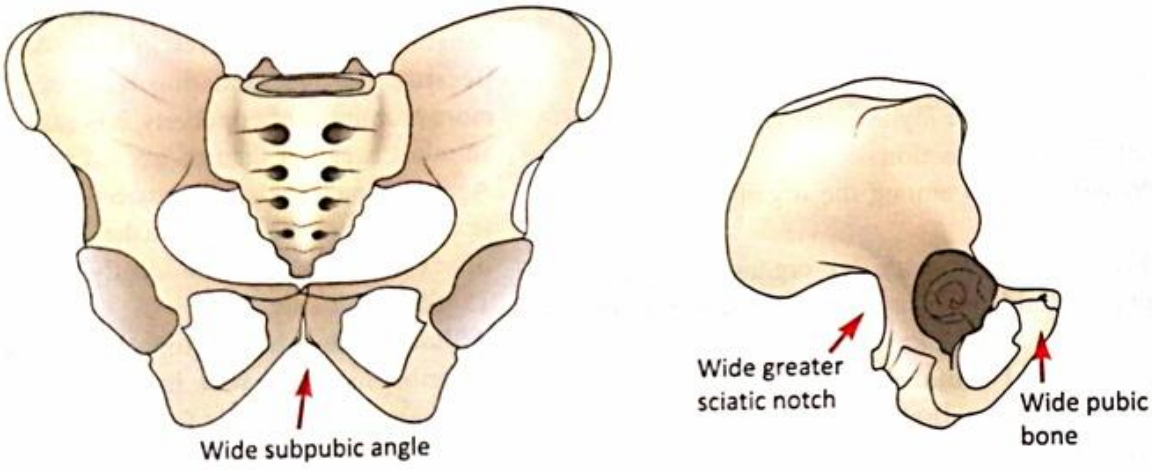
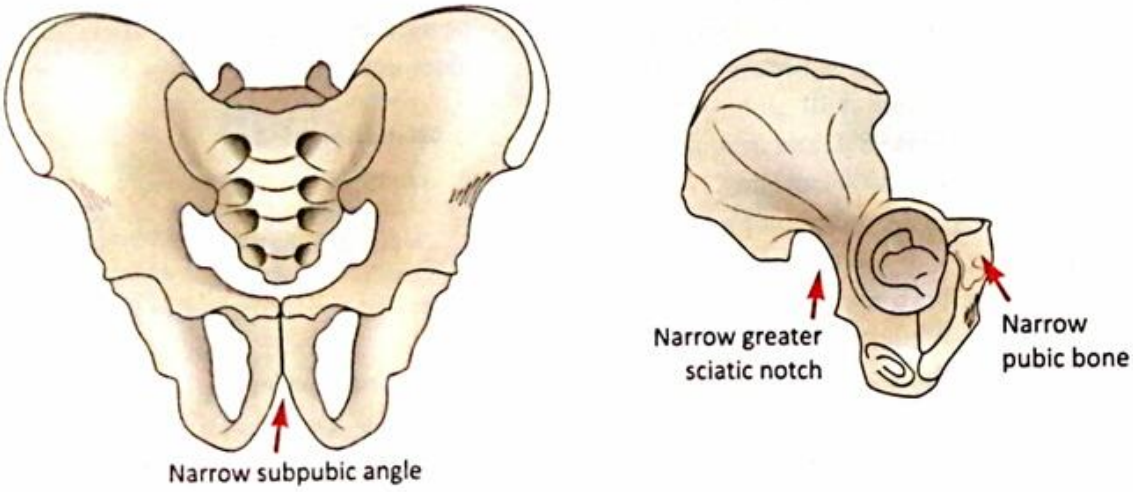


| **Fig. 4.5** Skull – Sex differences. (a) Male (b) Female |



| **Fig. 4.6** Pelvic bone – Sex characteristics (Female) |



| **Fig. 4.7** Pelvic bone – Sex characteristics (Male) |

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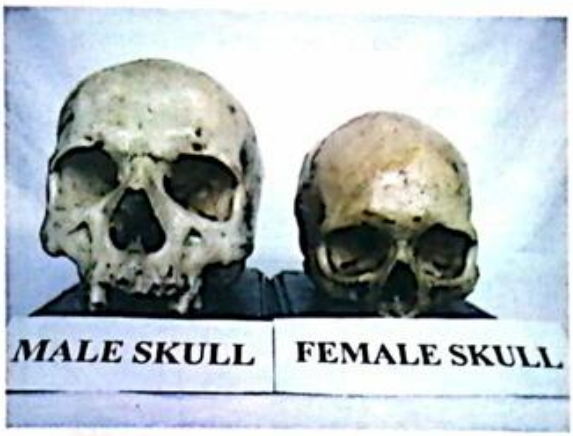
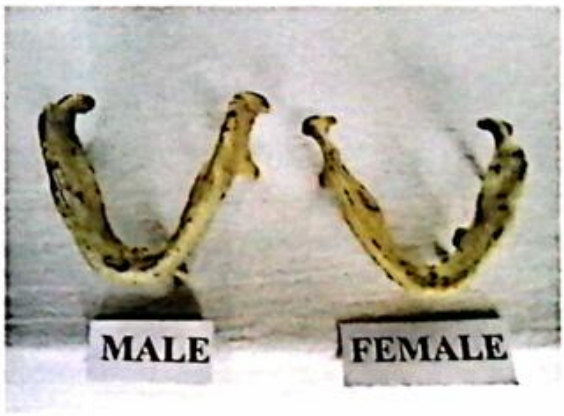


| **Fig. 4.8a** Sex Differences – Skull front view – male (*left*); female (*right*) |

| **Fig. 4.8b** Sex Differences – Skull profile male (*left*); female (*right*) |

| **Fig. 4.9a** Sex Differences – Mandible front view – male (*left*); female (*right*) |

| **Fig. 4.9b** Sex Differences – Mandible profile – male (*left*); female (*right*) |



| **Fig. 4.9c** Sex Differences – Mandible inferior surface - male: square shaped chin (*left*); Female: rounded chin (*right*) |

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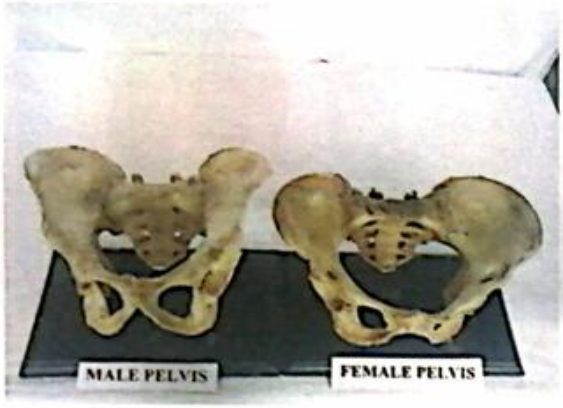
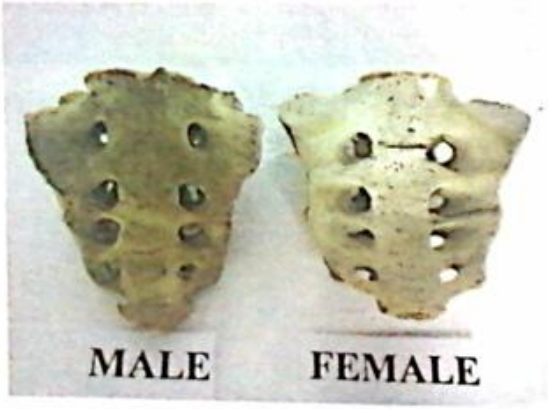
| **Fig. 4.10a.** Sex Differences - Male pelvis front view: acute (V shaped) sub-pubic angle (left); Female pelvis front view: obtuse (U shaped) sub-pubic angle (right) |



| **Fig. 4.10b.** Sex Differences - Male pelvis superior view: heart-shaped pelvic brim (left); Female pelvis superior view: elliptical pelvic brim (right) |



| **Fig. 4.11** Sex Differences - Sacrum |

| **Fig. 4.12** Sex Differences - Femur |

(Pic 4.10–4.12 : Dr Anu Sasidharan)

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iii) **Corporobasal sacral index**

$$\frac{\text{Breadth of 1}^{st}\text{ sacral vertebra (mm)}}{\text{Breadth of base of sacrum (mm)}} \times 100$$

Male: 45; Female: 40.5

iv) **Sternal index**

$$\frac{\text{Manubrial length (mm)}}{\text{Body length (mm)}} \times 100$$

Male: 46.2; Female: 54.3

STATURE

- Estimation of stature or height of a person is subject to variations during life due to muscular relaxation and elasticity of intervertebral discs, but could still be valuable in identification.
- Stature estimation from dismembered body parts can be done on the basis of the ratio of the body part concerned, in relation to the entire body.

Thus, stature
= 2 x (length of either arm) + 30 + 4 cm
= 2 x (length from vertex to symphysis pubis)
= 2 x (length from symphysis pubis to either heel)
= 3.3 x (length from sternal notch to symphysis pubis)
= 8 x (height of the skull)
= 19/5 x (length of forearm)

- Generally, 2.5 to 4 cm is added to the stature calculated from skeletal remains in order to account for soft tissues.
- Stature can be estimated from skeletal remains quite accurately with the help of regression formulae using the length of long bones. The weight bearing long bones especially of the lower limbs are supposed to provide more reliable estimates of stature as compared to the other bones.
- **Karl Pearson** developed regression formulae which became popular in the UK and other parts of the Western world.
- **Dupertuis & Hadden** suggested using more than one long bone in the calculation of stature, and

4

Table 4.5 Sex Differences in the Skull and Mandible

Trait	Sex: Male	Sex: Female
General size	Large	Small
Architecture	Rugged	Smooth
Supraorbital ridges	Medium to large	Small to medium
Mastoid processes	Medium to large	Small to medium
Frontal & parietal eminences	Small	Large
Orbits	Square, lower, smaller with rounded margins	Rounded, higher, larger with sharp margins
Forehead	Steeper, less rounded	More vertical and rounded
Cheek bones	Heavier, more laterally arched	Lighter, more compressed
Mandible	Larger, higher symphysis, broader ascending ramus	Small
Palate	Larger, broader, U shape	Small parabola
Occipital condyles	Large	Small
Teeth	Large, lower M1 often 5 cusped	Small molars, often 4 cusped

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Table 4.6 Sex Differences in the Pelvis

Trait	Sex: Male	Sex: Female
Pelvis as a whole	Massive, rugged, marked muscle sites	Less massive, gracile, smoother
Symphysis	Higher	Lower
Subpubic angle	V-shaped	U-shaped, obtuse angle
Obturator foramen	Large, often ovoid	Small, triangular
Acetabulum	Large, directed laterally	Small, directed antero-laterally
Greater sciatic notch	Smaller, narrower, deeper	Larger, wider, shallower
Ischiopubic rami	Slightly everted	Strongly everted
Sacroiliac joint	Large	Wide
Pre & Post auricular sulcus	Not frequent	More frequent, better developed
Ischial tuberosity	Not everted	Everted
Sacrum	Longer, narrower, evenly distributed curvature, with 5 or more segments	Shorter, broader, marked curvature at S1-2, & S2-5, with 5 segments
Pelvic brim	Heart-shaped	Circular, elliptical
True pelvis, or cavity	Relatively smaller	Oblique, shallow, spacious

felt that the tibia and femur provided better estimates than radius and humerus.

- **Trotter & Gleser** studied the racial differences in stature calculation, and evolved regression formulae for the 3 major races, as well as the Mexican and Puerto Rican groups.
- **Steele** devised formulae to estimate stature from fragmented bones. He deduced the ratio of various segments of long bones in relation to their entire length, so that the length of a long bone could first be estimated from its fragments, which can then be applied to regression formulae to arrive at the stature. (Box 4.1 outlines an Indian case where this was done successfully for the first time, while Box 4.2 recounts a classic Western case in forensic reconstruction.)
- Of all the formulae used for deducing stature from long bones, those devised by Dupertuis and Hadden are generally considered to be the most reliable (Table 4.7).

- The bones must be measured in a dry state without cartilage, using a Hepburn osteometric board.
- The maximum length should be taken for all bones except femur and tibia, which are to be measured obliquely.
- Best results are obtained with lower limb bones, particularly, femur and tibia.

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Box 4.1 **A Puzzle of Skeletal Remains**

On 30 December 1981, Miss S, a 37-year-old woman from a village in Karnataka left home for a nearby town on a personal matter. She never returned. On 28 January 1982, her twin sister, Miss SS, formally reported the disappearance to the police. On 11 March 1982, policemen discovered decaying bones (part of a skull, and fragments of long bones), along with some hair tufts and feminine apparel in an isolated part of a nearby forest area. These were sent to the Medical Officer of the local Primary Health Centre (PHC) who opined that the bones were of an adult human female, and that they bore signs of antemortem injury. However, he referred the case for expert opinion to the Forensic Medicine Department of the nearby Government Medical College. The report issued subsequently by a specialist from the department contained conflicting information, and therefore the matter was referred through the Corps of Detectives, Bangalore, to the Central Forensic Science Laboratory, Hyderabad, for final opinion.

At the laboratory, experts in Forensic Medicine and Forensic Science collaborated on the case and systematically set about the task of identity fixation.

Methodology

- Precipitin test (*Ouchterlony test*) was done on the hair and bones which established their human origin conclusively.
- All the remains were concluded to belong to the same individual since they had the same configuration, did not demonstrate discrepancies in age or sex, and did not show evidence of duplication.
- Sex was deduced to be female on the basis of feminine characteristics (especially in the skull).
- Age was deduced to be around 35 to 40 years on the basis of suture closure, mandible characteristics, and Gustafson's method. The fact that the dentition indicated only 28 teeth to be present was explained by the (not uncommon) condition of permanent partial anodontia in which the 3rd molars do not erupt at all.
- Height was difficult to determine, since only fragments of long bones were available. However, by utilising specialised formulae (*Steele's formula*), the stature was meticulously worked out to be around 5 feet 1 inch (+/- 1 inch). The height of the missing woman had been 5 feet 1 inch.
- Even though the skull was incomplete with some parts missing, reconstruction was accomplished with plasticine, and superimposition done with a recent life-size photograph of the missing woman. They matched perfectly.
- An anomalous condition with reference to the mandibular incisors was noticed at the time of examination, which was verified as having been present in the missing woman as per the statements of the surviving sister, other relatives, and friends.
- Some bangles recovered along with the remains demonstrated an average diameter of 5.8 cm which matched perfectly with the average diameter of the bangles belonging to the missing woman (provided by the surviving sister).
- The black dye used in the tuft of hair was analysed as to its constituents and matched with the dye belonging to the missing woman (recovered from her home).
- The cause of death was deduced to be blunt injury to the skull on the basis of antemortem fractures.

Adapted from Kashyap VK, Kulashekharan AR, Pillay VV, Patnaik VP. A puzzle of skeletal remains: How forensic science and medicine succeeded in unravelling a complex and controversial murder case. Med Sci Law 1990; 30: 321–328.

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Box 4.2 The Buck Ruxton Case: Classic Forensic Reconstruction

On the morning of September 29, 1935, at an isolated spot on the outskirts of Scotland, a young lady on her afternoon walk happened to notice a bundle jammed between some rocks in a stream. She was shocked to see what appeared to be a human arm sticking out of it. The police were on the scene by mid-afternoon, and had soon discovered two human heads on the banks of the stream, as well as four bundles of human remains - thigh bones, legs, pieces of flesh, and an armless torso. One piece of newspaper wrapped around two upper arms proved to be the Sunday Graphic for 15 September 1935. The remains were sent to the Anatomy Department of the University of Edinburgh, and were subsequently examined by an eminent forensic expert, Prof John Glaister, and his colleague Dr. Gilbert Millar. They found themselves confronted with a human jigsaw puzzle of 70 pieces.

On careful sorting of the pieces it could be deduced that they belonged to two distinct persons, both female, one six inches shorter than the other. The taller body was almost complete, while the torso of the smaller one was missing. From the way the bodies had been dismembered it was clear that the murderer had knowledge of human anatomy, and was most probably a medical man. He had also removed the skin from the heads to make the faces unrecognizable, cut off the fingertips to make fingerprint identification impossible, and removed the teeth to avoid dental identification. However, some scalp hair still remained on the head of the smaller body, and further search of the river yielded parts of hands with intact fingertips. After soaking them in hot water, Glaister was able to get an excellent set of fingerprints.

Age estimation of the bodies was done by taking into account several features - sutural union of skull bones, status of dental roots (on X ray), and epiphyseal union of long bones. From these, it became clear that the age of the smaller victim was around 20 years, while the other victim appeared to be a middle-aged woman. As to the cause of death, this was fairly clear. The taller woman had five stab wounds in the chest, several broken bones, and many bruises. The hyoid bone in the neck was fractured, indicating strangulation before the other injuries had been inflicted. As to the other body, the signs were that she had been battered with some blunt instrument.

Superimposed face and skull of Isabella Ruxton

Meanwhile, the police discovered that the Sunday Graphic was a special local edition, and this fact led them to a suspect in that area. He was a Parsi doctor, Dr.Bukhtiar Rustomji Hakim, (shortened to a more fashionable Dr. Buck Ruxton), who was a small, rather good looking man with an excitable manner. He had called on the police five days earlier to the discovery of the remains, and had reported his wife missing. He had further alleged that Mrs. Ruxton's maid, Mary Rogerson had gotten pregnant by the laundry boy, and that probably his wife had taken her away somewhere for an abortion, since she was also missing. The police went to the maid's house

contd.

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and showed a blouse that had been used to wrap some of the remains, to her parents, who confirmed that it belonged to their daughter.

The police next spoke to the Ruxton's charlady, who told them that on the day Mrs. Ruxton and her maid had disappeared (September 15, 1935), Ruxton had arrived early at her house and explained that it was unnecessary for her to come to work that day, since his wife had gone to Edinburgh, and he was taking the children out for the day. The next morning, the charlady found the Ruxton's house in a state of chaos, with carpets removed, the bath full of yellowish stains, and a pile of burnt material in the yard. A neighbour told the police that Ruxton had persuaded her to come and clean up his house to prepare it for the decorators, claiming that he had cut his hand badly on a tin of peaches. She and her husband had obligingly scrubbed out the house. And Ruxton had given them some bloodstained carpets and a blue suit that was also stained with blood.

On 12 October, after a night of interrogation, the police formally arrested Buck Ruxton and charged him with the murders of his wife and her maid. The truth about the murders had now become clear. Ruxton was pathologically jealous, and constantly suspected his wife was unfaithful. Their married life had for long been a stormy one, and Mrs. Isabella Ruxton had even filed a police complaint a few years prior to the murder, alleging that her husband was beating her. A week before her disappearance, she had gone to Edinburgh with her maid, Mary Rogerson, to visit some close friends. Ruxton however suspected an adulterous relationship with a friend of his, and when she returned home had a showdown with her that became violent. In a fit of jealous frenzy, he throttled his wife and stabbed her repeatedly. Mary Rogerson probably heard the poor woman's screams and come in to investigate, whereupon she too was fatally assaulted by Ruxton. He had spent the next day dismembering both bodies, and the same night made the trip to an isolated spot several miles away to dispose of the remains.

At his trial, Ruxton's main line of defence was that the bodies were not those of Isabella Ruxton and Mary Rogerson, but of some other persons. However the medical experts (Prof. Glaister, Prof. Sydney Smith, and Dr. Millar) proved the real identities to the court. For the first time, the method of superimposition was used in the case, and became a graphic piece of forensic evidence that clinched the identity of Mrs Ruxton. The result was a unanimous verdict of guilty, arrived at in only one hour. Buck Ruxton was hanged on 12 May, 1936.

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Table 4.7 Dupertuis and Hadden's Formulae for Stature from Long Bones

	Centimetres	Inches
Male		
2.238F	+ 69.089	27.200
2.392T	+ 81.688	32.161
2.970H	+ 73.570	28.965
3.650R	+ 80.405	31.655
1.255 (F + T)	+ 69.294	27.281
1.728 (H + R)	+ 71.429	28.122
1.422F + 1.062T	+ 66.544	26.198
1.789H + 1.841R	+ 66.400	26.142
1.928F + 0.568H	+ 64.505	25.396
1.422F + 0.931T + 0.083H + 0.420R	+ 56.006	22.050
Female		
2.317F	+ 61.412	24.178
2.533T	+ 72.572	28.572
3.144H	+ 64.977	25.581
3.876R	+ 73.502	28.938
1.233 (F + T)	+ 65.213	25.674
1.984 (H + R)	+ 55.729	21.941
1.657F + 0.879T	+ 59.259	23.330
2.164H + 1.525R	+ 60.344	23.757
2.009F + 0.566H	+ 57.600	22.677
1.544F + 0.764T + 0.126H + 0.295R	+ 57.495	22.636

(F—Femur; T—Tibia; H—Humerus; R—Radius)

AGE

Estimation of the age of an individual is usually done by studying the following:

1. Physical development.
2. Teeth.
3. Appearance and fusion of ossification centres.
4. Age-related changes.

Estimation of Age During Intra-uterine Life

- Age of a foetus can be assessed by studying the developing morphology, appearance of ossification centres in various bones, and germination of teeth (Table 4.8). Important ossification centres for estimating foetal age include the talus, calcaneum, and tibial and femoral ends. These can be analyzed by dissection in the case of a dead foetus.
- ***Haase's Rule****: Haase's rule enables us to calculate the age of a foetus in lunar months from the length of the foetus.
  - Until the foetus reaches the length of 25 cm, the square root of the crown-heel length is taken to arrive at the age.
  - When the length of the foetus is more than 25 cm, it is divided by 5.

Estimation of Age from Birth till 25 Years

1. **Physical features**

   An approximate estimate of the age can be made from the height and weight of a person by referring to standard charts. A study of secondary sexual characteristics can be of added help.

2. **Teeth**
   - The development of human dentition in three stages, viz., deciduous dentition, mixed dentition, and permanent dentition, follows a periodic sequence which can be utilised for a more or less accurate estimation of age. Data regarding the eruption and root calcification of deciduous and permanent teeth are mentioned in Tables 4.9 & 4.10.
   - Differentiating points between deciduous and permanent teeth are given in Table 4.11.
   - An important point to remember in age estimation from dental eruption is with reference to the 3rd molar teeth, which have a predilection for either agenesis or impaction. In both cases, there will be non-eruption of the 3rd molars, but an X-ray of the jawbone will reveal impacted teeth, while agenesis will of course be associated with complete absence of the tooth concerned, even on X-ray. After

*Named after Karl Friedrich Haase (1788-1865), a German obstetrician.

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Table 4.8 Age Related Changes in Foetus

Months (IUL)	3	4	5	6	7	8	9
Features							
Length	9 cm	16 cm	25 cm	30 cm	35 cm	40 cm	45 cm
Weight	30–35 g	120–130 g	400 g	700 g	1 kg	1.5 kg	2–2.25 kg
Nails	Present in membranous form	—	Up to proximity of tips of fingers	—	Up to tips of fingers	—	Beyond the tips of fingers
Hair	—	Lanugo appears	Scalp hair appears	—	Scalp hair 1 cm long	Scalp hair 1.5 cm	Scalp hair 2 cm
Sex	—	Differentiable	—	Well differentiated	—	—	—
Eyelids	—	—	—	Adherent & eye lashes present	Non-adherent & eyelashes present	Well formed	—
Brain	—	—	—	Sylvian fissure formed	—	—	—
Intestine	—	Meconium in upper part of small intestine	Meconium up to ascending colon	Meconium in transverse colon	Meconium in descending pelvic colon	—	Meconium in rectum
Scrotum	—	—	—	Empty	—	Corrugated	Occupied by testes
Testes	—	—	—	On psoas muscle	Near the internal ring	In canal (L before R)	In scrotum (L before R)
Centres of ossification	—	—	Centre for manubrium, 1st segment of sternum	—	Talus & 2nd & 3rd segments of sternum	—	Lower end of femur, and cuboid

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Table 4.9 Calcification and Eruption of Deciduous Teeth

Tooth	Calcification	Eruption	Calcification of root completed
Central incisor			
Lower	5–6 months IUL	6–8 months	1.5–2 years
Upper	5–6 months IUL	7–9 months	1.5–2 years
Lateral incisor			
Upper	5–6 months IUL	7–9 months	1.5–2 years
Lower	5–6 months IUL	10–12 months	1.5–2 years
First molar	5–6 months IUL	12–14 months	2–2.5 years
Canine	5–6 months IUL	17–18 months	2.5–3 years
Second molar	5–6 months IUL	20–30 months	3 years

Table 4.10 Calcification and Eruption of Permanent Teeth

Tooth	Calcification	Eruption	Calcification of root completed
First molar	At birth	6–7 years	9–10 years
Central incisor	3–4 months	6–8 years	10 years
Lateral incisor	1 year	7–9 years	11 years
First premolar	1.5 years	9–11 years	12–13 years
2nd premolar	2 years	10–12 years	12–14 years
Canine	4–5 months	11–12 years	12–13 years
2nd molar	2.5–3 years	12–14 years	14–16 years
3rd molar	8–10 years	17–25 years	22–25 years

Table 4.11 Differences Between Temporary Teeth and Permanent Teeth

Temporary teeth	Permanent teeth
Smaller in size, lighter and more delicate	Longer and larger, stronger and heavier
Anterior teeth vertically placed	Anterior teeth slightly inclined forward
China white in colour	Ivory white in colour
Neck is more constricted	Less constricted
X-ray reveals tooth germ below the tooth	

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the eruption of second molar, the ramus of mandible grows posteriorly for the third molar to erupt. This can be made out by placing the index finger behind the 2nd molar. Because the eruption of 3rd molar is very irregular, X-ray examination of the jaw must always be undertaken to assess the calcification of 3rd molar, if spacing is present. If calcification is complete even without eruption of 3rd molar, age can be presumed to be more than 22 years.

- ***Boyde's method:*** Cross striations in the enamel of teeth represent daily incremental lines. The age of an individual can be calculated by counting the number of lines from the neonatal line onwards. This method is applicable mainly to infants. The age so calculated is accurate with an error of around 20 days.
- ***Medicolegal importance of teeth:*** Apart from estimation of age, dentition can be useful in a number of ways, and its study in relation to crime investigation has evolved into a dynamic new branch called Forensic Odontology (Box 4.3 presents an overview).
  - Because teeth resist putrefaction and other destructive processes such as fire for a longer period than most other structures in the body, they can be invaluable in the identification of decomposing or disintegrating remains. From the tooth pulp, tissues can be taken for determination of blood group, sex of the individual, and also for DNA fingerprinting.

3. **Appearance and fusion of centres of ossification**
   - Development and growth of bones take place by various methods of ossification. The process of appearance and union of ossification centres follows a definite time sequence which can be utilised for age estimation. As a general rule, the ageing of bones is more precise with respect to the appearance of centres of ossification than it is with respect to the union of epiphyses.
   - Fig. 4.13 displays the ages of appearance and fusion of ossification centres commonly utilised in age estimation.
   - One of the best methods of age estimation is undoubtedly the radiological survey of ossification status of various bones (Fig. 4.14). In young children, radiological examination of hand and foot alone can be sufficient for accurate fixation of age (Table 4.12).

Estimation of Age of an Individual Over 25 Years

1. **Physical features**
   Features like greying of hair, balding, decrease in stature, changes in the skin, arcus senilis (in the eyes), opacity of the corneal periphery, cataract, etc., give an idea of advancing age.
2. **Changes in the teeth** (Fig. 4.15)
   After the eruption and calcification of the 3rd molar (maximum 25 years of age), estimation of age in adults can be done based on the physiological changes of teeth. **Gustafson** used the following criteria:
   a) *Attrition* – Wearing down of the incisal or occlusal surface of teeth.
   b) *Paradentosis* – Loosening of teeth due to gum retraction.
   c) *Secondary dentine* – deposition of dentine in the pulp cavity.
   d) *Cementum apposition* – deposition of cementum in the root.
   e) *Root resorption.*
   f) *Transparency of the root.*
   The transparency of root & secondary dentine have the highest correlation with age.
   Gustafson developed a ranking scale from 0–3 for each of the six criteria. By studying the cross-section (ground to 0.25-mm thickness) of a tooth microscopically, points are assigned to the various changes, and the total score obtained is applied to the following regression formula:
   Total score = A + P + S + C + R + T
   Age (years) = 11.43 + 4.56 x (total score)

This has come to be known as the **Gustafson's method** of estimating age from teeth. In order to

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Box 4.3 Forensic Odontology (Forensic Dentistry)

Definition

Application of dental knowledge in the investigation of crime and administration of justice.

Scope

Dental study can be extremely helpful in:

1. Identification of unknown dead body: This is done by comparing antemortem and postmortem records, or by DNA study of tooth pulp.
2. Identification of burnt, mutilated, or decomposing remains (teeth are very resistant to decomposing or destructive processes).
3. Estimation of age, on the basis of eruption status, Gustafson's method, etc.
4. Identification of race, occupation, sex, etc., by study of characteristic features.
5. Identification of culprit through bite marks.
6. Diagnosis of poisoning, e.g., lead poisoning leaves behind a bluish line on the gingival margins.

Charting of teeth

1. ***Universal system***: Each tooth is given a number, 1 through 16 for upper jaw, beginning with right upper 3rd molar; and 17 through 32 for lower jaw, beginning with left lower 3rd molar. For example, lower left canine is tooth no.22.
2. ***Palmer's notation***: The Palmer's notation consists of a symbol (^{UL}, $_{LR}$) designating in which quadrant the tooth is found and a number indicating the position from the midline. Adult teeth are numbered 1 to 8, with deciduous (baby) teeth indicated by a letter A to E. Hence the left and right maxillary central incisor would have the same number, "1", but the right one would have the symbol "^{1}", underneath it, while the left one would have, "$_{1}$". Thus, lower left canine is designated $_{3}$.
3. ***Haderup system:*** Similar to Palmer's notation, except that it uses a + sign for upper teeth, and a – sign for lower teeth. The sign is placed before the number for left teeth, and after the number for right teeth. Thus, lower left canine is designated –3.
4. ***Federation Dentaire Internationale (FDI) two-digit system***: Similar to Palmer's notation, but substitutes a number for quadrant sign: 1 for right upper, 2 for left upper, 3 for left lower, and 4 for right lower quadrant. Thus, lower left canine is designated 33. For deciduous teeth: 5 for right upper, 6 for left upper, 7 for left lower, and 8 for right lower quadrant. Thus, lower left temporary canine is designated 73.
5. ***Modified FDI system***: Same as above, except that right lower quadrant is 3, and left lower quadrant is 4 (zig-zag system). For deciduous teeth: 5 for right upper, 6 for left upper, 8 for left lower, and 7 for right lower quadrant. Thus, lower left permanent canine is designated 43.

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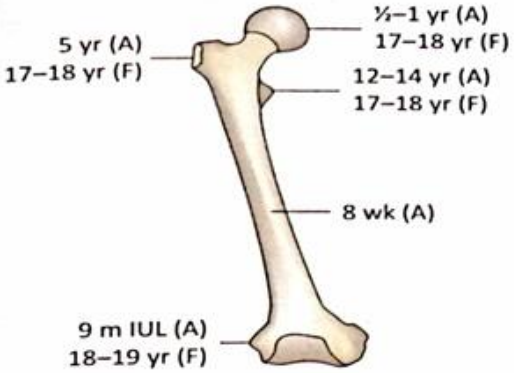
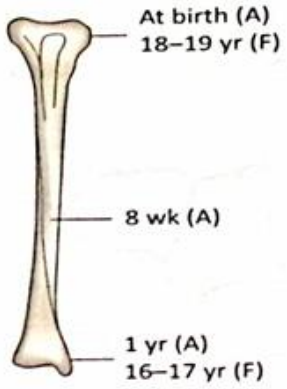
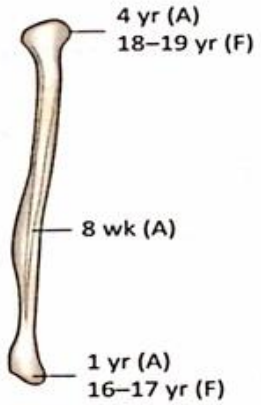


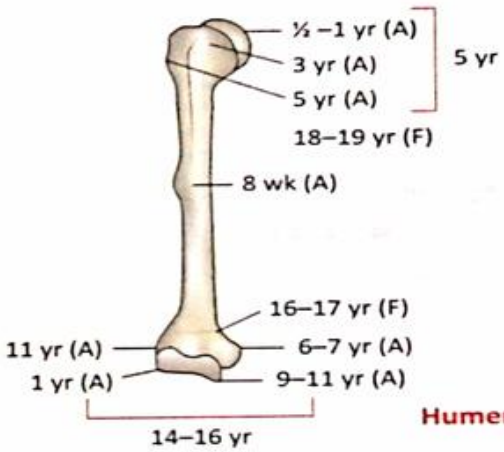
Femur



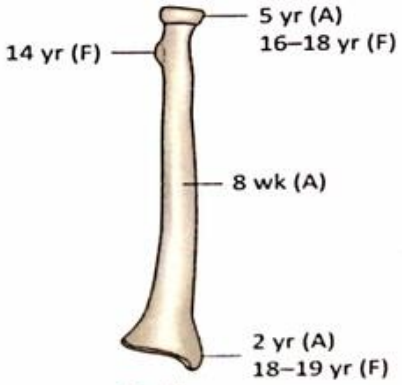
Tibia



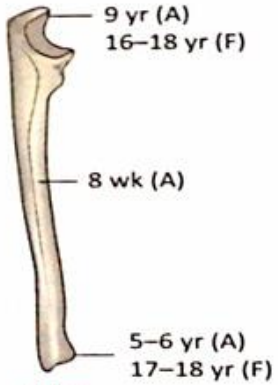
Fibula



Humerus



Radius



Ulna

Note: Normal range of variability in appearance and fusion of ossification centre is + ½ yr to 1 yr

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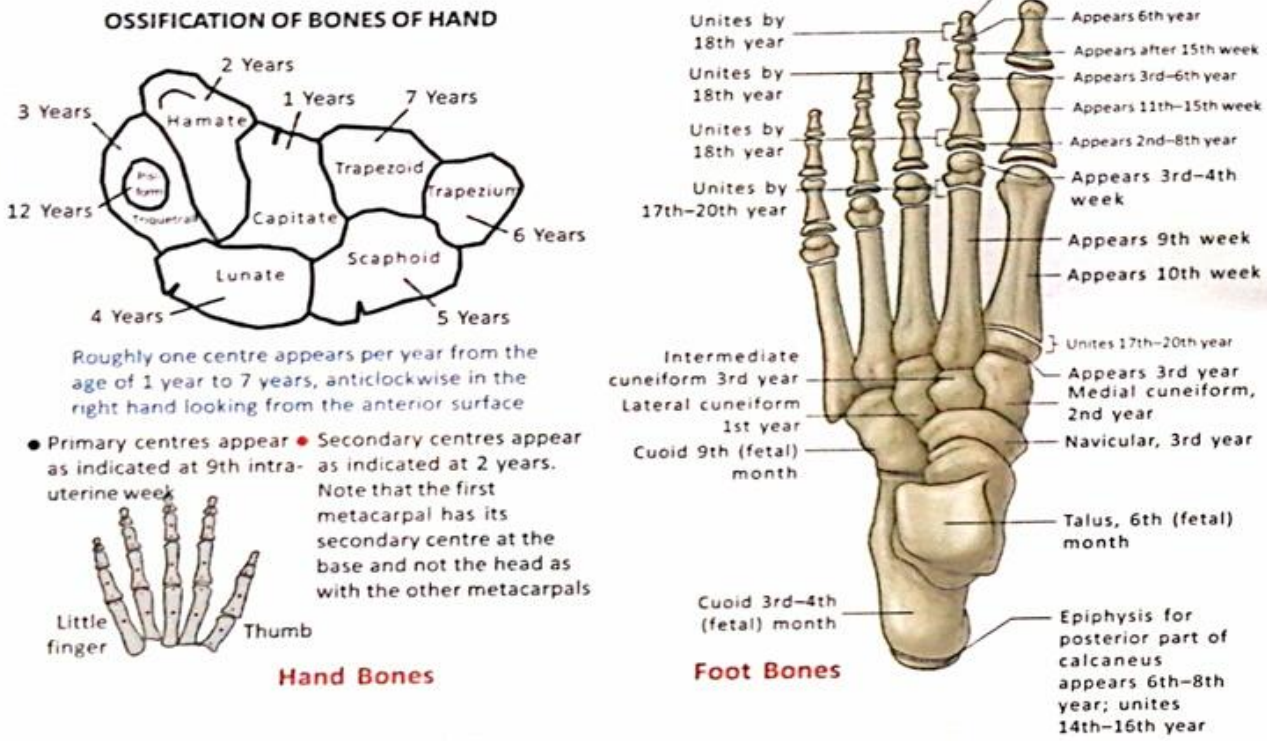

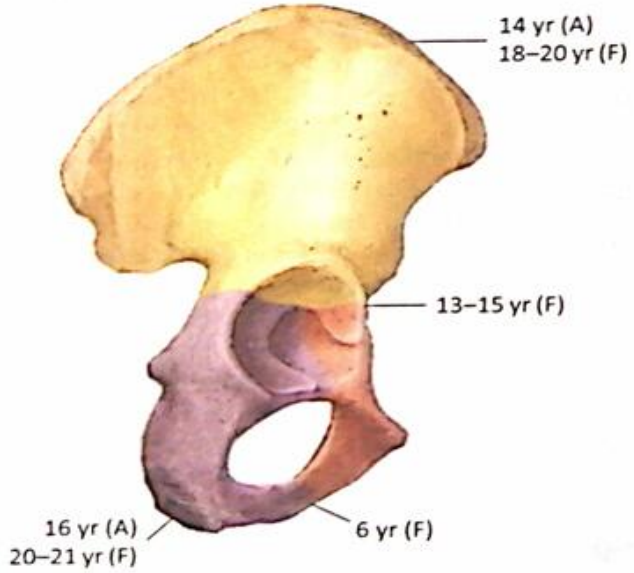

| **Fig. 4.13** Chronology of appearance and fusion of important ossification centres *(Illustration: Dr Hareesh S Gouda & Dr Shashidhar C Mestri)* |

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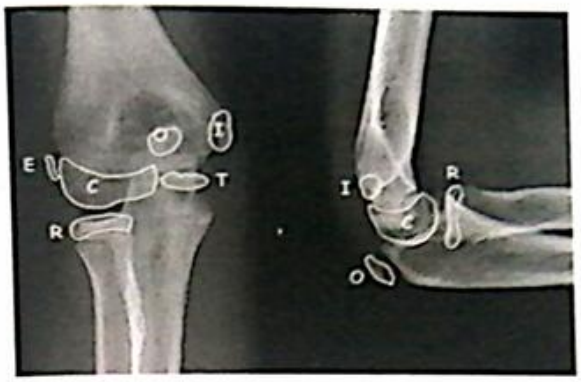
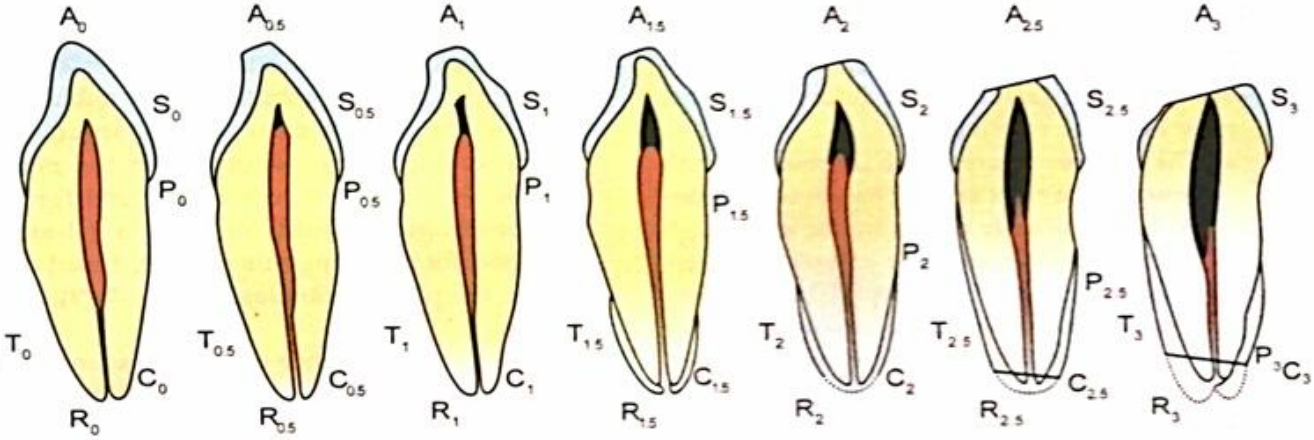


| **Fig. 4.14** Ossification centres at elbow. C—Capitellum; R—Radius; I—Internal or Medial Epicondyle; T—Trochlea; O—Olecranon; E—External or Lateral Epicondyle |



| **Fig. 4.15** Six stages of changes in teeth (Gustafson method): attrition (A), secondary dentine (S), cementum apposition (C), periodontal recession (P), root resorption (R), and root translucency (T) |

Table 4.12 **Beginning of Ossification in Children**

Age	Hand	Foot
5th–6th month IUL	Whole hand cartilaginous	Calcaneum (body)
7th month IUL	Whole hand cartilaginous	Talus
9th month IUL	Whole hand cartilaginous	Cuboid
1st year	Capitate and hamate	External cuneiform (1–2 yr)
2nd year	First four metacarpal heads	External cuneiform
3rd year	Triquetral (2–3 years)	Internal cuneiform, tarsal navicular
4th year	Lunate (4–5 years)	Mid cuneiform
5th year	Trapezium, carpal navicular	Scaphoid
6th year	Scaphoid (6–7 years)	—
8th year	Trapezoid	—
10th year	Pisiform (female 9 to 10 yr, male 10 to 11 yr)	Tuberosity of calcaneum

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make the method simpler, some investigators have reduced the number of parameters to 4: attrition, secondary dentine, cementum apposition, and transparency of root.

3. **Changes in the skeleton**

i) *Closure of skull sutures*: The closure of skull sutures seems to take place from the inner to the outer table, i.e., endocranial to ectocranial surface. Due to the phenomenon of lapsed union, i.e., incomplete union ectocranially, more reliance should be placed on endocranial closure. However, age evaluation by this method is generally not accurate, since it can only provide a range in decades. But it can be considered partially corroborative in the presence of other features. The following points must be borne in mind:

- The metopic suture which is present at birth between the right and left halves of the frontal bones, usually closes by the age of 2–6 years. However, in some cases it may persist throughout life (metopism) (Fig 4.16).
- Basal suture of the skull usually closes by 18–21 years (but can be delayed up to 40 years).
- Closure of vault sutures rarely occurs before the age of 30 years (Fig 4.17).
- Between 30 and 50 years, the sagittal and coronal sutures close endocranially. Ectocranial closure may or may not occur. The usual sequence is for the sagittal suture to close by 30–40 years (posterior one third), 40–50 years (anterior one third) and 50–60 years (middle one third), followed by coronal suture which fuses between 40–50 years (lower part), and 50–60 years (upper part), and termporal suture (around 60 years) (Fig 4.18).
- In general, suture closure occurs a little later in females than in males.

ii) *Age changes in the scapula*: **Stewart** summarised the age-related changes in the scapula as follows:

- Lipping of the circumferential margin of the glenoid fossa and clavicular facet
- Appearance of facet on the underside of the acromial process
- Increasing demarcation of the triangular area at the base of the scapular spine
- Appearance of the cristae scapulae
- Atrophy of the bone producing thinning, buckling, and pleating of the infraspinous area.

These changes begin around 30 years of age and become prominent at about 50 years or more.

iii) *Age changes in the symphysis pubis*: A study of the morphological changes of the articular surfaces of the innominate bone provides a reasonably good age indicator for adult remains. Variation in the face of the pubic symphysis, the anterior-most point of articulation between the two innominates in the pelvic girdle, is a common region analyzed for age determination. **Todd** outlined a 10-stage method for assessing this surface, based on a large sample of innominates (Fig 4.19).

The medicolegal importance of various ages is outlined in Table 4.13.

Other Factors that are Helpful for the Estimation of Age

- The various segments of the sternum appear mostly during intra-uterine life, but ossify from about 14 years to 40 years or more, as shown in Fig 4.20. The ossification centers can be made out in an immature sternal bone by holding it against light (Fig 4.21).
- Thyroid and cricoid cartilages tend to ossify by 45–50 years.
- The fusion of cornua with the body of hyoid bone occurs after 40 years.
- Lipping of the body of lumbar vertebrae starts around 40–50 years of age.
- Atrophic changes in the intervertebral discs start around 50–60 years of age.
- Arcus senilis, i.e., an opaque zone around the periphery of cornea may be noticed around 60 years.

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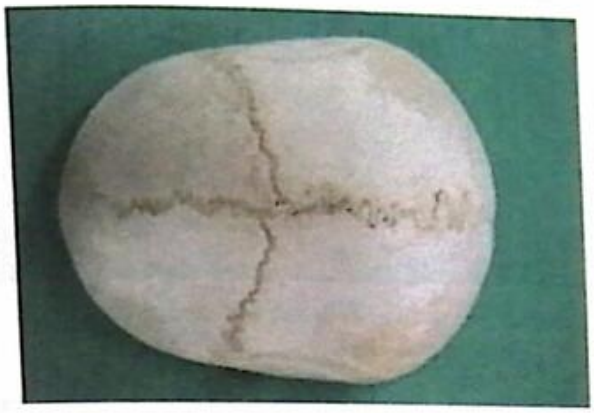
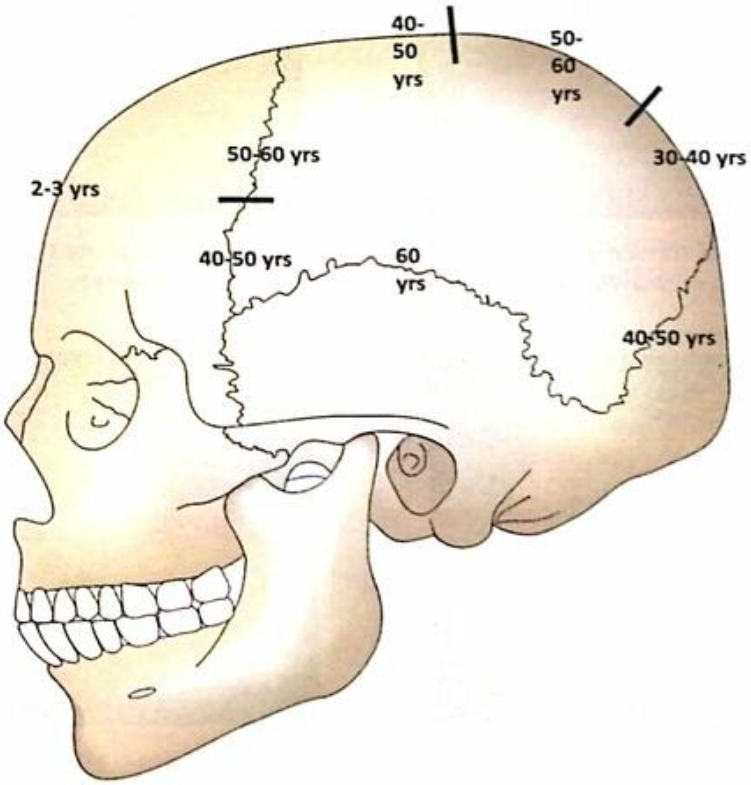


| Fig. 4.16 Persistent metopic suture |

| Fig. 4.17 Un-obliterated cranial sutures |



| Fig. 4.18 Suture closure. *(Fig. 4.16 to 4.18 : Dr Hareesh S Gouda & Dr Shashidhar C Mestri)* |

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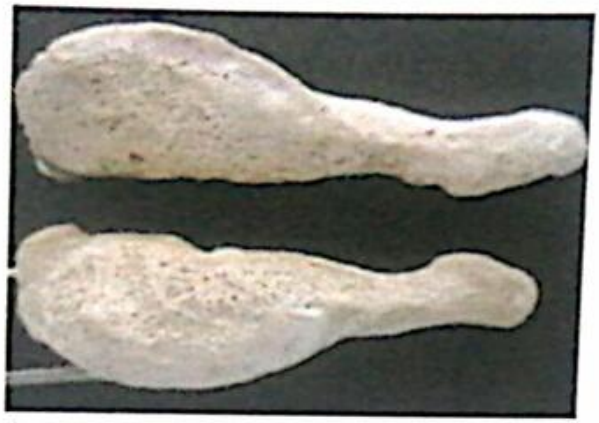
(a) Transverse ridges across the symphyseal surface (2nd decade)

(b) Gradual disappearance of symphyseal transverse ridges (2nd to 3rd decade)



(c) Granular symphyseal surface with well defined ventral and dorsal margin (4th decade)

(d) Beaded rim along the symphyseal margin (end of 5th decade)

(e) Erosion of symphyseal surface and break-down of ventral margin (6th decade)

(f) Irregular erosion of symphyseal surface (7th decade)

| **Fig. 4.19** Pubic symphyseal changes. *(Pic : Dr Hareesh S Gouda, Dr Shashidhar C Mestri)* |

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Table 4.13 Medicolegal Importance of Various Ages

Age	MLI	IPC Sec/Act	Remarks
> 7 months IUL	Infanticide	Sec. 300 IPC	Viability is attained
> 5 years	Criminal responsibility	Railway Act	Punishable for the offence
< 7 years	Criminal responsibility	Sec. 82 IPC	No criminal intent & not guilty of the crime
7–12 years	Criminal responsibility	Sec. 83 IPC	Guilty of offence, if sufficient maturity and understanding is present
< 12 years	Consent	Sec. 89 IPC	Parents/Guardians must give consent for physical examination
< 14 years	Employment	Factory Act	Cannot be employed in factory jobs
14–15 years	Employment	Factory Act	Non-hazardous jobs in the factory during daytime can be given
> 15 years	Employment	Factory Act	Can be employed, provided a fitness certificate is given
< 15 years (girls)	Rape	Sec. 375 IPC	Sexual intercourse with his own wife, with or without consent
< 16 years (girls)	Statutory rape	Sec. 375 IPC	Sexual intercourse with a girl, with or without consent
< 16 years (boys) < 18 years (girls)	Kidnapping	Sec. 361 IPC	Taking away without the consent of the lawful guardian. 10 years imprisonment, with or without fine
< 18 years (girls)	Kidnapping	Sec.366-A IPC	Procuring a girl for illicit intercourse 10 years imprisonment, with/without fine
> 18 years	Consent	Sec. 87 IPC	Can consent to suffer any harm not intended or known to cause death/ grievous hurt

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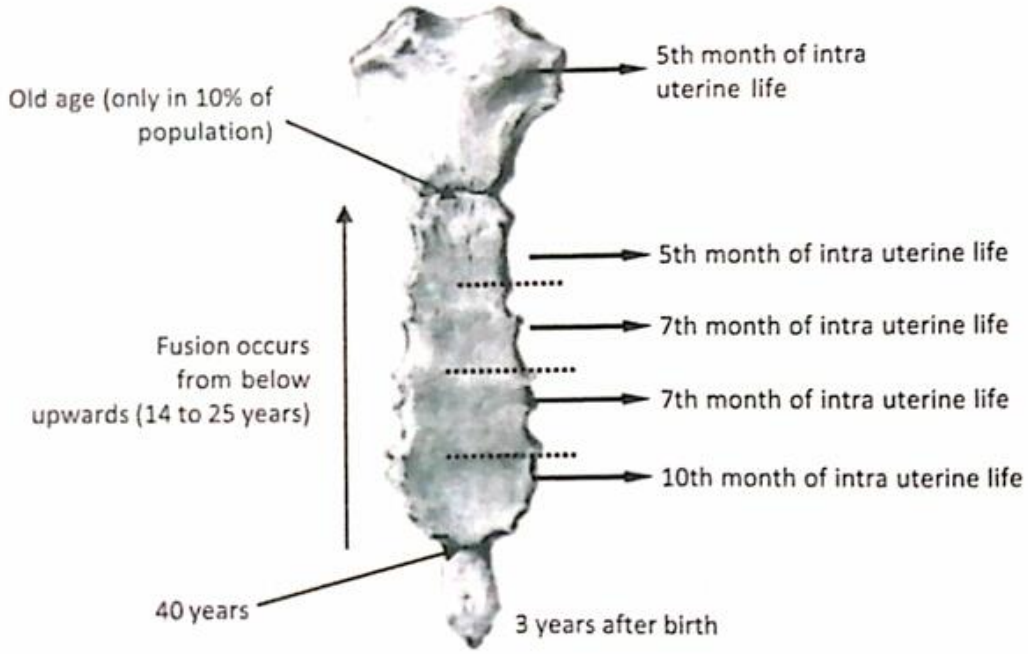
> 18 years	Attainment of majority	Sec.3, Indian Majority Act, 1875	Except those under the guardianship of court, can make a valid will, cast votes in election
> 18 years (girls)	Marriage	Child Marriage Restraint Act, 1978	—
> 18 years	Employment	—	Minimum age to enter government services
< 18 years (both sexes)	Judicial punishment	Juvenile Justice (Care and Protection of Children) Act, 2000	Sent to a reformatory
> 21 years	Attainment of majority	Sec. 3, Indian Majority Act, 1875	For those under guardianship of courts
> 21 years (boys)	Marriage	Child Marriage Restraint Act, 1978	—
< 21 years (girls)	Kidnapping	Sec. 366-B IPC	Procuring girls from outside the country or from Jammu & Kashmir for illicit intercourse. Punishment 10 years imprisonment with fine
55–65 years	Employment	—	Age of retirement



| **Fig. 4.20** Appearance and fusion of segments of sternum
(Fig : Dr Hareesh S Gouda & Dr Shashidhar C Mestri) |

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- Although greying of head or facial hair is not very reliable in the estimation of age, greying of pubic hair is more reliable, and usually starts after 60 years of age.

| Fig. 4.21 Ossification centres – Sternum *(Pic : Dr Shashidhar C Mestri)* |

HAIR

- The epidermal appendages referred to as hair, constitute a unique characteristic in human beings.
- Hair is known to resist putrefaction for a long time, and hence attempts were made to determine whether it could have the specificity of fingerprints in identification. Though this has now been proved wrong, a great deal of information can still be obtained from this trace evidence.
- Before trying to individualise a sample of hair, it is pertinent on the part of the forensic scientist to ascertain *whether it is really **hair**, or could it be some **fibre**?* The distinct morphology of hair with the three layers, viz., cuticle, cortex, and medulla, distinguishes it from fibres which are tubular and devoid of the three layers.
- The next step involves **species identification**, i.e., determining whether it belongs to human or animal (Figs 4.22 & 4.23).
  - ***Human hair*** is characterised by:
    - a thin medullary canal,
    - a broad cortex,
    - medullary index below 0.3,
    - circular or oval cross section,
    - pigmentation towards the periphery of the cortex,
    - and cuticular scale type VII
  - ***Animal hair*** is characterised by:
    - a wider medulla (sometimes filling the entire shaft),
    - medullary index above 0.5,
    - pigmentation around the medulla,
    - a variety of cuticular scale types,
    - colour changes along the hair shaft called "banding" is also seen in certain animals.
- Human scalp hair can be **racially** classified.
- Before attempting to compare the test hair from the exemplars, and individualise the hair sample, it is necessary to determine the **somatic** origin, i.e., the part of the body from which it originated.
  - Features that can help in pinpointing the body origin of hair include:
    - shape of the tip and the root
    - length
    - diameter
    - contour of cross-section, and
    - character of medulla, cortex, and cuticle.
- **Sex determination** of hair based on length of hair, and the nature of cut ends, is not reliable. Refractive index appears to be one of the best criteria for sex determination, since a significant difference exists between male and female hair. Sex can also be determined by studying Barr bodies in root sheath cells.
- An approximate **estimation of age** can be done based on the type of the hair such as primordial, lanugo, terminal, etc, and also from the variation in thickness and distribution of pigments. Various physical factors such as index, size, medullation, cuticular scale count, refractive index, birefringence of the cuticle, and chemical tests such as the rate of solution of hair root in caustic potash, etc., have also been studied for the determination of age from birth to maturity.
- Further steps in **individualisation** include:
  - ABO blood grouping.
  - Isozyme typing – PGM, RGD, EsD, AK, EAP, GLO, etc.
  - Identification of trace elements by neutron activation analysis
  - Evidence of disease
  - Evidence of application of dyes, henna, etc.

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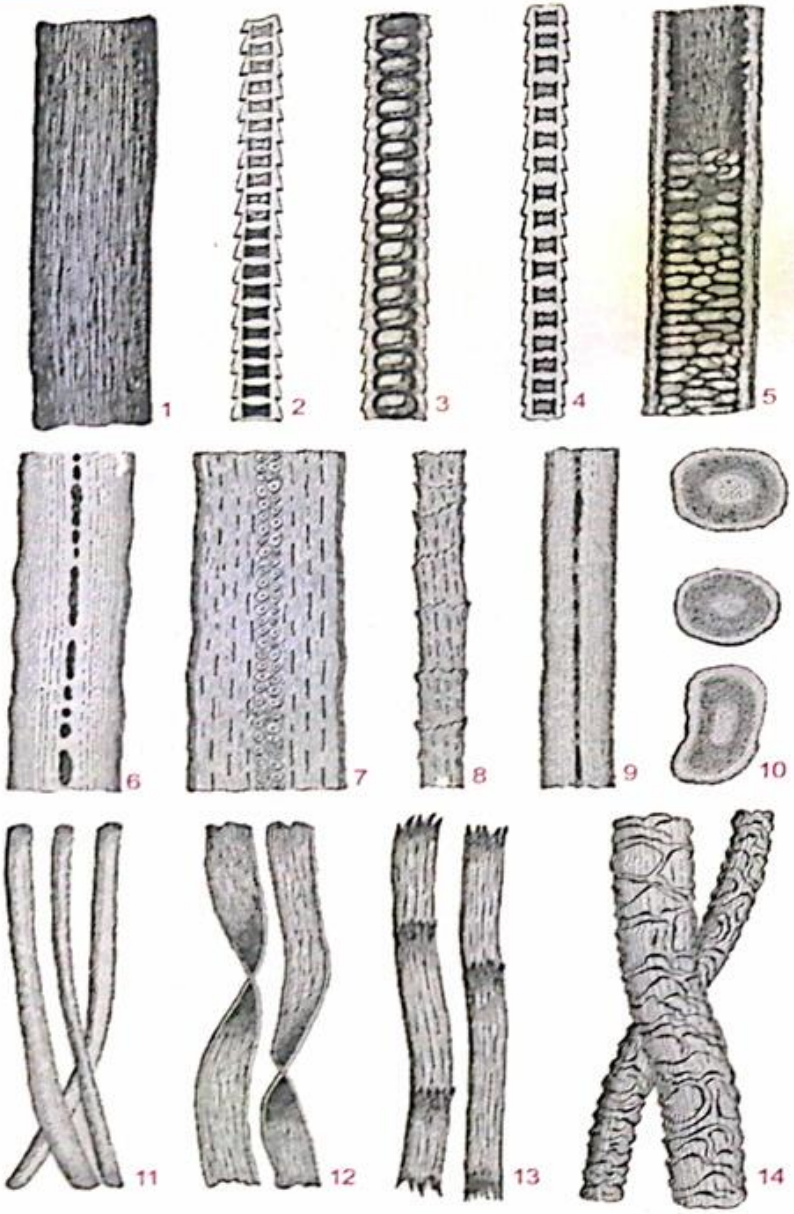

Fig. 4.22 Microscopical appearance of hairs from various sources, and vegetable and other fibres. Figs. 1 to 14—1, horse (back); 2, mouse; 3, cat; 4, chinchilla; 5, large hair from seal; 6, hair from head of human female, age, eighteen; 7, hair from head of man after treatment with caustic soda; 8, fine hair from back of hand; 9, from head of child; 10, cross-sections of hairs from the head; 11, silk; 12, cotton; 13, flax; 14, wool.

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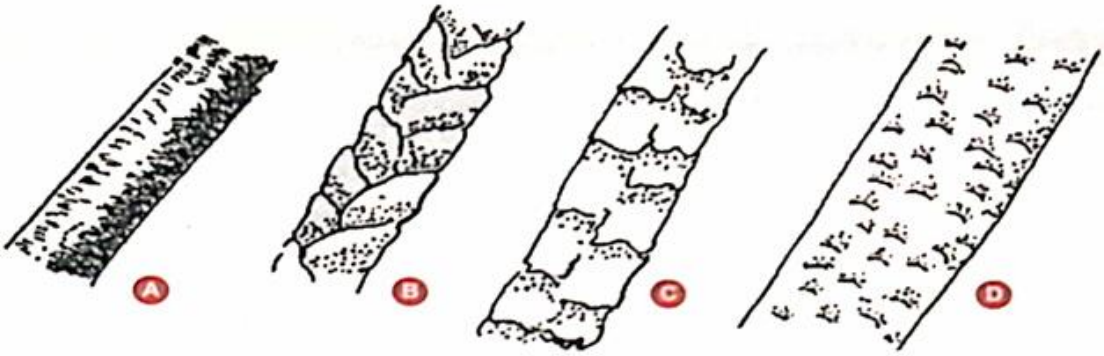

| Fig. 4.23 Hair – different species: (A) Human; (B) Cat; (C) Dog; (D) Mouse |

Burnt hair | Pulled hair | Cut hair

| Fig. 4.24 Microscopic appearance of hair when it is burnt, pulled or cut. *(Pic : Dr MB Rao)* |

Medicolegal Importance of Hair

- Apart from **aiding in identification**, hair can also help in a variety of ways in medicolegal situations (Fig 4.24):
  - The type of weapon which caused injury in a particular case can be deduced by examining the tip of the hair. Neatly cut ends suggest the use of a sharp-edged weapon, whereas crushed ends result from blunt force injury.
  - Singed hair is characteristic of burns and contact firearm injuries.
  - By examining the root of the hair, it is possible to opine as to whether it fell naturally or was pulled off forcefully during an assault.
  - Heavy metals such as arsenic, as well as many drugs of abuse get deposited in the hair, thereby permitting the identification of poison or drug consumed. The deposition of arsenic at intermittent levels on the shaft can also give us useful information regarding the periods of ingestion of the poison. For instance, the analysis of the hair of **Napolean Bonaparte** has proved beyond doubt that he was chronically poisoned with arsenic leading to his death.

THE EVOLUTION OF FINGERPRINTING (DACTYLOGRAPHY) (Box 4.4)

Through the ages there has been a constant quest for a reliable method of identification. This is especially true with regard to identification of criminals, to link them either to their previous criminal history or to a particular crime. **The Prevention of Crime Act** passed in **1871** in Great Britain, and amended in **1877**, culminated in the creation of a **Habitual Criminals Register**, comprising a list of criminals identified by

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Box 4.4 The Fall of Anthropometry and the Rise of Dactylography

Alphonse Bertillon was born in 1853 to Louis-Adolphe Bertillon, a brilliant scientist who together with his mentor (and later father-in-law) Prof Achille Guillard founded the new scientific discipline of Anthropology in France. Alphonse was a rebel right from the beginning and had severe problems with his teachers at school. As a young man he was virtually unemployable and drifted from one petty job to another, until finally landing a clerical job (with help from his distinguished father) at the Prefecture of Police in Paris. Here his daily work involved copying out forms which contained descriptions of criminals, a task that set him thinking. He realised that the existing system of identifying habitual criminals on the basis of haphazard physical descriptions was virtually useless, and devised a more systematic method. Bertillon began by attempting to invent what would be later called "photofit pictures." He sliced up photographs, stuck them on bits of cardboard like pieces of a jigsaw puzzle, and tried making different arrangements of ears, noses, mouths. He knew that measurements of human characteristics tended to fall into statistical groups, and yet no two human beings had exactly the same set of measurements. His idea was that if he could devise a series of simple measurements - length of the head, width of the head, length of the middle finger, and so on - he could use these as a system of criminal classification that would enable a policeman to check whether a suspect had a criminal record, or was using a false name.

Alphonse Bertillon

Thus was born the system of "Anthropometry" or "Bertillonage." But at first, the method was received with a great deal of scepticism, and Bertillon's immediate superior in fact dismissed the whole thing as a joke. It was only in 1882, when a new man, Jean Camecasse took charge of the Prefecture that Bertillon began to be taken seriously. By that time, he had greatly improved his system of identification, and had finalised a set of 11 basic measurements, including length and width of head, the right ear, forearm, middle and ring fingers, left foot, height, and length of trunk, and two photographs - full face and profile. The chances of two men having all 11 identical measurements were more than 4 million to one, a very good figure for those days! These measurements were copied down on filing cards, which in turn were stored in a cabinet with 81 drawers. Camecasse studied the method carefully and was impressed. He asked Bertillon to try his method out in actual practice. This was done and immediately proved to be successful. In fact, by 1888, "anthropometry" had proved itself so successful that a new Department of Judicial Identity was founded at the Prefecture, with Bertillon in charge.

But ironically, at the very moment of his long awaited triumph, Bertillon's achievement was about to be undermined. The cause: the rise of a more efficient system of identification known as "dactylography" or "fingerprinting." As early as the 1820s, a professor of anatomy named Johann Purkinje had pointed out that everyone's fingerprints are different, and even suggested a crude method of classification. But the real credit for the system of fingerprinting must go to an Indian Civil Servant named William Herschel who in 1860, when he was a magistrate near Calcutta, found himself confronted with the problem of preventing illiterate pensioners from coming back twice for their government pensions. His solution was to make them sign by pressing a finger dipped in ink on the receipt. The cheating immediately ceased. In 1877, Herschel wrote a letter to the Inspector General of Bengal prisons outlining his ideas on fingerprinting.

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At about the same time, a Scottish doctor named Henry Faulds who was living in Tokyo and teaching physiology to medical students at the Tsukiji Hospital, began studying fingermarks on Japanese pottery. A couple of years later, Faulds used his knowledge of fingerprints to clear a suspected burglar. In October 1880, Faulds wrote a letter to the scientific journal Nature about his theory of the use of fingerprints to identify criminals. Herschel, who was now in retirement in England, read the letter, and wrote to Nature describing how he had first used fingerprints for identification in 1858. Faulds was enraged. He dashed off dozens of letters to various public figures and scientists, including Charles Darwin, and even the Parisian Prefect of Police, accusing Herschel of trying to steal the credit for his discovery. Later he shifted to England where he became a police surgeon and tried subsequently to interest Scotland Yard in fingerprinting. But unfortunately he met with some initial failures when the technique was applied in practice, and this embittered him. He grew increasingly frustrated and aggressive, which only made him unpopular. This explains why when a distinguished scientist asked the editors of Nature to help him track down the founders of fingerprinting, they sent him only the address of William Herschel.

William Herschel

The scientist was 66 year-old Sir Francis Galton, a cousin of Charles Darwin who was an avid researcher of anthropometry. When he learned about the discovery of fingerprinting, he made a detailed study of the technique and came to the inescapable conclusion that it was far more accurte and far less complicated in identifying individuals than anthropometry.

Henry Faulds

Galton later met Herschel who handed over to him all his material. Galton took three years of careful study to assure himself that no two fingerprints were exactly alike, and set about developing an effective method of classifying them. In 1891, Galton published a paper on fingerprints in Nature, in which he acknowledged his debt to Herschel. The following year, he wrote the first treatise on fingerprinting. Over the subsequent years, more and more investigators became interested in fingerprinting, while interest in anthropometry declined rapidly. Alphonse Bertillon died a shattered man on February 13, 1914, after failing in his desperate efforts to convince everybody (in vain) that his system of identification was the best.

Sir Francis Galton

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By treating the fingerprint with gold nanoparticles with attached cotinine antibodies, and then subsequently with fluorescent agent attached to cotinine antibodies, a fingerprint of a smoker becomes fluorescent, while a non-smoker's fingerprint stays dark. The same approach can be used for identifying heavy coffee drinkers, cannabis smokers, and users of various other drugs. This application can perhaps be called "**dactylotoxicology**."

Poroscopy

- The papillary ridges of epidermis are studded with minute pores through which sweat exudes out in life.
- The number of pores, as well as their size, shape, and site in a given length of a ridge vary from person to person and are quite individualistic. In fact, they are as reliable as the minutiae of the ridges. This method of identification introduced by **Edmund Locard**, utilising the study of pores is called **poroscopy**.
- Poroscopy further enhances the reliability of latent fingerprints especially in cases of partial fingerprints where the usual comparison of minutiae cannot be resorted to.
- Since 9 to 18 pores (per mm) are present in a ridge, and each is unique in its characteristics, this method can lead to positive identification.

FOOTPRINTS

- Impressions of human feet on various substrates have been studied and have been found to be quite individualistic with reference to dermatoglyphics, various measurements, and also the morphological analysis.
- Dermatoglyphics or the ridge pattern, if clearly visible on the substrate against a contrasting background, is highly individualistic. The comparison of the footprints of the suspect with the test print can be carried out in the same way as in the case of fingerprints. Latent prints are also developed in the same way.
- In the absence of ridge patterns, as happens often in substrates such as soil, sand, etc., the measurements like length and width of the foot, length and width of toes, toe pads, the angles of declination from each toe, and from the ball to its juncture with the arch, etc., aid in distinguishing the footprints of one individual from another.
- It has been estimated that stature of an individual constitutes 15% ratio of foot length, i.e.,

$$\text{Stature} = \frac{\text{Maximum foot length}}{0.15}$$

- The weight of a person can also be estimated by studying the foot outline ball width. It is around 60.5% ratio of the foot outline width in case of males above 14 years, and around 67% ratio in case of females above 14 years.
- In the case of a walking footprint, i.e., if a series of footprints are available, it is possible to relate them with the gait pattern of the suspect. The weight distribution, length of the stride, and presence of abnormalities can be studied.
- Footprints are recorded by photography or by making casts.

Applications of Footprinting

- When recovered at crime scenes or on items of evidence, sole and toe impressions are used in the same manner as finger and palm prints to effect identification.
- Footprints of infants, along with thumb or index fingerprints of mothers, are still commonly recorded in hospitals to assist in verifying the identity of infants.
- It is not uncommon for military records of flight personnel to include barefoot inked impressions. Friction ridge skin protected inside flight boots tends to survive the trauma of a plane crash (and accompanying fire) better than fingers.

SCARS

- A scar is an acquired defect widely accepted as a marker of identification. The size, shape, and location of a scar can aid in positive identification, especially if it is unusual or unsightly.
- A scar is the result of a repair mechanism to an injury involving the dermis of the skin. It is

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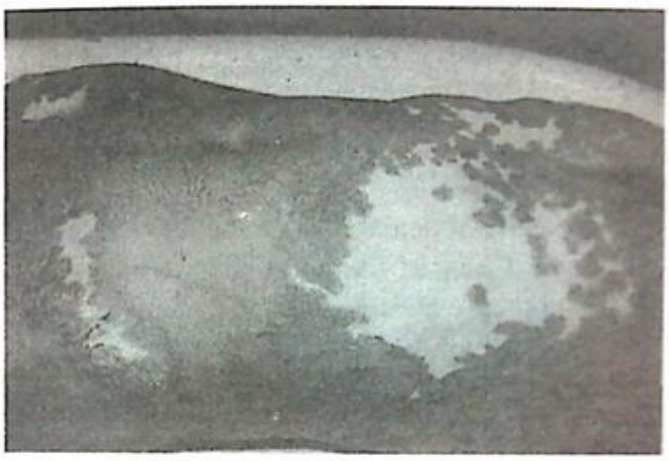
covered by epithelium and is devoid of pigmentation, sweat glands, and hair follicles.

- Apart from aiding in identification, a scar can also give information regarding:
  - the nature of the injury (Fig. 4.27), and
  - the causative agent.
- The size and shape of a scar will be approximately the size and shape of the original wound. Hence the nature of injury, as to whether it is an incised, lacerated, stab wound, etc., can be made out, which in turn can help predict the type of the weapon used to produce the injury.
- The age of a scar usually correlates well with the time of infliction of the injury.



| Fig. 4.27 Healed, hypopigmented burn scar |

CHEILOSCOPY*

- Lip prints are similar to fingerprints and footprints in that individual characteristics are used for identification.
- The creases on the vermilion border of the lips, which appear as white areas in lip prints, and the raised reddish areas outlined by these creases, which appear as dark areas, are analogous to the furrows and ridges of friction ridge skin (Fig. 4.28). The creases on the vermilion border are also referred to as grooves, furrows, wrinkles and valleys.
- Lip prints are unique and do not change during the life of a person. It has been verified that they recover after undergoing alterations like trauma, inflammation and diseases like herpes, and that the disposition and form of the furrows does not vary with environmental factors.
- The lip prints of parents and children and those of siblings have shown some similarities, which can help in establishing relationships to a limited extent.
- It has also been suggested that variations in patterns among males and females could help in sex determination.

| Fig. 4.28 A lip print |

- Cheiloscopic patterns are classified as:
  - *Linear*: Lines are predominant
  - *Bifurcate*: Bifurcation of lines is dominant
  - *Reticular*: Lines cross each other
- Apart from these class characteristics, 24 individual properties are distinguished in the same manner as the minutiae in the fingerprints.
- Suzuki's classification of lip prints (Fig 4.29): Suzuki divided lip prints into five main types:
  - Type I has an additional "sister group"; it is called Type İ (pronounced as "one-dash"). Type I represents a lip with clear-cut grooves running vertically over the lips. Type İ has partial length grooves of Type I variety. They do not quite cover the entire breadth of the lips.
  - Type II comprises branched grooves
  - Type III comprises intersected grooves, which look almost like crosses
  - Type IV comprises a reticular pattern much like a wire-mesh.

*From the Greek word 'cheiloswhich' which means lips.

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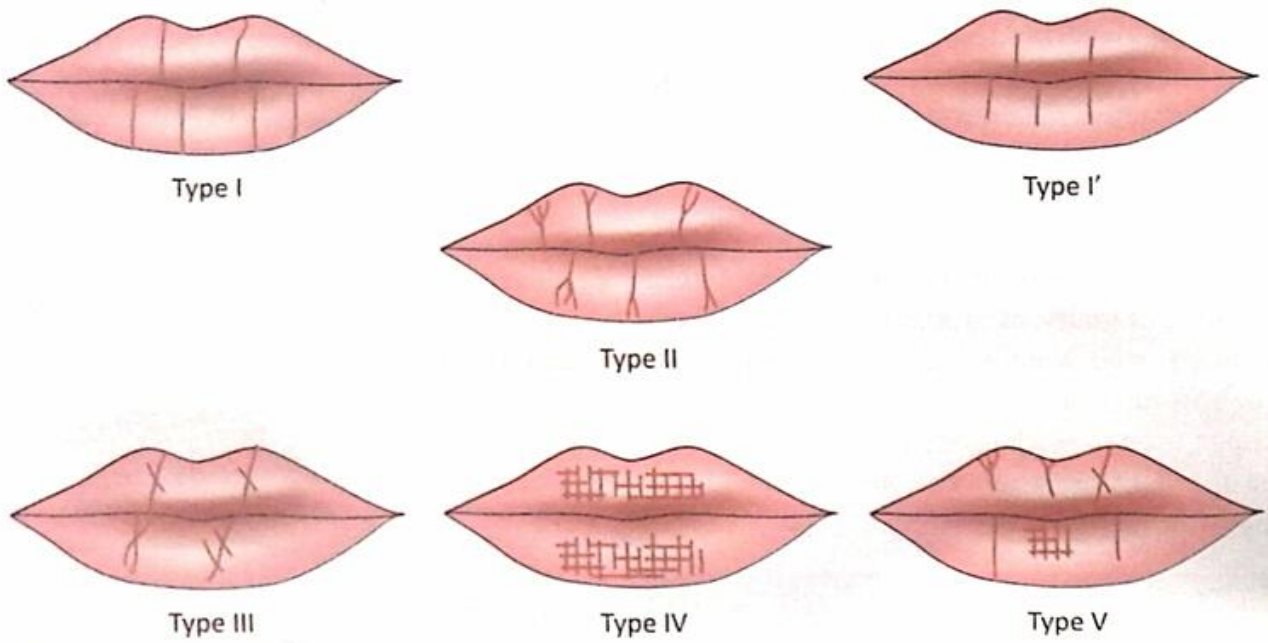

| Fig. 4.29 Suzuki's Classification of Lip Prints |

- Type V includes all other patterns, which are mostly irregular patterns.

- Different areas of lips may have different patterns. To simplify the study of lip prints in practice, the lips are divided into four quadrants. Each quadrant is then studied.
- Method of recording lip prints:
  - The lips of the subject are first cleaned thoroughly.
  - The lips are then outlined using a sharp lip liner pencil.
  - Lipstick is applied uniformly to the lips using lipstick applicator brushes starting at the midline and moving laterally.
  - The lipstick is allowed to dry for about 2 minutes after which lip prints are taken in two ways:
  - Lip prints of each lip are taken separately using scotch tape.
  - A thin coat of lipstick is then reapplied and a second lip print of both the lips together is taken using cellophane tape.
  - These prints are then stuck onto white paper.
- Three methods of cheiloscopic examination are generally employed for identification purposes:
  - Method of determining common features: establishment of 7 to 9 fine characteristics leads to positive identification.
  - Method of photographic montage.
  - Contour method.

    The second and the third methods supplement each other, wherein the contour of the lips is compared.
- Apart from this, the substance forming the print, i.e., saliva, cosmetics, etc., can be identified which can act as corroborative evidence.

Applications of Cheiloscopy

- Lip prints have been studied in postmortem identification. Advances have been made in the techniques and dyes for developing lip prints. Software has been developed for the analysis of lip prints.
- However, limitations still exist in the use of lip prints. The permanent nature of lip prints requires more long-term studies to be substantially documented. Advanced methods of developing lip

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prints at a scene of crime are still confined to research laboratories. Full utilization of lip prints depends to a high degree on the skill of members of law enforcement agencies.

- The problems involved in cheiloscopy are relatively little known and thus, so far lip prints have been used only occasionally despite their frequent occurrence at the scene of crime.

RUGOSCOPY

- Palatal rugae are as unique to each individual as are lip prints.
- The use of human palatal rugae as a method of identification was suggested by **Harrison Allen** as early as **1889**.
- The advantages of palatal rugae as an ideal method of postmortem identification include:
  - They are protected from trauma by their internal location.
  - They are insulated from heat by the tongue and buccal fat pads.
  - No two palates are alike in their configuration. Study of the rugae pattern of twins showed that they are similar, but not identical.
  - Palatoprints do not change during growth.
- **Thomas & Kotze** have classified rugae into 3 types:
  - Primary rugae: 5–10 mm & 10 mm or more
  - Secondary rugae: 3–5 mm
  - Fragmented rugae: less than 3 mm
- The shape of the rugae could be either curved, wavy, straight, or circular.

TATTOO MARKS

- Tattoo marks are designs or patterns imprinted on the skin surface by multiple small puncture wounds with the help of needles dipped in colouring matter.
- Tattooing is a form of identification procedure deliberately acquired by a person for various reasons. The practice of tattooing is prevalent among some sections of the people all over the world (Fig. 4.30a & b).

| **Fig. 4.30a** Tattoo mark in a cadaver rendered clearer after the epidermis was burnt away *(Pic : Dr Shashidhar C Mestri)* |

| **Fig. 4.30b** Tattoo over forearm *(Pic : Dr EJ Rodrigues)* |

- Colouring pigments in common usage include carbon (black), cinnabar, vermilion (red), ochre (brown), chromic oxide (green), prussian blue (blue), etc.
- The permanence of the mark depends on both the type of the dye used, and the depth of the skin involved. Stable pigments such as carbon, prussian blue, etc., impregnated into the deeper layers of the skin last longer.

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- Even faint/disappeared marks of unstable pigments like cinnabar can be made out on histological study of the regional lymph glands.
- When tattoo marks are obscured by decomposition or mummification, they can be visualised by treating the area with 3% H_2O_2 which temporarily removes the products of decomposition.
- Tattoo marks can be removed by surgical methods such as skin grafting, and also by the use of laser beams, without leaving any permanent mark. But crude methods of erasure like application of corrosives, burning, cautery, etc., will leave a permanent scar in that area (Fig. 4.31).
- A tattoo mark can be either altered or superimposed over another design subsequently.

Medicolegal Importance

Apart from being a mark of identification by virtue of its size, shape, design, anatomical position, etc., tattoo marks can also provide additional information about an individual, viz:

| Fig. 4.31 Attempted erasure of tattoo mark (Pic : Dr Shashidhar C Mestri) |

- Race, religion, nationality: The design prevalent in that particular country/cult may be reproduced.
- Language.
- The name tattooed could be that of a person associated/related to him.
- The mental makeup and sexual preferences of the person can sometimes be made out, for example, the blue bird design on the back of the hand at the base of the thumb and the forefinger, is said to be common among homosexuals.
- Dates of personal events may be depicted.
- Drug addicts often imprint tattoos over areas where multiple injection marks are present, in order to conceal them.
- The social status to which the person belongs can be guessed by the nature of the dye used, the design, and also the presence of complications arising out of employing unsterilised needles.

SKULL SUPERIMPOSITION

- Superimposition is a technique where a postmortem record is placed over a comparable antemortem record for comparison.
- Skull superimposition (craniofacial superimposition) is the technique in which the skull to be identified is superimposed on a recent photograph of the suspected deceased (Fig. 4.32).
- The photograph is enlarged to "life size," the enlargement factor being based upon the measurements of the fabric on the victim, or other measurable items seen in the photograph, or the focal length of the camera lens used, or the dimensions of the anterior teeth, etc.
- The skull is adjusted in such a way that the inclination and orientation are the same as that of the head in the photograph.
- A life size picture is taken and superimposed on the transparency of the life size antemortem photograph, making allowances for soft tissue and hair thickness.
- Anatomical landmarks compared for a positive match include: external auditory meatus, orbits, anterior nasal spine, chin point, angles of the mandible, and zygomatic processes.
- Arriving at a positive match does not always mean a positive identification, since a photograph of any other person with similar craniometry can produce a successful match with the same skull. Thus, this test can help in exclusion rather than conclusion.
- **Disadvantages**
  - The major disadvantage in photographic superimposition is that a slight change in the enlargement of the photograph or a slight

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| Fig. 4.32 Superimposed skull and photograph |

change in the angulation of the skull from that of the photograph can lead to major discrepancies resulting in a mismatch.

- Exact determination of the parameters however, results in loss of valuable time.

These problems can be avoided by the use of video superimposition technique.

Video Superimposition

- The skull devoid of any extraneous soft tissue and foreign matter, is mounted on an adjustable support allowing movement in three planes.
- The antemortem photograph (preferably with the person smiling or displaying his teeth) is also mounted.
- A colour video camera, firmly mounted on a tripod, is aligned at right angles to the antemortem photograph. The centre of the lens should be at the same level as the horizontal centre of the photograph.
- The mounted skull is placed in a contrasting background, and a second camera similar to the first one, is aligned to the skull in the same way as the first camera to the photograph.
- The individual video signals from each camera are fed into a vision mixer so that a variety of functions like horizontal and vertical wiping, superimposition, and negative simulation can be performed.
- The skull is oriented on the adjustable mount as closely as possible to the angulation of the head in the photograph.
- Video pictures from both the cameras are relayed into the video mixer. By adjusting the mixer, the video picture of the photograph can be enlarged. If teeth are visible in both the skull and photograph, enlargement is carried out till the teeth in the antemortem photograph overlap the teeth in the superimposed picture. If teeth are not present or visible in either specimen, the enlargement factor is estimated by adjusting the vertical facial height of the photograph to the skull.
- The video mixer offers flexibility in making the adjustments and provides immediate results without having to process photographs or make tracings.
- After correct enlargements and orientation, superimposition is done, and features are compared with respect to the landmarks.
- The video mixer allows for the fading in and out of either the skull or the photograph, or for sweeping over each other in the vertical or the horizontal plane. This procedure allows part of the skull or the photograph to be superimposed in either the vertical or horizontal plane on the video screen so that an accurate match is obtained.
- This technique can be videotaped for court purposes.

Computer-aided Superimposition

Computer-aided craniofacial superimposition comprises non-automatic and automatic methods. Non-automatic methods use some kind of digital infrastructure to support the craniofacial superimposition process, i.e., computers are used for storing and/or visualizing the data. However, they are characterized by the fact that their computational capacity to automate human tasks is not considered. On the other hand, computer-aided automatic methods use computer programs to accomplish an identification sub-task itself.

Most advanced method of computer-aided superimposition is with the use of imaging tool softwares. But it is not an automatic method as images have to be manually resized, shifted and rotated by a process of trial and error. Thus it is a time consuming and potentially error-affected process.

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CHAPTER 5

Forensic Psychiatry

When you speak to God, it's praying; but when God speaks to you, its called schizophrenia.
—**Yorkshire Ripper's Trial** *("Science Against Crime", Marshall Cavendish, 1982)*

SOME DEFINITIONS

- **Psychiatry**
  It is a subject that deals with the study of mental illness, with particular reference to diagnosis and treatment of mental disorders.
- **Forensic Psychiatry**
  Deals with the application of psychiatry in the administration of justice.
- **Insanity** (lunacy, unsoundness of mind, mental derangement, mental illness)
  It is a disorder of the mind or personality in which there is derangement or impairment of mental or emotional components. Terms such as "insanity" and "lunacy" must not be used as far as possible in scientific discussions, though unfortunately they still find acceptance in legal parlance. The term used and accepted today by most psychiatrists is "mental illness."

SYMPTOMS OF MENTAL ILLNESS

Delusion

- It is a disturbance of thought.
- It is a false belief in something which is not a fact, and which persists even after its falsity has been clearly demonstrated.
- **Types***:
  - **Delusion of Grandeur**: The patient imagines that he is rich or famous, when he is acutally poor or inconsequential.
  - **Delusion of Poverty**: Imagines he is poor when in fact he is wealthy.
  - **Delusion of Persecution**: Imagines that other people are out to harm him.
  - **Delusion of Reference**: Imagines that people or events relate or refer to him in some special way.
  - **Delusion of Influence (control)**: Imagines that his thoughts or actions are controlled by some external agency.
  - **Delusion of Infidelity**: Imagines that the spouse is unfaithful.
  - **Delusion of Self-accusation (self-reproach)**: Keeps blaming himself for trivial incidents that happened in the past.
  - **Nihilistic Delusion**: The patient is convinced that nothing exists around him in the real sense of the term.
  - **Erotomania (Clerambault-Kandinsky complex)**: Usually seen in women. The patient is convinced that a particular individual (usually an employer or superior), is in love with her.
  - **Pseudologia phantastica**: A variation of this is the *Munchausen syndrome*, in which a person is convinced that he is seriously ill, and goes from doctor to doctor, hospital to hospital, in a vain attempt to diagnose his non-existent illness. It is a psychiatric factitious disorder more than a form of delusion, wherein those affected feign disease, illness, or psychologi-

*Can be remembered by the mnemonic GRIN PEPPSI: Grandeur, Reference, Influence, Nihislistic, Persecution, Erotomania, Poverty, Pseudologia phantastica, Self accusation, Infidelity

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cal trauma to draw attention, sympathy, or reassurance to themselves. It is also known as *hospital addiction syndrome, thick chart syndrome, or hospital hopper syndrome*. True Munchausen syndrome fits within the subclass of factitious disorder with predominantly physical signs and symptoms, but they also have a history of recurrent hospitalization, travelling, and dramatic, untrue, and extremely improbable tales of their past experiences. *Munchausen syndrome is related to Munchausen syndrome by proxy (MSbP/MSP)*, which refers to the abuse of another person, typically a child, in order to seek attention or sympathy for the abuser *(page 404)*.

Hallucination

- It is a disturbance of perception.
- It is a false sensory perception without any real, external stimulus.
- **Types**:
  - **Auditory**: The patient hears imaginary voices.
  - **Visual**: The patient sees non-existent shapes (*unformed images*), or people or animals (*formed images*).
  - **Olfactory**: Perceiving non-existent odours.
  - **Gustatory**: Perceiving a bad taste in the mouth constantly without apparent cause.
  - **Tactile (haptic)**: This may take the form of imaginary sensations over the skin (*formication*), or in a limb that has been amputated (*phantom limb*).
  - **Lilliputian (micropsia)**: Perceiving objects to be much smaller than they are.
  - **Synesthesia**: A stimulus perceived by a sensory organ other than the one that should actually perceive it, e.g., visualising music, hearing different colours, etc.

5

Box 5.1 **Some Common Terms Used in Psychiatry**

- **Affect**: Subjective and immediate experience of emotion at a given time.
- **Mood**: Pervasive emotion or feeling which is sustained.
- **Cognition**: Refers to higher mental functions such as memory, intelligence, concentration, orientation, etc.
- **Insight**: It is to do with awareness of one's own mental condition, and is rated on a 6-point scale, from complete denial of illness to true emotional insight, characterised by significant basic changes in the future behaviour and personality.
- **Phobia**: An irrational fear of an object, situation, or activity.
- **Panic**: An acute, intense, overwhelming episode of anxiety, often associated with feelings of impending doom.
- **Stupor**: A state of akinesis and mutism, with relative preservation of conscious awareness.
- **Confabulation**: A false memory that the patient believes to be true.
- **Deja vu**: A sense of familiarity with unfamiliar surroundings.
- **Lucid interval**: A temporary period of resolution of symptoms in a mentally unsound individual. During this period he will be held responsible for criminal acts.
- **Neurosis**: An emotional disorder in which the patient does not lose touch with reality.
- **Psychosis**: A psychiatric disorder in which the patient loses touch with reality, often experiencing delusions and hallucinations. There is a tendency for violent behaviour.
- **Psychopath**: An essentially normal individual who has deep rooted abnormalities of personality, as a result of which he is unable to conform to conventional standards of behaviour. There is often criminal behaviour, without accompanying feelings of guilt or remorse.
- **Abreaction**: A process of bringing to conscious awareness, previously suppressed unconscious conflicts and emotions. Such a release (*catharsis*) can have therapeutic value.

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Illusion

- It is a disturbance of perception.
- It is a misinterpretation of a real external stimulus, e.g., perceiving a rope as a snake.

Obsession

- It is a disturbance of thought.
- A single idea or thought is constantly entertained by the patient, which is irrational, but persists in spite of all efforts to drive it from his mind, e.g., checking and re-checking (repeatedly) whether a door has been bolted or not.

Impulse Control Disturbance

- There is a sudden and irresistible force compelling a person to the conscious performance of an action without motive or forethought.

- **Types**
  - **Kleptomania**: Irresistible desire to steal articles of little or no value.
  - **Pyromania**: Irresistible desire to set fire to objects.
  - **Mutilomania**: Irresistible desire to hurt or torture animals.
  - **Dipsomania**: Inability to stay off alcohol.

CLASSIFICATION OF PSYCHIATRIC DISORDERS

- There are two internationally recognised methods of classifying psychiatric disorders – **DSM-5** and **ICD-10**.
  - **DSM-5**: It is an essentially American system, and is an abbreviation of *Diagnostic and Statistical Manual of Mental Disorders*, Vth edition, **2013**. It is a classification prepared and regularly updated by the American Psychiatric Association (APA). DSM-5 was published on May 18, 2013, superseding the DSM-4-TR, which was published in 2000. In most respects DSM-5 is not greatly changed from DSM-4-TR. Notable changes include dropping Asperger syndrome as a distinct classification; loss of subtype classifications for variant forms of schizophrenia; dropping the "bereavement exclusion" for depressive disorders; a revised treatment and naming of *gender identity disorder* to *gender dysphoria*, and removing the A2 criterion for posttraumatic stress disorder (PTSD) because its requirement for specific emotional reactions to trauma did not apply to combat veterans and first responders with PTSD.
  - **ICD-10**: It stands for *International Classification of Diseases, Injuries, and Causes of Death*, 10th edition, **1992**. This classification has been prepared by the WHO, and is periodically updated. Chapter 'F' of the ICD deals with psychiatric disorders. The ICD-10 classification will be followed in this book, since it has wider acceptance all over the world. ICD-10 is available in the six official languages of WHO (Arabic, Chinese, English, French, Russian and Spanish) as well as in 36 other languages (none of them Indian). ICD is currently under revision, through an ongoing 'Revision Process', and the release date for ICD-11 is 2017. However, updates are done almost every year, the last update being 2012.

MENTAL AND BEHAVIOUR DISORDERS (ICD-10)

I. **Organic (including symptomatic) Mental Disorders**

The disorders listed in this group have a demonstrable organic cause related to the brain, i.e., there is demonstrable brain pathology.

1. Delirium
2. Dementia
3. Organic amnestic syndrome
4. Other organic mental disorders

II. **Mental and Behavioural Disorders due to Psychoactive Substance Abuse**

This group includes mental disorders arising out of the abuse of psychoactive drugs, e.g., alcohol, cannabis, amphetamines, cocaine, LSD, phencyclidine, etc.

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III. **Schizophrenia, Schizotypal, and Delusional Disorders**

Includes disorders characterised by disturbances of thought, perception, affect, and behaviour.

1. Schizophrenia
2. Schizotypal disorder
3. Persistent delusional disorder
4. Acute psychotic disorders
5. Schizo-affective disorders

IV. **Mood (Affective) Disorders**

These disorders are characterised by prominent disturbance of mood.

1. Bipolar affective disorder
2. Manic disorder
3. Depressive disorder
4. Persistent mood disorder

V. **Neurotic, Stress-related & Somatoform Disorders**

These disorders were previously loosely termed "neuroses," and are mainly disturbances of emotion.

1. Anxiety
2. Phobic states
3. Obsessive-compulsive disorder
4. Dissociative (conversion) disorder
5. Somatoform disorders
6. Stress and adjustment disorders

VI. **Behavioural Syndromes associated with Physiological and Physical Disturbances**

Previously termed "psychosomatic disorders."

1. Eating disorders
2. Sleep disorders
3. Sexual dysfunctions
4. Puerperal psychiatric conditions

VII. **Disorders of Adult Personality and Behaviour**

These disorders are the persistent expression of an individual's characteristic lifestyle and mode of relating to the others.

1. Personality disorders
2. Impulse control disorders
3. Gender identity disorders
4. Disorders of sexual preference

VIII. **Mental Retardation (MR)** – This group includes disorders with arrested development of intellect and associated maladaptive behaviour.

1. Mild MR
2. Moderate MR
3. Severe MR
4. Profound MR

IX. **Disorders of Psychological Development**

These disorders have their onset during infancy or childhood and are characterised by an impairment of functions related to biological maturation of the CNS.

1. Speech and language disorders
2. Developmental disorders

X. **Behavioural and Emotional Disorders of Childhood and Adolescence**

1. Hyperkinetic disorder
2. Conduct disorders
3. Tic disorders

XI. **Unspecified Mental Disorders**

A detailed discussion of these psychiatric disorders is beyond the scope of this book. Interested readers are advised to consult standard works on Psychiatry for further elucidation.

CAUSES OF MENTAL ILLNESS

1. **Heredity**: Huntington's chorea.
2. **Organic**: Senility, myxoedema, head injury.
3. **Stress**: Sudden bereavement, financial loss.
4. **Unknown**: No cause can be pinpointed for several mental ailments.

DIAGNOSIS OF MENTAL ILLNESS

I. **Preliminary Particulars**

- Name, age, sex, marital status, education, occupation, income, address, religion, and socio-economic background.
- In medicolegal cases of psychiatric assessment, it is mandatory to record at least two permanent marks of identification.

II. **Accompanying Person's Particulars**

- The identification particulars of accompanying persons must be recorded, along with details of nature of relationship, whether he stays with the patient or not, etc.
- When recording history, it is important to take down the statement of the accompanying person in addition to that of the patient.

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- When recording history, it is important to take down the statement of the accompanying person in addition to that of the patient.

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III. Presenting Complaints

Record the details of presenting complaint with particular reference to:

- Onset of present illness
- Duration
- Course
- Precipitating factors
- Aggravating, maintaining, or relieving factors.

IV. History of Present Illness

- When was the last time that the patient appeared to be well?
- Time of onset
- Record the evolution of symptoms in a chronological manner.
- Record details of disturbances of sleep, appetite, sexual function, etc.
- Enquire about suicidal ideation.

V. Past Psychiatric and Medical History

- History of similar illnesses in the past.
- History of serious medical, neurological, or surgical illness.
- History of alcohol or drug abuse.

VI. Treatment History

- Record details of treatment taken for present and previous episodes, as well as the response.

VII. Family History

- Record details of family structure, family history of psychiatric and medical illnesses, family history of drug abuse, attempted suicides, and current social situation of family.

VIII. Personal History

1. *Perinatal history*: Details of pregnancy, date of birth, nature of delivery, perinatal complications etc.
2. *Childhood history*: Who brought the patient up, whether breastfed or bottlefed, relationship to mother, father and other family members, history of neurotic traits (stammering, tics, enuresis, night terrors, head banging), etc.
3. *Educational history*: Age of beginning and completion of formal education, academic achievements, relationship with peers and teachers, truancy, etc.
4. *Play history*: Nature of play activities, friends, relationship with children of opposite sex, etc.
5. *Puberty*: Age at which secondary sexual characteristics developed, details about masturbatory activities, nocturnal emissions (males), menarche (females).
6. *Menstrual and Obstetric history*: Regularity and duration of menses, last menstrual period, number of children delivered, abortions, etc.
7. *Occupational history*: Age at which he started working, jobs held (chronological order), reasons for job changes, job satisfaction, ambitions, relationship with authorities, peers, and subordinates, present income, etc.
8. *Sexual and Marital history*: How was sexual information acquired, masturbatory activities, sexual relationships, nature of sexual activity preferred, gender identity disorder, etc. Also, record details of marriage with reference to date, duration, relationship with spouse, divorces or separations, mode and frequency of sexual intercourse, etc.
9. *Premorbid personality*: Record details of :
   a) Interpersonal relationships
   b) Use of leisure time
   c) Predominant mood
   d) Attitude to self and others
   e) Attitude to work
   f) Religious beliefs and moral attitudes
   g) Fantasy life
   h) Habits

IX. Physical Examination

Conduct a detailed general physical examination in the usual manner.

X. Mental Status Examination

1. *General appearance and behaviour*:
   a) General appearance: physique, build, height and weight, dress, hygiene, etc.
   b) Attitude: cooperative, evasive, combative, hostile, attentive, interested?
   c) Comprehension: intact or impaired?
   d) Gait and Posture: nature of walking, standing, sitting, reclining, etc.
   e) Motor activity: increased/decreased, excited, presence of involuntary movements, restlessness, catatonic signs, etc.
   f) Non-verbal behaviour: nature of eye contact.

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g) Rapport: could or could not be established with the patient?

h) Hallucinatory behaviour: talking to himself, odd gesturing, smiling or crying without reason, etc.

2. *Speech*:
   a) Rate and quantity
   b) Volume and tone
   c) Flow and rhythm
3. *Mood and Affect*: *Mood* refers to the pervasive feeling which is sustained, while *affect* refers to immediate and subjective experience of emotion at a given time.
4. *Thought*:
   a) Stream and form: Spontaneity, productivity, poverty of speech, flight of ideas, continuity, tangentiality, etc.
   b) Content: delusions, obsessions, phobias, etc.
   c) Perception: hallucinations, illusions, depersonalisation, etc.
5. *Cognition assessment*:
   a) Consciousness
   b) Orientation
   c) Attention
   d) Concentration
   e) Memory: immediate, recent, remote
   f) Intelligence
   g) Abstract thinking
6. *Insight*: Assess the degree of awareness and understanding of the patient regarding his illness.
7. *Judgement*: His ability to assess a situation correctly and act appropriately.

XI. **Investigations**

- Complete medical and toxicological screen, drug levels, electrophysiological tests, brain-imaging tests, neuro-endocrine tests, genetic tests, sexual disorder investigations, etc.
- Psychological investigations include objective tests, projective tests, neuropsychological tests, rating scales, etc.

XII. **Diagnostic Formulation**

After complete psychiatric assessment, a diagnostic formulation must be made, along with differential diagnosis and treatment plan.

MENTAL HEALTH ACT 1987

- The **Mental Health Act (MHA) 1987**, came into effect only in **April 1993**, in all the states and union territories of India. It replaces the **Indian Lunacy Act** of **1912**, which had earlier replaced the **Indian Lunatic Asylums Act** of **1858**. The **Mental Health Care Bill 2013** is set to replace the Mental Health Act of 1987, and has some revolutionary changes **(Box 5.2)**. It was passed by the Rajya Sabha on 8 Aug 2016 and is likely to be enacted sometime in 2017.
- The MHA is divided into 10 chapters consisting of 98 Sections –
  - **Chapter I** deals with various definitions.
    - The Act uses the term 'mentally ill person' instead of the more offensive 'lunatic', and 'mentally ill prisoner' instead of 'criminal lunatic.' Also the term 'psychiatric hospital' is used in place of 'mental hospital.'
    - A mentally ill person is defined by the Act as *a person who is in need of treatment by reason of any mental disorder other than mental retardation.*
  - **Chapter II** of MHA details the procedures for establishment of Mental Health Authorities at Centre and State levels.
    - There is provision for a Licensing Authority who will process licenses.
    - Private psychiatric hospitals and nursing homes can be run only on a valid license which has to be subsequently renewed every 5 years.
    - An Inspecting Officer will periodically inspect the hospital or nursing home to check for any irregularities.
  - **Chapter III** lays down the guidelines for establishment and maintenance of psychiatric hospitals and nursing homes.
  - **Chapter IV** deals with the procedures of admission and detention in psychiatric hospitals **(Box 5.3)**.
  - **Chapter V** deals with the inspection, discharge, leave of absence, and removal of mentally ill persons.

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Box 5.2 **Mental Health Care Bill, 2013**

On 8 August, 2016, the **Mental Health Care Bill, 2013** was passed in the Rajya Sabha. The new bill, when passed in the Lok Sabha, will replace the outdated Mental Health Act of 1987, and when compared to the existing law, it is quite reformist.

Highlights:

- The **definition** of mental illness is no more "any mental disorder other than mental retardation." It is broader and more inclusive. Mental illness is defined as "a substantial disorder of thinking, mood, perception, orientation or memory that grossly impairs judgment, behaviour, capacity to recognise reality or ability to meet the ordinary demands of life, and mental conditions associated with the abuse of alcohol and drugs. **It does not include mental retardation**."
- One of the salient features of the new bill is that it **decriminalises the attempt to suicide**. This repeals Section 309 of the Indian Penal Code which provided for a year-long imprisonment for a failed suicide bid. This law had been criticised for a very long time. In 1971, the Law Commission had tried to do away with it. The Janata Party had tried to implement the recommendation in 1978, but it fell before both Houses could pass that Bill. Proposing that attempted suicide will not be criminally prosecuted helps the world look at suicide in a more kindly light. Criminalising suicide attempts actually stops many people from reporting, and this hinders people in distress from receiving the help that they need. The new law actually recognises suicide as a cry for help, and stresses on the immediate need to reach out and help the person overcome their issues. It does not treat the person as a criminal.
- The bill **does not allow psychosurgery** unless it is approved by the district medical board. The bill also bans the use of shock therapy for treating children with mental illness. It is still permissible for adults provided they are given anaesthesia and necessary muscle relaxants.
- However, the most remarkable feature of this bill is the introduction of **advance directive** - this gives people suffering from a mental illness the right to choose their mode of treatment, and by nominating representatives who will ensure that their choices are carried out. Giving people diagnosed with a mental illness the freedom to choose conveys a strong message to the masses that suffering from a mental disorder does not rob an individual of decision-making capacities. It instils in the citizens that everyone, even those diagnosed with a mental illness, are entitled to a life of dignity, and they must not have to live in isolation, away from their families or the community, at large.
- The bill **identifies inhuman and degrading treatment** of the mentally ill as a **crime**, and for the first time, tackles the issue of mentally ill patients often admitted in institutionalised care forcibly, against their will.

Drawbacks

- However, no matter how progressive the new bill is, it is still only a small step in the direction of reform. For example, the bill only recognises the role of psychiatrists in the treatment of a mental illness. It still does not acknowledge the roles of counsellors and psychologists who also work with patients suffering from mental and emotional distress.
- Also, the bill largely addresses requirements of those in mental healthcare facilities, but not every person diagnosed with a mental illness needs institutionalisation.
- While the bill mandates insurance companies to provide medical insurance to the mentally ill on the same grounds that they would issue insurance for physical illnesses, counselling services would probably not be covered even in the new insurance schemes.
- Implementation of the Act will also pose to be a problem, as there is a shortage of mental health professionals in India.

Divya Srivastava

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Box 5.3 **Procedures of Admission and Detention in Psychiatric Hospitals (Restraint of the Insane)**

Chapter IV of the **Mental Health Act, 1987,** lays down guidelines for psychiatric hospitals in relation to the admission, detention, and discharge of mentally ill persons.

Admission

A. *Voluntary admission:*
   1. On patient's request, if he is a major.
   2. On guardian's request, if he is a minor.

B. *Admission under special circumstances:* This is a type of involuntary hospitalisation when a mentally ill person cannot express his willingness for admission. A relative or friend of his can apply in writing for admission, and the medical officer in charge of the hospital can do so, if he is satisfied that the admission would be in the best interests of the patient. The duration of admission cannot exceed 90 days.

C. *Reception order on application.*

D. *Reception order without application:* This is done in the case of wandering, dangerous, neglected, or ill-treated mentally unsound individuals. The patient must be produced before a magistrate.

E. *Admission as inpatient after judicial inquisition.*

F. *Admission as a mentally ill prisoner.*

Detention: A magistrate can order the detention of an alleged mentally ill person for short periods pending report from the medical officer concerned, or pending his removal to a psychiatric hospital or nursing home. In the former case, the period of such detention cannot exceed 10 days, while in the latter case, maximum period permissible is 30 days.

Discharge

1. A voluntary patient must be discharged within 24 hours of receipt of request for discharge made by the patient himself, or his guardian.
2. A mentally ill person admitted on application can be discharged on his own request, or the request of a friend or relative. In these cases, it must first be made certain that the patient has been cured of his illness, and that he is fit to be discharged.
3. The officer in charge of a psychiatric hospital can order the discharge of any inpatient, on the recommendation of two medical practitioners one of whom should be a psychiatrist.
4. A relative or friend of a mentally ill person can make an application for his discharge even if he is not fully cured, provided he is not dangerous to society. In such a case, the patient can be discharged on the guarantee of the relative or friend that he would take care of the patient. Execution of a bond attesting to this is necessary.
5. A person detained on a reception order can be discharged, if a judicial inquisition finds him of sound mind.

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- **Chapter VI** deals with the judicial inquisition regarding alleged mentally ill persons possessing property, and how such property should be managed.
  - If the court feels that a mentally ill person is incapable of looking after himself or his property, an order can be issued for appointing a guardian.
  - If however, it is felt that the person can look after himself, but is only unable to manage his property, a manager can be appointed.
- **Chapter VII** deals with the liability to meet the cost of maintenance of mentally ill persons detained in psychiatric hospitals.
- **Chapter VIII** deals with issues relating to the protection of human rights of mentally ill persons.
- **Chapter IX** outlines the penalties for infringement of guidelines.
- **Chapter X** deals with miscellaneous matters.

MENTAL ILLNESS AND RESPONSIBILITY

- The term **responsibility** in the legal sense refers to the liability of a sane person for his actions (or omissions), and consequent punishment if such be contrary to law.
- The law presumes every individual to be sane, unless proved otherwise.

Civil Responsibility

1. **Marriage**
   - If it is proved that at the time of marriage, one of the parties (spouses) was insane, then such marriage is declared as *null and void*, i.e., as per law the marriage never took place even if consummation had been accomplished.
   - Insanity developing later in the course of married life, which was not present at the time of marriage, may constitute sufficient grounds for *divorce*, but not for *nullity*.
2. **Business contract**
   - As per the **Indian Contract Act** of **1872**, if it is proved that at the time of signing a contract one of the two parties was insane, then the contract becomes legally invalid.
   - However, insanity developing subsequent to a legal agreement will not necessarily invalidate the contract.
   - Also, if at the time of signing, the fact that one of the signatories to the contract was insane was not known to the other party, then the contract may not be declared invalid.
   - For the purposes of a contract, a person is said to be of sound mind if at the time of making the contract, he is capable of understanding it, and of forming a rational judgement.
3. **Management of property**
   - If a person who owns property becomes insane and is incapable of managing his affairs with sound judgement, any relative or friend can approach the court for a judicial inquisition. If it is proved that the person is insane in the course of such inquisition, then the court can appoint a Guardian or Manager depending on the circumstances.
4. **Capacity to depose as witness**
   - As per **section 118** of the **Indian Evidence Act**, an insane person is not competent to give evidence if he is incapable of understanding the questions put to him, or giving rational answers to them.
   - However, such a person can give evidence during a lucid interval, depending on the discretion of the judge.
5. **Testamentary capacity**
   Detailed in **Box 5.4**.

Criminal Responsibility

- The entire concept of criminal responsibility revolves around the principle of ***mens rea*** or ***guilty mind***. This is itself a component of a legal dictum (in Latin): *Actus non facit reum, nisi mens sit rea*. When translated, it reads: "The physical act alone does not make a person guilty; the mental component in the form of evil intent (guilty mind) is equally important."
- Since an insane person cannot comprehend the nature of his own actions, or that they may be contrary to law, he is exempted from criminal responsibility.

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Box 5.4 **Testamentary Capacity**

Testamentary capacity refers to the capacity of a person to make a valid will.

A **will** is a document detailing the disposal of property owned by a person, which is prepared by him during his lifetime but takes effect only after his demise. The person who makes the will is referred to as testator. It can be revoked or changed any number of times (at his own sweet will!).

Eligibility for making a will: As per the **Indian Succession Act, Section 59**, the following persons are eligible to make a valid will:

- Every person of sound mind who is over the age of 18 years.
- An insane person cannot write a valid will, unless he is in a lucid interval.
- An intoxicated person cannot make a will, unless it is certified by a doctor that he was in possession of his senses.
- A deaf, dumb, or blind person can make a will if he can communicate effectively.
- Convicts are not debarred from making a will.

Conditions: The person making a will should:

- Have a sound disposing mind.
- Have thorough knowledge about his wealth and property.
- Be free from undue influence, coercion, or fraud.
- Do it voluntarily.

Procedure: The will must always be in writing. The only exception provided for under law, is for members of the armed forces who are out on an expedition or engaged in warfare. They can make an oral will (*privileged will*). Also, Muslims are permitted to make an oral will by their personal law.

There is no particular format for a will as per law. In fact, it need not even be executed on a stamp paper. Typing is desirable, but not essential. The testator can write a will himself, using a fountain pen or ball pen (*holograph will*). The will must be attested by at least two witnesses, neither of whom can be beneficiaries. It is preferable that one of them should be a doctor. The signature or thumb impression of the testator himself is of course mandatory. The will comes into effect only on the death of the testator.

- However, insanity per se is not enough to render a person innocent (of his alleged criminal action). He must satisfy certain conditions which are laid out in law. In India, **section 84** of the **Indian Penal Code** outlines the guidelines applicable to criminal responsibility of insane individuals. This is an offshoot of the **McNaughten Rule** which came into force in the UK in the 19th century.
  - Daniel McNaughten (Fig 5.1) was a psychotic suffering from delusions of persecution, who was convinced that his problems would end only with the demise of the then Prime Minister of Britain, Sir Robert Peel. In January 1843, he lay in wait for the Prime Minister, and when he encountered him, fired at him with his revolver. But because of mistaken identity, the secretary to the Prime Minister, Edward Drummond, was assassinated, and Sir Robert Peel escaped.
  - McNaughten was arrested and tried, but the jury after testification by 9 physicans, found him "not guilty by reason of insanity." The people were outraged, as also Queen Victoria and Sir Robert Peel himself.

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| Fig. 5.1 Daniel McNaughten |

- As a result, 15 prominent judges were invited by the House of Lords. They were asked to respond to a series of questions on criminal responsibility. The answers were subsequently condensed and put forth as the **McNaughten Rule**.
- After his acquittal, McNaughten was transferred from the prison to the State Criminal Lunatic Asylum at Bethlem Hospital. Apart from one hunger strike, which ended with force-feeding, McNaughten's 21 years at Bethlem appear to have been uneventful. In 1864, he was transferred to the newly opened Broadmoor Asylum. He had developed diabetes and heart problems in Bethlem; by the time he was transferred to Broadmoor his health was declining and he died on 3 May 1865.
- Interestingly, while the commonest manner in which his name is spelt is 'McNaughten', there is great controversy about the actual spelling (Box 5.5).

Section 84 (Indian Penal Code)

Nothing is an offence which is done by a person, who, at the time of doing it, by reason of unsoundness of mind, is incapable of knowing the nature of the act, or that he is doing what is either wrong or contrary to law.

- In order to apply S.84 in a given case, it has to be clearly established that at the time of committing the offence, the accused was labouring under a defect of reason which had been caused by unsoundness of mind, with the result that he was rendered incapable of knowing the nature of the act, or that he was doing what was wrong or contrary to law.
- A plea of insanity at the time of the trial will not help the accused. Two things have to be therefore, clearly established, i.e.,
  - that at the time of committing the crime the accused was of unsound mind, and
  - that the unsoundness of mind was of a degree and nature which rendered the accused incapable of knowing the nature of the act, or that he was doing what was either wrong or contrary to law.
- It is important to note that "legal insanity" is not the same as "medical insanity." While the latter follows the classification laid down in psychiatry, "legal insanity" is mainly with reference to mental deficiency and psychotic conditions. It does not recognise most of the neuroses and personality disorders as evidence of insanity.
- It is also important to remember that it is the state of mind of the accused at the time of the commission of the offence that matters, and not at any other time before or after the event.
- The burden of proving insanity is cast upon the accused, and he must prove that at the time of the incident he was by reason of unsoundness of mind incapable of judging the nature of his act (**S.105, Indian Evidence Act**).
- Every man is presumed to be sane and to possess sufficient degree of reason to be responsible for his crime unless the contrary is proved.
- One major defect in the **McNaughten Rule** (which in turn is reflected in S.84 IPC), is that emotional aspects relating to unsoundness of mind are not given due weightage. Hence some of the major psychiatric disorders, especially neurotic disorders, are not given any importance.
- This aspect has been attempted to be rectified in Western countries such as the UK and the USA, by way of new guidelines:

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Box 5.5 **What's in a Name? The Conundrum of the Spelling of McNaughten's Name!**

There is widespread disagreement over how McNaughten's name should be spelt (is there 'Mc' or 'M'' at the beginning, 'au' or 'a' in the middle, 'a', 'e', 'o' or 'u' at the end?).

- **'M'Naghten'** is the favoured spelling in both English and American law reports.
- Original trial report used **'M'Naughton'**.
- Bethlem and Broadmoor hospital records use **'McNaughton'** and **'McNaughten'**.
- In a 1981 book about the case, Richard Moran, Professor of Criminology at Mount Holyoke College, uses the spelling **'McNaughtan'**, arguing that this was the family spelling. The spelling 'McNaughtan' was confirmed in the Glasgow Postal Directory for the years 1835 to 1844.
- There is only one known signature: that which McNaughten affixed to a sworn statement given before the magistrate at Bow Street during his arraignment. This signature was spelt **'McNaughtun'**.

So, what is the correct spelling of this most famous gentleman's name, who is responsible for the framing (in a manner of speaking) of Section 84 of the Indian Penal Code?

- **Durham Rule (1954)** – or "Product Test," was adopted by the United States Court of Appeals for the District of Columbia Circuit in 1954, and states that "... an accused is not criminally responsible if his unlawful act was the product of mental disease or defect." This rule was however later overturned in 1972, as it places too much emphasis on "mental disease or defect," and thus on testimony by psychiatrists, and is said to be quite ambiguous.
- **Currens Rule (1961)** – Outlined by Judge Biggs in the case of *Currens* Vs United States, but lost favour with the courts since it was too liberal a view.
- **American Law Institute's Test (1962)** –
  - This rule (also called the **Model Penal Code**) was formulated in 1962, and is used as a test of criminal responsibility in most criminal cases in the United States today.
  - The ALI test says that an individual accused of a crime is not criminally responsible, if at the time of such conduct as a result of mental disease or defect, the person lacks substantial capacity either to appreciate the wrongfulness of the conduct, or to conform such conduct to the requirements of law.
  - The ALI test also requires that the mental disease or defect be a medical diagnosis. In this way, it manages to incorporate elements of all three of its predecessors: the knowledge of right and wrong required by McNaughten, the prerequisite of lack of control in the Currens Rule, and the diagnosis of mental disease and defect required by Durham.

Role of the Medical Officer in Criminal Cases with Insanity Plea

In a criminal case where insanity is pleaded as a defence, the opinion of a psychiatrist is necessary to prove its existence in the accused. If he is requested by the authorities to examine the accused and furnish his opinion, he must proceed cautiously and meticulously.

Some helpful pointers to an insane crime include the following:

- History of mental disease in the family of the accused.
- Lack of motive in the commission of the offence.
- Lack of premeditation/pre-planning.
- Absence of accomplices.
- No attempt to destroy evidence, or to flee from the scene of crime.
- Ghastly or bizarre nature of crime.

Box 5.6 presents a classical case of a psychotic killer.

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Box 5.6 The Vampire Killer

The first murder occurred on 20 December 1977. A 51-year-old man who was retrieving groceries from his car outside his home in Sacramento, California, was shot twice in the chest by an unknown assailant. The murder was without any motive. The assailant was Richard Trenton Chase, a young psychotic male. But the police were clueless.

On January 23, 1978, Chase burglarised a home, stealing 16 dollars in cash, a pair of binoculars, and a dagger. He also urinated into an open drawer of undergarments and defecated on a bed. He then proceeded to a supermarket where he came across a woman he had known in high school. She was horrified by his appearance – unkempt, straggly hair, dirty hands, and yellow crust around his lips. She figured he was either crazy or on drugs, and made a quick getaway.

Later the same day, Chase shot dead a 22-year- old woman as she came out of her home carrying some garbage bags. He then savagely mutilated her body, and dipping his hands in her blood, smeared his face with it, and licked his fingers. Not satisfied, he fetched a paper cup from her kitchen, scooped blood into it and drank it.

The Sacramento police department was completely baffled by this vicious homicide. The neighbourhood of the crime was thoroughly canvassed for information. Investigators learned that there had been a burglary on the same block earlier that day, which appeared to be related.

On January 27, 1978, the police were called to a residence in the same general area, on a report of a multiple murder. A neighbour discovered the whole family murdered when she went on a casual visit. The woman of the house who was 36 years old, had been shot three times and her body was eviscerated. Her 52-year-old male companion had been shot in the head, as also the woman's 6-year-old son. A 22-month-old baby, who the woman was baby sitting was missing from a bloodstained crib. There was also evidence of sodomy (of the woman) and anthropophagy, since some body parts and organs were missing, apparently cut out with a knife. A search of the rest of the house revealed bloodstained water in a tub in the bathroom, and pieces of human entrails.

By now it was clear that these series of murders had been committed by the same assailant who was obviously quite disturbed. Forensic psychologists profiled the suspect to be a young white male in his twenties, probably schizophrenic, a loner type of individual, unmarried, unemployed or working as a menial labourer, and living within a 1-mile radius of the crimes.

An extensive canvas operation was initiated. On January 28, a witness reported seeing Richard Chase a few days earlier in a supermarket, from whom she had in fact fled. She told police that he appeared crazy enough to be considered as a suspect. Investigators were despatched to Chase's apartment. There was no response when they knocked on his door, though they could hear somebody moving inside. Suddenly the suspect burst through and began running away. The police officers chased him and wrestled him to the ground. They were horrified to discover that he was carrying fast food containers stuffed with human body parts and blood. He was also carrying a gun in a shoulder holster.

Subsequent search of his apartment revealed extensive evidence of all the murders. There was also ample evidence that he had drunk his victims' blood, and cooked and eaten their body parts. The refrigerator was stocked with human organs. Psychiatric examination of Richard Chase disclosed the reason for his gruesome activities. He was convinced that alien flying saucers were drying up his blood through some sort of radiation, and therefore in order to survive he had to constantly replenish his supply. Chase was sent for trial, but while being incarcerated in his cell, he overdosed on psychiatric medication and killed himself.

*(Courtesy **Lt. Ray Biondi**, Commanding Officer, Homicide Bureau, Sacramento County, California, USA)*

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Serial Killer – A Special Psychiatric Entity

- A serial killer is an individual (invariably a male) who kills several victims of usually a particular type, over a period of time with varying intervals in between, apparently without motive, except for sexual or sadistic gratification. This has always been perceived to be a Western phenomenon, especially common in some countries such as the USA. But of late, it is being recognized that serial killers exist in other parts of the world too, and India is no exception.
- With the popular press churning out books and movies centered around the serial killer, the term has almost become a catch-phrase, replacing earlier terms such as 'homicidal maniac.'
- Under the heading of intentional homicide falls the work of hired assassins, mercenaries, and terrorists. They work for obvious, understandable goals. The hired assassin and mercenary work for money, while the terrorist kills for some ideal.
- Serial killers do not work for such external, obvious goals. Instead, they are driven from within, living and dying for that which appeals only to them. The nature of this drive has been heavily debated, but there is a consensus on some points. Sexual undertones in the murder have been noted by many researchers. These sexual undertones have inspired several researchers to refer to the self-motivated serial murderer as a serial sexual murderer.
- One of the other common points concerning the serial killer is the presence of free will. It cannot be denied that there are a great deal of unconscious drives present in the actions of the serial killer, and that these drives are still shrouded in darkness. At the same time, there is a great deal of evidence that the serial killer "acts from a conscious perspective."
- The serial killer is a distinct psychological phenomenon. It is well known that fantasy plays a large role in the life and motivation of the serial killer. And it is also widely accepted that the serial killer uses fantasy as a crutch, as a coping mechanism for day-to-day life. The serial killer, much like the chronic gambler and problem drinker, is addicted to the use of fantasy.
- Serial killers are viewed by many experts in both psychology and psychiatry to be the ultimate extension of violence. As this statement would suggest, serial killers have many traits in common with each other. The proper psychological classification for serial killers has been discussed for many years, but the most appropriate is that of psychopathic sexual sadist.
  - In psychiatry, the phrase ASPD, or antisocial personality disorder has replaced the earlier terms psychopathy and sociopathy. Antisocial personality disorder has a variety of characteristics, some of which better describe serial killers than others. The inability to love, which is often considered to be the core of ASPD, is especially evident in the serial killer.
  - Highly impulsive and aggressive behaviour is another part of the serial killers' psyche, and studies show that they require more thrills than normal people.
  - An inherent sadistic nature is yet another part of the serial killer, along with a fascination for violence, injury and torture. While the young child may pull the legs off of a grasshopper for entertainment, the serial killer enjoys doing, or fantasizing about doing such things to fellow humans.
  - The classic feature of the psychopath (and thus the serial killer), or the ASPD individual, is an absolute lack of guilt. Participation in activities which could result in social disapproval will generate guilt and remorse in a normal, healthy individual, but the serial killer does not experience either of these feelings to any sufficient degree.
- There is no external motive in a serial murder. The victim is killed for psychological gain on the part of the murderer. The evidence of forethought, of sometimes extensive planning, is always observable. The serial killer spends an amount of time planning the murder, whether

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consciously or not, and this is reflected in the killer's actions and in the crime scene.

- Another interesting feature of serial killers is their ability to thoroughly conceal their criminal activities. Their lack of close relationships and of remorse only aid this ability. These traits serve to make the serial killer very dangerous. Their lack of conscience, as a result of ASPD, lack of external motivation, planning, and ability to hide their criminality make them virtually invisible.
- However, not all serial killers are alike. Regardless of all the similar attributes serial killers share, many experts insist on dividing them into subgroups. Holmes and De Burger divide serial killers into four categories:
  - **Visionary**: They murder in response to voices, or visions urging them to kill. This type of killer is most usually classified as psychotic.
  - **Mission-oriented**: They have a distinct goal, for instance, the elimination of a group or category of people, such as murdering prostitutes to clean up the city.
  - **Hedonistic**: They are thrill-seekers, killing for the kicks of it.
  - **Control-oriented**: They enjoy the absolute power over the victim.
- Another way of classifying is as follows:
  - **Process-focused**: They use more excessive violence, and often engage in dismemberment or abuse of the dead victim.
  - **Act-focused**: They murder quickly and efficiently.
- These differentiations are close to the FBI's organized/disorganized classification scheme. In this scheme, laid out by the Behavioral Science Unit of the FBI, killers are classified as:
  - **Disorganized**, when there is little evidence of extensive pre-crime planning, including such things as using a weapon of opportunity at the scene, and picking a victim at semi-random. Disorganized killers tend to be far more violent than their counterparts, and also seem to kill for the process of the killing, rather than the end result.
  - **Organized** killers, on the other hand, tend to plan out the crimes in great detail, perhaps stalking the victims for weeks on end, bringing their own weapons, and having elaborate disposal schemes for the body. Just like the act-focused murderer, the organized offender kills quickly and efficiently, and does not mutilate as often as the disorganized offender.
- The actual origin of the serial killer is still mostly a mystery. No one knows of any definite genetic predispositions toward serial murder, or any particular life experiences that will produce serial killers. But the foundation for the serial killer is usually laid down in their early life experiences during childhood. Virtually all serial killers report harsh childhood punishment and discipline.
- The serial killer never truly bonds to his family, much like some alcoholics. In addition, this inability to bond extends to peers, resulting in very few friendships. Even as young children, the future serial killer is viewed as a loner. Episodes of bedwetting and firesetting (pyromania), coexist with a tendency for cruelty to animals, and have been called the 'triad' of childhood characteristics representative of future serial killers. In relation to other children, the future killer is rebellious and aggressive, lying constantly. Their anger toward society is reflected in the way they bully other children when given the chance.
- As a result of their reliance on fantasy, and as a result of childhood abuse, the future killer has developed a series of negative personality traits which results in only increased isolation. These traits include a preference for autoerotic activity, aggression, chronic lying, rebelliousness, and a preference for fetish behaviour.
- The serial killer, though outwardly secure and apparently stable, is in reality terribly insecure. When the killer is not in complete control of the situation, he feels helpless, without power. Fantasy, here, is like other forms of addiction, lending a form of temporary self-esteem. The extreme violence of some killers is because of this low self-esteem.

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Box 5.7 **Ted Bundy–Cold Blooded Serial Killer**

Ted Bundy (born Theodore Robert Cowell) was an American serial killer, rapist, paedophile, and necrophiliac who was active in several US states in the mid to late 1970s.

Bundy was born in Burlington, Vermont to Eleanor Louise Cowell. His father's identity remains unknown. For most of his life, Bundy was raised to believe that his grandparents, Samuel and Eleanor, were his actual parents, and that Louise was his older sister. He didn't find out that "Louise" was his mother until his college years. This was done to avoid any social stigma placed on Louise for being an unwed mother. When Louise married a man named Johnny Culpepper Bundy, his surname was changed to "Bundy". During high school, Bundy was often isolated from other kids his age. He couldn't seem to understand teenage social behavior but was skilled in "faking it", indicating a propensity towards psychopathy.

Ted Bundy

In college, Bundy studied Psychology and Asian studies. After a breakup with a fellow female student, Bundy became depressed and dropped out of college. He returned to Burlington and, doing a search of public records, discovered his true parentage. After this, he became more focused and dominant. Returning to Washington, he enrolled in the University of Washington as a psychology major and became an honor student who was well-liked by professors and students alike. Bundy's personality underwent a major paradigm shift; from shy and introverted, to confident and social.

Shortly after midnight on January 4, 1974, Bundy first attempted murder. He broke into the basement bedroom of a female student at the University of Washington, bludgeoned her in her sleep and sexually assaulted her. She survived, but suffered permanent brain damage. Over the following four months, he killed three students. After more abductions and murders, the authorities became aware that the same man, who a number of witnesses had said called himself "Ted", was responsible for the disappearances. Because of his reputation as a clean-shaven and well-mannered student, the police paid no attention to their tips. During this time, he also killed women in Oregon. Bundy then moved on to Salt Lake City, Utah where he attended the University of Utah College of Law. During the first semester, he killed four more women, one of whom was the daughter of a police chief. The next semester, 1975, he killed four more women, three of whom were taken in Colorado. He killed another girl, 15-year old Susan Curtis, during his summer break.

On August 16, he was pulled over when he did not stop for a police officer. Inside his car, the officer found items he suspected to be burglary tools. On March 1, 1976, he was sentenced to 15 years in prison for the kidnapping of Carol DaRonch, whom he had tried to abduct in Utah in 1974 by pretending to be a police officer.

In 1977, investigators had found enough evidence to charge Bundy with the January 1975 murder of Caryn Campbell, who had disappeared while on a ski trip, and managed to extradite him to Aspen. At the County courthouse, Bundy was allowed to visit the courthouse library. From there, he escaped through a window but was pulled over in a stolen car for having dimmed headlights, and arrested again. He was placed in a jail in Glenwood Springs, from which he escaped again on December 30, 1977, by somehow getting out through a crawlspace. By the time the jail staff realized that he was missing, he had already made his way to Chicago.

After spending some time at the University of Michigan in Ann Arbor and in Atlanta, Bundy settled at Tallahassee, Florida on January 8, where he supported himself through shoplifting and purse snatching. On January 15, 1978, he committed his first murders in almost two-and-a-half years. He broke into the hostel of

contd.

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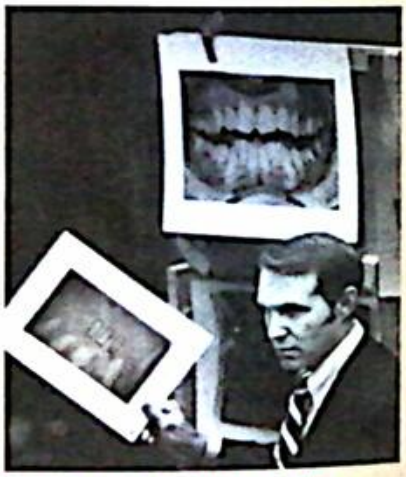
Florida State University, raped, strangled, and bludgeoned students Lisa Levy and Margaret Bowman. Two other students were also attacked but survived.

On February 9, 1978, Bundy committed his last known murder. He abducted 12-year-old Kimberly Leach outside her school, raped and killed her and tried to hide the body in an abandoned hog shed. On the morning of February 15, he was arrested for driving a stolen vehicle and was quickly linked to the Florida University murders. Two pieces of evidence proved crucial: a set of bite marks on one of the victim's buttocks, and the testimony of a Florida University student who had not been present at the killings, but saw Bundy leave the building. Bundy spent the better part of the 1980s fighting his sentence. During this time, he married Carole Ann Boone, a former co-worker, and had a daughter, Tina, with her in October 1982.

Some Confirmed Victims of Bundy

Bundy was convicted for two of the several murders he had committed and sentenced to death. As the execution date came closer, he confessed to more murders for which he had not previously been conclusively linked to. At 7:06 a.m. on January 24, 1989, Bundy was executed by electric chair.

Modus operandi: Bundy targeted women aged 12 to 26 years old. All of the victims were either in college or had a middle-class background. His method of obtaining the victims varied; sometimes he would burglarize their homes and bludgeon them in their sleep, sometimes he would use an elaborate ruse, and sometimes he merely relied on his looks alone. The latter method was successful for Bundy because of the fact that women considered him to be good-looking and charming. In fact, this characteristic even allowed him to successfully abduct women in broad daylight, even if they were aware that a serial killer was present in the area. His facial features were also "unremarkable"; that is, though attractive, not especially memorable. This allowed him to completely change his appearance with only minor adjustments; a moustache, different hair style, a hat, etc. Sometimes, Bundy would use a fake cast to play on a potential victim's sympathy. He would ask them for assistance of some kind, such as helping him put something in his car, or asking for directions. Whatever the method, his initial attacks were typically blunt force trauma to the head with a crowbar. He would later kill his victims by strangulation and would sometimes decapitate them. In one case, he cremated the severed head in a fireplace.



Bite Mark Evidence Being Presented During Bundy's Trial

Bundy would often visit his victims, whom he dumped at a site in Taylor Mountain. He admitted to applying makeup to the corpses, having sex with them, and would lie with them for hours afterward. Bundy also kept a collection of photos of his victims.

Psychological profile: Dorothy Otnow Lewis, a psychologist who interviewed Bundy for several hours, diagnosed him as a manic-depressive (bipolar disorder). She concluded that his murders took place during his depressive episodes. While other experts found Bundy's precise diagnosis elusive, the majority of evidence

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pointed away from bipolar disorder or other psychoses, and toward antisocial personality disorder (ASPD). Such patients (frequently referred to as "sociopaths" or "psychopaths") are often outwardly charming, even charismatic; but beneath the facade there is little true personality or genuine insight. Most sociopaths are not demonstrably psychotic; they can readily distinguish right from wrong, but such ability has minimal effect on their behaviour. They are devoid of feelings of guilt or remorse, a point readily admitted by Bundy himself.

Ted Bund'y Body after Autopsy

Table 5.1 Differences Between True and Feigned Insanity

Feature	True insanity	Feigned insanity
Onset	Gradual and insidious	Abrupt and dramatic
Motive	Absent	Present (commission of offence)
Precipitating factors	May be present (stress, financial losses, bereavement, etc)	Absent
Symptomatology	Conforms to a particular type of psychiatric disorder	Usually does not conform to any known type of disorder, and is often exaggerated. Symptoms may be absent when the patient is not under observation
Facial expression	Usually listless, vacant, and fixed	Frequent changes, exaggerated grimaces
Insomnia	Often present	Cannot withstand lack of sleep for more than a night or two
Exertion	Can withstand fatigue and hunger for prolonged periods	Cannot withstand fatigue or hunger for more than a day or two
Personal hygiene	Does not pay attention to his personal hygiene	May only pretend to be disinterested in appearance or dress
Frequent psychiatric examinations	Does not mind	Resents, since he fears detection

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- The serial killer generally does not stop of his own accord. Unless prevented, the serial killer will kill again and again. Each successful murder exhilarates the killer, both confirming and reinforcing the act. All serial killers follow this pattern, increasing the frequency of their killings. Unless removed from society, the killer will continue to murder.

Box 5.7 gives an account of one of the most notorious serial killers - Ted Bundy.

FEIGNED INSANITY

- Since the law provides for exempting a criminal from punishment if he was insane at the time of the offence (though he may be incarcerated in a psychiatric hospital for treatment), it is not uncommon for an offender to plead insanity as a defence, especially in cases of murder. Such a defence may be put forth even though the culprit is actually sane, so that he may escape stiff punishment such as life imprisonment or death. In order to substantiate his claim, the person may pretend to be insane by manifesting fabricated signs and symptoms. This is refered to as **feigned insanity**.
- The court or the police may then request for the opinion of a psychiatrist to clarify the issue. When called upon to do so, the psychiatrist must meticulously examine the individual and pay special attention to certain clues which could indicate pretence ("feigning or shamming or malingering"). Some of these are mentioned in Table 5.1. Some practical clues to indicate that an individual is feigning insanity include the following:
  - The first step is to do a thorough review of the suspect's history. Mental illness does not develop overnight, so it is important to know if the person has been hospitalized or treated for similar symptoms.
  - The investigator must also review the crime-scene report. If the suspect has hidden the weapon, washed off his fingerprints, or taken other steps to elude the police, it is a sign of clear thinking-not mental illness.
  - It is recommended to conduct long, rambling interviews-the longer the better, because after a few hours, some suspects begin to lose track of their symptoms or grow weary of the pretence.
  - Most malingerers are not aware as to how a mentally disturbed individual is expected to behave, so they may present a confusing or even bizarre picture - a Bollywood version of insanity!
  - Malingerers often exaggerate their symptoms and ignore common, subtle signs such as the blunting of a mentally ill patient's emotions. Some fakers say one thing and do another. They might feign confusion to the psychiatrist but later converse easily with cell-mates, or claim to be paranoid while sitting at ease. Some combine symptoms from different conditions, such as hallucinations of schizophrenia and suicidal ideations of a depressive.
  - Today, there are standardized tests that trip up malingerers. A preliminary, 10-minute test, called M-FAST (Miller Forensic Assessment of Symptoms Test), presents a series of 25 questions that intermix phony and real symptoms. It is almost impossible to pick the right combinations if the suspect is not mentally ill. A more thorough series of questions called SIRS (Structured Interview of Reported Symptoms) is used subsequently.
  - There is even a test for faking amnesia, which is among the most common of feigned mental illnesses. Contrary to popular belief, people with amnesia do not completely lose their ability to remember things. Therefore forensic psychologists give a memory test that is so easy that even a person with amnesia could pass it. They show a series of letters, numbers, and shapes for a few seconds and then ask him to draw them on a blank sheet of paper. Even people with amnesia caused by brain damage can reproduce most of the symbols. If the suspect says he cannot remember anything, he is most probably a malingerer.

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Box 5.8 **Criminal Responsibility in Some Special Situations**

1. **Automatism**: This refers to a condition in which the conscious performance of an action is impaired to such an extent that the patient does not remember anything subsequently. This may occur: (a) after an epileptic fit, (b) after an episode of concussion, (c) due to hypoglycaemia. The person is usually **not** held responsible for his actions.
2. **Somnambulism** (sleep walking): This is a condition in which a person walks about in his sleep. Such individuals may not be abnormal, though some suffer from psychiatric problems. A stressful episode usually precedes the walk. The person is usually **not** held responsible for any action committed during the episode of sleepwalking.
3. **Somnolentia (Semi-somnolence)**: This is a condition midway between sleep and wakefulness, as for instance, when a deeply slumbering person is rudely awakened. In the brief period during which he is confused, he may strike out reflexly at somebody who is near him, or who is in fact shaking him awake. The person is usually **not** held responsible for his actions during this "twilight period."
4. **Hypnotism or Mesmerism**: It is a sleep-like trance induced in a person by a process of suggestion. A hypnotised person may be subsequently induced into the performance of actions which he does not remember afterwards. Hypnotism and mesmerism cannot be pleaded as defence in the commission of crimes. Both the hypnotiser and the hypnotised **will be** held liable. An absolutely mesmerizing (*pun intended!*) British film titled 'Trance' directed by Danny Boyle on this theme was released in 2013.
5. **Drunkenness**: (a) If a person voluntarily consumes an intoxicating drink and commits a crime under its influence, he **will be** held responsible for his action (S. 86 IPC). (b) But if the drink was administered without his knowledge or against his will, he will **not** be held criminally responsible (S. 85 IPC).

A near-flawless portrayal of feigned insanity was essayed by the legendary Hollywood actor Jack Nicholson in the multi-award winning film by Milos Forman - **One Flew Over the Cuckoo's Nest** (1975) (Fig 5.2). It was one of the few films ever to win Academy awards (Oscars) for all major categories: Best Film, Best Director, Best Actor, Best Actress, and Best Screenplay.

| Fig. 5.2 |

Criminal Responsibility in Some Special Situations

The question of criminal responsibility may arise in a number of situations which are ambiguous, posing difficulties for the medical officer as well as the investigating authorities. Box 5.8 outlines the current status with reference to these conditons.

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CHAPTER 6

Human Rights, Torture and the Medical Profession

First they came for the Jews, and I did not speak out, because I was not a Jew.
Then they came for the communists, and I did not speak out, because I was not a communist.
Then they came for the trade unionists, and I did not speak out, because I was not a trade unionist.
Then they came for me, and there was no one left to speak out for me.

—**Pastor Martin Niemoller** (a victim of the Nazis)

Part—1

HUMAN RIGHTS & THE MEDICAL PROFESSION

Introduction

- One of modern civilization's achievements is the realization of the knowledge that the rights to life, liberty, and security of a person are primary, inherent, and inalienable to every human being, irrespective of race, nationality, economic status or other man-made discriminations.
- The **Universal Declaration of Human Rights** (Article 3) of **1948**, and Article 21 of the **Indian Constitution** recognize these rights as fundamental rights. This means that governments must not discriminate, torture, or imprison any individual under inhumane conditions, or interfere with the free flow of information, or invade privacy of any individual. A basic minimum number of facilities must be ensured for all (elementary education, housing, food, medical care).
- Fifty years ago in Nuremberg, Germany (25/10/1946–20/8/1947), 23 physicians and scientists stood trial for war crimes committed before and during the Second World War. They were accused of inflicting a range of vile and lethal procedures on vulnerable populations and inmates of concentration camps from 1933 to 1945. The medical experiments conducted by them, listed under the heading of 'crimes conducted in the guise of scientific research,' included exposing human beings to high altitudes, freezing them; infecting them with malaria, epidemic jaundice, and typhus; subjecting them to the effects of mustard gas, sulfanilamide, and other drugs and poisons; sterilisation experiments, incendiary bomb experiments, crimes of mass extermination, and 'euthanasia.' The Nuremberg Trials led to the emergence of the **Nuremberg code** which explicitly outlines the boundaries of acceptable medical experimentation (Box 6.1).
  - The Doctors' trial was the first of 12 trials for war crimes of German doctors that the United States authorities held in their occupation zone in Nuremberg, Germany after the end of World War II. The trials are collectively known as the "Trials of War Criminals before the Nuremberg Military Tribunals" (NMT).
  - Twenty of the 23 defendants were medical doctors (Viktor Brack, Rudolf Brandt, and Wolfram Sievers were Nazi officials), and were accused of having been involved in Nazi human experimentation and mass murder under the guise of euthanasia. Josef Mengele, one of the leading Nazi doctors, had evaded capture. The indictment was filed on October 25, 1946; the trial lasted from December 9 that year until August 20, 1947.

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Box 6.1 **The Nuremberg Code**

1. The voluntary consent of the human subject is absolutely essential. This means that the person involved should have legal capacity to give consent; should be so situated as to be able to exercise free power of choice, without the intervention of any element of force, fraud, deceit, duress, over-reaching, or other ulterior form of constraint or coercion; and should have sufficient knowledge and comprehension of the elements of the subject matter involved as to enable him/her to make an understanding and enlightened decision. This latter element requires that before the acceptance of an affirmative decision by the experimental subject there should be made known to him the nature, duration, and purpose of the experiment; the method and means by which it is to be conducted; all inconveniences and hazards reasonably to be expected; and the effects upon his health or person which may possibly come from his participation in the experiment. The duty and responsibility for ascertaining the quality of the consent rests upon each individual who initiates, directs or engages in the experiment. It is a personal duty and responsibility which may not be delegated to another with impunity.
2. The experiment should be such as to yield fruitful results for the good of society, unprocurable by other methods or means of study, and not random and unnecessary in nature.
3. The experiment should be so designed and based on the results of animal experimentation and a knowledge of the natural history of the disease or other problem under study that the anticipated results will justify the performance of the experiment.
4. The experiment should be so conducted as to avoid all unnecessary physical and mental suffering and injury.
5. No experiment should be conducted where there is a prior reason to believe that death or disabling injury will occur; except, perhaps, in those experiments where the experimental physicians also serve as subjects.
6. The degree of risk to be taken should never exceed that determined by the humanitarian importance of the problem to be solved by the experiment.
7. Proper preparations should be made and adequate facilities provided to protect the experimental subject against even remote possibilities of injury, disability, or death.
8. The experiment should be conducted only by scientifically qualified persons. The highest degree of skill and care should be required through all stages of the experiment of those who conduct or engage in the experiment.
9. During the course of the experiment the human subject should be at liberty to bring the experiment to an end if he has reached the physical or mental state where continuation of the experiment seems to him to be impossible.
10. During the course of the experiment the scientist in charge must be prepared to terminate the experiment at any stage, if he has probable cause to believe, in the exercise of the good faith, superior skill and careful judgment required of him that a continuation of the experiment is likely to result in injury, disability, or death to the experimental subject.

Reprinted from Trials of War Criminals before the Nuremberg Military Tribunals under Control Council Law No. 10, Vol. 2, pp. 181-182. Washington, D.C.: U.S. Government Printing Office.

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- Of the 23 defendants, seven were acquitted and seven received death sentences, including **Karl Brandt** (Fig 6.1), the personal physician to Adolf Hitler; the remainder received prison sentences ranging from 10 years to life imprisonment.
- Those sentenced to death were hanged on June 2, 1948 in Landsberg prison, Bavaria.

| **Fig. 6.1** Sentence of death being pronounced upon Adolf Hitler's personal physician, Karl Brandt |

- Subsequently, the **Helsinki Declaration on Human Experimentation** was adopted by the World Medical Association (WMA) in **1964**. Today there are stringent guidelines for research involving human subjects.
- Ancient India's political leadership was dominated by monarchs whose whims decided their subjects' rights. Criminal investigations in the past involved forcing suspects to prove their innocence by undergoing tests of innocence such as dipping their hands into boiling oil or burning embers. In British India, the earliest evidence of custodial death was reported in Madras in 1678 when Thomas Savage, a soldier who abused his superior officer, was punished by being tied to a cot, and bound by the neck and heels. He died.
- Further, when the British system of judiciary and policing was introduced in India, some tribes and castes were notified as 'criminal' and this prejudice was inherited by independent India's police force. When such historical verisimilitudes blended into the frailities of politicians and bureaucrats of democratic India, the constitutionally guaranteed rights often remained only on paper. Also, the nascent Indian democracy's viability and resilience was often tested by traditional practices.
- Even today in India, the military, intelligence agencies, and the police have all occasionally been put in the dock for human rights violations.
- In many such instances, the autopsy appearances of fatal abuse are no different from those by any other homicide, and the confirmation of lethal torture must depend on circumstantial and other corroborative evidence. Certain features may arouse suspicion or provide definite evidence that the death had 'political' overtones. Abuses of human rights are not directed or condoned by higher levels of government though there is often an indifference on being informed of such activities.
- The occurrences of death or sexual/physical abuse while a person is either in the custody of the police, or is the inmate of a prison, often creates sociopolitical problems. There is an immediate complaint or rumour of ill-treatment, by the relatives or the media. A meticulous autopsy/medical examination is a necessary part of the investigation needed to dispel–or sometimes confirm–allegations that an act of commission or omission on the part of the custodians of the law has led to, or contributed to, a death.
- Further, the medical professional may be coerced to take part in the unlawful interrogation of politically inconvenient persons.
  - In several countries using the death penalty, health personnel are responsible for the victim being 'fit for execution.' The presence of health personnel during executions in order to use the organs for transplantation has also been documented.
  - Enforced sterilization of women, prenatal sex determination and enforced abortion in order to 'eliminate' female babies, female circumcision, and mandatory testing for virginity are other examples of violation of human rights using medical participation.

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Health personnel have a great responsibility in regard to these violations of human rights.

- The **London Declaration of Amnesty International** for health professionals on the occasion of the 21st anniversary of the establishment of the first Amnesty International Medical Group lays down that health professionals should defend and promote human rights as an inherent part of their activities to promote health and well-being. Some of the recommendations include:
  - free all prisoners of conscience;
  - ensure fair and prompt trials for political prisoners;
  - abolish the death penalty, torture and other cruel, or degrading treatment or punishment;
  - end the denial of medical care to prisoners as a form of ill-treatment and extra-judicial executions and 'disappearances'.

Health professionals should apply their clinical skills and professional ethics to the prevention of human rights violations and the defense of human values. Professional associations and societies must undertake systematic activities to defend those under threat of human rights violations, and must investigate and act upon all reports of human rights abuses by health professionals.

- Medical professionals must realize that promoting and protecting human rights is essential for promoting and protecting health. This insight will be helpful in the evolving approach to population and women's health, drug and alcohol abuse, and in the work of HIV/AIDS.

Human Rights: The Current Indian Scenario

- The situation of **human rights in India** is a complex one, as a result of the country's large size and tremendous diversity, its status as a developing country and a sovereign, secular, democratic republic, and its history as a former colonial territory.
- The Constitution of India provides for Fundamental Rights, which include freedom of religion. Clauses also provide for freedom of speech, as well as separation of executive and judiciary, and freedom of movement within the country and abroad.
- It is often held, particularly by Indian human rights groups and activists, that members of the Dalit or Untouchable caste have suffered and continue to suffer substantial discrimination. Although human rights problems do exist in India, the country is generally not regarded as a human rights concern, unlike other countries in South Asia. Based on these considerations, the report Freedom in the World 2016 by Freedom House gave India a freedom rating of 2.5, a civil liberties rating of 3, and a political rights rating of 2, earning it the designation of free. The rating scale runs from 1 (most free) to 7 (least free).
- However, with regard to freedom of expression, even though the Constitution guarantees it, certain restrictions are placed on content, with a view towards maintaining communal and religious harmony, given the history of communal tension in the nation. Watching or possessing pornographic materials is apparently legal, but distribution of such materials is strictly banned. The Central Board of Film Certification allows release of certain films with sexual content (labelled A-rated), which are to be shown only in restricted spaces and to be viewed only by people of age 18 and above. Films, television shows and music videos are prone to scene cuts or even bans; however if any literature is banned, it is not usually for pornographic reasons. The Indian Press currently enjoys extensive freedom. The freedom of speech, mandated by the constitution guarantees and safeguards the freedom of press.
- It is quite a mixed state of affairs with regard to censorship relating to books, films, drama, and the internet (Box 6.2).

Box 6.3 gives a historical evolution of the human rights scenario in India.

National Human Rights Commission of India

- The **National Human Rights Commission** (NHRC) of India is an autonomous statutory body

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Box 6.2 **Censorship in India: A History of Intolerance - Some Recent Examples**

Films

The **Central Board of Film Certification (CBFC)**, the regulatory film body of India, regularly orders directors to remove anything it deems offensive, including sex, nudity, violence or subjects considered politically subversive.

- In 2002, the film **War and Peace**, depicting scenes of nuclear testing and the September 11, 2001 attacks, created by Anand Patwardhan, was asked to make 21 cuts before it was allowed to have the certificate for release. Patwardhan objected, saying "The cuts that they asked for are so ridiculous that they won't hold up in court". The court decreed the cuts unconstitutional and the film was shown uncut.
- In 2003, the CBFC banned the film **Gulabi Aaina (The Pink Mirror)**, a film on Indian transsexuals produced and directed by Sridhar Rangayan. The censor board cited that the film was "vulgar and offensive". The filmmaker appealed twice again unsuccessfully. The film still remains banned in India, but has screened at numerous festivals all over the world and won awards.

- In 2004, the documentary **Final Solution**, which looks at religious rioting between Hindus and Muslims, was banned. The film follows 2002 clashes in the western state of Gujarat, which left more than 1,000 people dead. The censor board justified the ban, saying it was "highly provocative and may trigger off unrest and communal violence". The ban was lifted in October 2004 after a sustained campaign.
- In 2006, seven states (including Nagaland, Punjab, Goa, Tamil Nadu, Andhra Pradesh) banned the release of the Hollywood movie **The Da Vinci Code**, although India's CBFC cleared the film for adult viewing throughout India.
- The CBFC demanded 5 cuts from the 2011 American film **The Girl with the Dragon Tattoo** because of some scenes containing rape and nudity. The producers and the director David Fincher finally decided not to release the film in India.
- In 2013, Kamal Haasan's **Vishwaroopam** was banned from screening for a period of 2 weeks in Tamil Nadu.
- In 2015, the CBFC demanded 4 cuts from the art-house Malayalam feature film **Chaayam Poosiya Veedu (The Painted House)** directed by Santosh and Satish Babusenan because the film contained scenes where the female lead was shown in the nude. The directors refused to make any changes whatsoever to the film and hence the film was denied a certificate.
- In 2016, the film **Udta Punjab**, produced by Anurag Kashyap and Ekta Kapoor, ran into trouble with the CBFC, resulting in a very public re-examination of the ethics of film censorship in India. The film, which depicted rampant drug problem in the state of Punjab, used a lot of expletives and showed scenes of drug use. The CBFC, on 9 June 2016, released a list of 94 cuts and 13 pointers, including the deletion of names of cities in Punjab! On 13 June 2016, Udta Punjab was cleared by the Bombay High Court with just one cut and some disclaimers. The court ruled that, contrary to the claims of the CBFC, the film was not out to "malign" the

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state of Punjab, and that it "wants to save people" The film eventually released and grossed over $13 million finishing as a commercial success.

Music

- Heavy metal band Slayer's 2006 album **Christ Illusion** was banned in India after Catholic churches in the country took offense to the artwork of the album and a few song titles and launched a protest against it. The album was taken off shelves and the remaining catalog was burnt by EMI Music India.

Dramas

- In 1999, Maharashtra government banned the Marathi play **Me Nathuram Godse Boltoy** or **I, Nathuram Godse Speaking**. The Notification was challenged before the Bombay High Court, which allowed the writ petition and declared the notification to be ultra vires and illegal, thus rescinding the ban.
- In 2004, Eve Ensler's **The Vagina Monologues** was banned in Chennai. The play however, has played successfully in many other parts of the country since 2003.A Hindi version has been performing since 2007.

Books

- In 1989, the import of Salman Rushdie's **The Satanic Verses** was banned in India for its purported attacks on Islam. India was the second country in the world (after Singapore) to ban the book.
- In 1990, **Understanding Islam through Hadis** by Ram Swarup was banned. In 1990 the Hindi translation of the book was banned, and in March 1991 the English original became banned as well.
- The book **Shivaji** by Queen's University professor Jayant Lele about the 17th century Indian warrior king Shivaji Bhosale was banned because the book raised a question about Shivaji's father.
- **Shivaji: Hindu King in Islamic India** by American scholar James Laine was banned in 2004.
- Laine's translation of the 300-year-old poem **Sivabharata**, titled **The Epic of Shivaji**, was banned in Jan 2006.
- RV Bhasin's **Islam - A Concept of Political World Invasion by Muslims** was banned in Maharashtra in 2007 on grounds that it promotes communal disharmony between Hindus and Muslims.

Internet

- Freedom House's *Freedom on the Net 2015* report gives India a Freedom on the Net Status of "Partly Free" with a rating of 40 (scale from 0 to 100, lower is better). Its Obstacles to Access was rated 12 (0-25 scale), Limits on Content was rated 10 (0-35 scale) and Violations of User Rights was rated 18 (0-40 scale). India was ranked 29th out of the 65 countries included in the 2015 report.
- Following the November 2008 terrorist attacks in Mumbai, which killed 171 people, the Indian Parliament passed amendments to the **Information Technology Act (ITA)** that expanded the government's censorship and monitoring capabilities. While there is no sustained government policy or strategy to block access to Internet content on a large scale, measures for removing certain content from the web, sometimes for fear they could incite violence, have become more common.
- Internet users have sporadically faced prosecution for online postings, sometimes for political reasons, at other times on the basis of frivolous or motivated complaints by other individuals.
- In 2009, the Supreme Court ruled that bloggers and moderators can face libel suits and even criminal prosecution for comments posted on their websites.

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Box 6.3 Human Rights in India – Chronological Evolution

- **1829** – The practice of *sati* was formally abolished by Governor General William Bentick after years of campaigning by Hindu reform movements such as the Brahmo Samaj of Ram Mohan Roy.
- **1929** – *Child Marriage Restraint Act*, prohibiting marriage of minors, is passed.
- **1950** – The Constitution of India establishes a sovereign democratic republic with universal adult franchise. Part 3 of the Constitution contains a Bill of Fundamental Rights enforceable by the Supreme Court and the High Courts. It also provides for reservations for previously disadvantaged sections in education, employment and political representation.
- **1952** – *Criminal Tribes Act 1871* repealed by government, former "criminal tribes" categorized as "denotified" and *Habitual Offenders Act (1952)* enacted.
- **1955** – Reform of family law concerning Hindus gives more rights to Hindu women.
- **1975–77** – State of Emergency in India – extensive rights violations take place.
- **1978** – SC rules in *Maneka Gandhi v. Union of India* that the right to life under Article 21 of the Constitution cannot be suspended even in an emergency.
- **1985-6** – The Shah Bano case, where the Supreme Court recognised the Muslim woman's right to maintenance upon divorce, sparks protests from Muslim clergy. To nullify the decision of the Supreme Court, the government enacts *The Muslim Women (Protection of Rights on Divorce) Act 1986*.
- **1989** – *Scheduled Caste and Scheduled Tribe (Prevention of Atrocities) Act, 1989*, is passed.
- **1992** – A constitutional amendment establishes Local Self-Government (Panchayati Raj) as a third tier of governance at the village level, with one-third of the seats reserved for women. Reservations were provided for scheduled castes and tribes as well.
- **1993** – National Human Rights Commission is established under the *Protection of Human Rights Act*.
- **2001** – Supreme Court passes extensive orders to implement the right to food.
- **2005** – A powerful *Right to Information Act* is passed to give citizen's access to information held by public authorities.
- **2005** – *National Rural Employment Guarantee Act (NREGA)* guarantees universal right to employment.
- **2006** – Supreme Court orders police reforms in response to the poor human rights record of Indian police.
- **2009** – Delhi High Court declares that Section 377 of the Indian Penal Code, which outlaws a range of unspecified "unnatural" sex acts, is unconstitutional when applied to homosexual acts between private consenting individuals, effectively decriminalising homosexual relationships in India. Strangely, on 11 December 2013, homosexuality was again criminalized by a Supreme Court ruling.
- **2016** - On 2 February 2016, the Supreme Court agreed to reconsider its judgment on re-criminalizing homosexuality, stating it would refer petitions to abolish Section 377 to a five-member constitutional bench, which would conduct a comprehensive hearing of the issue. This is currently awaited.

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established on October 12, 1993, under the provisions of **The Protection of Human Rights Act, 1993** (TPHRA). The Commission is in conformity with the **Paris Principles** – a broad set of principles agreed upon by a number of nations for the promotion and protection of human rights, in Paris in October 1991.

- **Composition:**
  - A Chairperson who has been a Chief Justice of the Supreme Court of India
  - One Member who is, or has been, a Judge of the Supreme Court of India
  - One Member who is, or has been, the Chief Justice of a High Court
  - Two Members to be appointed from among persons having knowledge of, or practical experience in, matters relating to human rights
- **General Functions**
  - Can enquire into violations of human rights, or negligence in the prevention of such violation by a public servant
  - Can intervene in any proceeding involving any allegation of violation of human rights pending before a court
  - Can visit any jail or other institution under the control of the government, where persons are detained, for the study of the living conditions of the inmates and make recommendations
  - Can review the safeguards provided by the Constitution or any law for the time being in force, for the protection of human rights, and recommend measures for their effective implementation
  - Can review various factors, including acts of terrorism that inhibit the enjoyment of human rights, and recommend appropriate remedial measures
  - Can study treaties and other international instruments on human rights and make recommendations for their effective implementation
  - Must encourage the efforts of NGOs and institutions working in the field of human rights
  - Must ensure that every state in India has a State Human Rights Commission, and appropriate Human Rights Courts.
- **Medicolegal Functions:**
  - Makes it mandatory for the law and order agencies at the district level throughout the country to report matters relating to custodial death and custodial rape within 24 hours of occurrence.
  - In 1995, the NHRC issued directions to all State Governments to video-film all autopsies done in cases of death in police custody, and in jails. The video casette and the autopsy certificate have to be forwarded to the Commission after the autopsy. The investigating officer must make necessary arrangements for videography, and for submission of the documents to the NHRC.
  - In 1997, the NHRC prepared a model autopsy form, on the lines of the UN model autopsy protocol, which must be strictly adhered to in custodial and jail deaths.
- The commission also suggested improvements in the conduct of inquest.
- Temperature changes and onset of rigor mortis should be determined to find out the time of death in all cases where they are applicable.

- The NHRC has been accredited with "A status" by the International Coordinating Committee of National Human Rights Institutions (the ICC), indicating that it is in conformity with the Paris Principles - a broad set of principles agreed upon by a conference of experts on the promotion and protection of human rights, in Paris in October 1991, and subsequently endorsed by the UN General Assembly.

PART—2

TORTURE & THE MEDICAL PROFESSION

Introduction

Torture is a comparatively new entry in Forensic Medicine. It deals with medical, legal, and ethical issues in relation to the barbaric practice of torture in various situations. In the early days, in virtually any society, Western or Eastern, torture of alleged

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criminals, spies, and political prisoners was considered acceptable. Today, torture in any form is condemned by civilised societies, and is not acceptable in any situation. Yet, clandestinely, this is going on in some form or the other all over the world. Only the methods of torture have changed, and have become more "sophisticated," and consequently more "effective," and very difficult to detect medically. According to Amnesty International, the world-wide organisation that monitors human rights violations, torture is practiced even by governments in authority in 65 out of 144 countries, on those considered inimical to the state.

Definition of Torture

As per the **Tokyo Declaration** of the **World Medical Association** in **1975**, **torture** is defined as **the deliberate, systematic, and wanton infliction of physical or mental suffering by one or more persons acting alone, or on the orders of any authority, to force another person to yield information, or to make a confession, or for any other reason.**

Aims of Torture

As per the definition given above, there is invariably some purpose or objective behind an act of torture. Some of the common reasons for torture are as follows:

- **To obtain information**:
  - It depends on the case and its gravity. In many cases, torture is carried out by criminal gangs, terrorist organizations, etc., to ferret out some specific, desired information.
  - Occasionally, if a person is suspected to have indulged in anti-national activity, or terrorist activity, governmental organizations are themselves involved in the infliction of torture.
  - Such torture will usually continue till the desired information is obtained.
- **To force a confession**:
  - A person may be tortured in order to force him/her to confess to a crime.
  - The victim is often coerced into signing a document of confession saying that he/she has committed the crime.
  - Invariably the person eventually signs the confessional document under such threat and force, even though he/she may not have committed the crime, only to avoid further torture.
- **To obtain testimony incriminating others**: In some cases, victims are forced into signing documents incriminating other people, whether they are involved or not, in order to build a case against them.
- **To take revenge**: Sometimes a victim is tortured merely to take revenge, which may be not only against the individual concerned, but also the family members of the victim, or even an entire community. For example, raping an enemy's wife, sister or daughter, kidnapping family members, especially small children, aged parents, etc.
- **To spread terror in the community**:
  - This is very common in dictatorial regimes. Anybody who dares to raise his/her voice against the regime, may be tortured mercilessly.
  - If the victim dies, his body is often displayed to the community openly, with overt evidence of torture.
  - This creates terror in the minds of the people, and nobody would then dare to rise up against the regime. The dictator thus manages to continue his/her dictatorial rule in the country.
- **To destroy the personality**:
  - There are always some people with leadership qualities in every community. These people are most likely to raise their voices against dictatorial rule, or oppression in the society. They are capable of mobilising people in the community against tyrants or dictators.
  - Such persons are sometimes identified by the dictatorial regime, arrested, kidnapped, and tortured, so that they are transformed into a kind of "living dead." Their behaviour, thoughts, and feelings are suppressed, and they lose their self-confidence. There is often generation of

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feelings of hopelessness and worthlessness in the society.

Common Methods of Torture

Physical Torture

Physical methods of torture are those which inflict pain, discomfort, and dysfunction in different parts of the body.

a. **Physical torture that causes extreme and excruciating pain:**
   i. **Severe Beating** – is a common type of torture by using sticks, cables, whips, iron rods, etc.
   ii. **"Falanga" Torture** – Also called "foot whipping" or "bastinado." It involves beating on the soles of the feet. It is a systematic form of torture that is often used in our country. The person may become disabled for a long time. It leaves few physical marks, though evidence can be detected via ultrasound technology.
   iii. **Finger Torture** – Pencils or similar objects are placed in between two fingers and squeezed hard. Sometimes the fingers are twisted to cause severe pain.
   iv. **Cold Torture** – Victim is made to lie on an ice slab without clothing, or on a cold and damp floor.
   v. **Heat Torture** – Victim is suspended upside down very near to fire, or cigarette burns are inflicted.
   vi. **Dental Torture** – Pulling out teeth by clips or forceps. Sometimes the victim is asked to chew hard on small stones, metal pieces, etc. Actor Laurence Olivier played Nazi torturer-dentist Christian Szell in Director John Schlesinger's 1976 classic thriller film **Marathon Man**. He famously tortures the innocent Thomas 'Babe' Levy (enacted by Dustin Hoffman), by using a dental probe on a cavity in his tooth (Fig 6.2).

| Fig. 6.2 The Dental Torture Scene from "Marathon Man" |

b. **Physical torture that causes fear of immediate death:**
   i. **Electrical Torture**
      - Electric shock is applied to sensitive parts of the body such as nipples, genitals etc.
      - Sometimes the victim is tied to a metallic bed and electricity is passed, causing shock all over the body.
   ii. **Sham Execution** – Victim is sometimes blind folded and asked to stand before a wall, and then threatened that a vehicle is going to hit him. The victim hears the sound of a vehicle very near to him, and coming towards him, causing fear and shock.
   iii. **Waterboarding** – This is a form of torture that consists of immobilizing the victim on his back with the head inclined downwards, and then pouring water over the face and into the breathing passages. By forced suffocation and inhalation of water, the subject experiences drowning, and believes that he is about to die. In the critically acclaimed 2012 Hollywood film **Zero Dark Thirty** directed by Kathryn Bigelow, which dramatizes the decade-long manhunt for al Qaeda leader Osama bin Laden after the September 11, 2001 terrorist attacks in the United States, leading to the discovery of his compound in Pakistan, and the military raid on it that resulted in his death on May 2,

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2011, graphic depiction of enhanced interrogation (including waterboarding) (Fig 6.3) generated controversy, with some critics describing it as pro-torture propaganda, as the interrogations are shown producing reliably useful and accurate information.

| Fig. 6.3 Waterboarding Scene from "Zero Dark Thirty" |

c. **Physical torture that causes extreme exhaustion**:
   i. **Physical Exhaustion** – The victim may be asked to stand in the hot sun on one leg for a long time, or he may be asked to stretch out both his hands holding heavy bricks or stones.
   ii. **Forced Labour** – The victim is made to work very hard without food or water.
   iii. **Dunking** – This is a form of torture in which the victim is immersed into a vat of water, or a pond, and taken out after some time, and given the chance to confess. If he does not confess, he is submerged again. This process is usually repeated until the victim drowns or gives up.

d. **Physical torture that causes disfiguration, mutilation or permanent disability**:
   i. **"Telefono"** – In this method, simultaneous beating of both ears with the palms of the hands is done, causing rupture of tympanic membranes.
   ii. **Mutilation** – Chopping off ears, nose, fingers, etc.
   iii. **Disfiguration** – Throwing acids or corrosives over face and other parts of the body, causing severe burns leading to disfiguration.

Mental Torture

a. **Deprivation Techniques**:
   i) **Sensory deprivation** – Victim may be blindfolded for a long time.
   ii) **Perceptual deprivation** – Inducing confusion and disorientation in the victim, for example, by frequent transfer of the victim from one place to another, after blindfolding him.
   iii) **Social deprivation** – Solitary confinement in a dark environment.
   iv) **Deprivation of basic needs** – Withholding food, water, toilet facilities, etc.

b. **Coercion Techniques**: These methods of torture involve the compelling of a victim to perform certain acts, or witness certain traumatic acts, which can cause mental anguish, e.g.,
   i. Coercion to commit blasphemous acts.
   ii. Coercion to witness torture of other victims.
   iii. Coercion to torture other victims.

In Anthony Burgess' book **A Clockwork Orange** (later made into a highly controversial film of the same title by Stanley Kubrick), Alex, the anti-hero of the story, undergoes a fictional medical torture program called 'The Ludovico Technique', in which he is given a nausea-inducing drug, strapped to a chair with his eyelids forced open, and forced to watch hours of films of extreme violence and rape to condition him to associate feelings of nausea with rape and violence. Fig 6.4 is an image from the film version showing the Ludovico Technique being inflicted upon Alex (enacted by Malcolm McDowell).

c. **Communications Techniques**: The victim is mentally tortured by exposure to a variety of confusing, contradictory, or false communications, such as
   i. **Misinformation** – Giving false information to victim regarding tragedy involving close relatives such as wife and children, which causes mental anguish.

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| Fig. 6.4 Malcolm McDowell in "A Clockwork Orange" |

Sexual Torture

a. **Sexual torture using instruments**: Infliction of injuries to private parts of male or female victim, forcible introduction of rods, bottles, or batons in the rectum or vagina, mutilation of breasts or genital organs, etc.

b. **Sexual torture without the use of instruments**: The victim may be forced to undress in front of others, or raped in front of others, or photographed in humiliating positions or situations, or sexually tortured by trained animals.

Pharmalogical Torture

This method employs psychotropic and/or other chemicals to induce pain and cause compliance with the torturer's goals. Another form is when the victim is forcibly injected with addictive drugs to get him dependent, and then denied the drug and forced to go through withdrawal unless he provides what the torturer wants.

Consequences of Torture

Physical Consequences

1. **Early consequences**: Injuries in the form of abrasions, bruises, haematomas, lacerations, incised wounds, penetrating wounds, dislocations, fractures, etc.
2. **Late consequences**: Infections, scars, malunited bones, disfiguration of the face, impairment of hearing, impairment of vision, vertigo, etc.

Psychological Consequences

Anxiety, depression, sleep disturbances, alcohol/drug abuse, seizures, low self-esteem, stress disorders, etc.

Social Consequences

Social stigma, employment problems, negativity in social activities, etc.

Treatment of Torture Victims

As discussed earlier, torture has three dimensions – physical, psychological, and social. It is very difficult to assess which is more important, and which is less, in a particular individual. Treatment may not be effective if it is focussed on only one dimension. Doctors, psychologists, social workers, physiotherapists, nurses, and legal experts must work together in close collaboration, for maximum efficacy.

Principles of Treatment

Torture victims and their families are a special category of clients, because they have experienced an unusual (and often brutal) trauma at the hands of other human beings. Therefore, while dealing with torture victims and their families, the following principles need to be kept in mind –

- Developing a good rapport with the victim.
- Empathising with the victim and his/her family.
- Avoiding situations or objects that remind the victim of the torture event.
- Punctuality in keeping appointments with the victim, and his/her family, should be strictly maintained.

Medicolegal and Ethical Aspects of Torture

- Under the **Hippocratic Oath**, doctors are prohibited from using their professional knowledge to harm their patients, which was reconfirmed in

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the **Geneva Declaration** passed by the World Medical Association. However, in spite of this, it is a sad truth that doctors sometimes involve themselves directly or indirectly in the perpetration of torture, especially military doctors, police and prison doctors, and forensic experts.

- The **World Medical Assembly** (WMA), in **Tokyo (1975)**, adopted a special resolution in regard to this.

  The following are the salient points of the **Tokyo Declaration**:

  1. A doctor shall not countenance, condone or participate in the practice of torture or other forms of cruel, inhuman, or degrading procedures.
  2. A doctor shall not provide any premises, instruments, substances, or knowledge to facilitate the practice of torture.
  3. Doctors should not be present during any procedure involving cruel or inhuman activities.
  4. A doctor must have complete clinical independence in deciding upon the care of a person for whom he or she is medically responsible.
  5. Doctors shall in all circumstances consider it their bounden duty to alleviate the distress of their fellowmen, and no motive, whether personal, collective, or political, shall prevail against this higher purpose.
  6. The World Medical Association will support and encourage the international community, the national medical associations, and fellow professional colleagues, to support a doctor and his or her family, in the face of threats or reprisal resulting from a refusal to condone the use of torture or other forms of cruel, inhuman, or degrading treatment.

- The **UN Convention Against Torture**, which also applies to medical personnel (in addition to law enforcement officers, military personnel, politicians, and other persons acting in an official capacity), prohibits the use of torture under any circumstance. Under Article 2(2) of the Convention, it states that "No exceptional circumstances whatsoever, whether a state of war or a threat of war, internal political instability or any other public emergency, may be invoked as a justification of torture."

The Indian Scenario

- Victims of torture may either suffer from injuries, or may die because of injuries. Such cases should be examined carefully and thoroughly, and reported to the police or magistrate, and treated appropriately.
- Systematic and meticulous examination will help in establishing or disproving a charge of torture.
- **Sections 330** and **331** of the **IPC** deal with the issue of voluntarily causing hurt and grievous hurt for the purpose of extorting confession or any information.
- The Government of India enacted **The Protection of Human Rights Act, 1993**, which monitors the violation of any of the rights of the individuals of this country.
- Unfortunately however, Indian law enforcement agencies, including the police, still resort to torture quite frequently for extracting confessions from "criminals." According to the National Human Rights Commission (NHRC) of India, complaints were received of 888 custodial deaths in 1996–97, 1012 custodial deaths in 1997–98, 1297 custodial deaths in 1998–99, 1093 custodial deaths and rape in 1999–2000, and 1305 custodial deaths in 2000–2001. These custodial deaths are in addition to disappearances, illegal detention, and other police excesses and violations by armed forces where individuals, accused or suspects, are subjected to torture, but not necessarily killed.
- With increasing incidents of terrorism in the country, the police have become even more harsh in certain situations. Under **Section 31** of the **Prevention of Terrorism Act (POTA)** of **2002**, a confession made by a person before a police officer not lower in rank than a Superintendent of Police is admissible as evidence in the trial of such person for an offence. This is actually a clear violation of Section 25 of the Indian Evidence

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Act and gives "License to Torture" to extract confessions. Under the **Terrorist and Disruptive Activities (Prevention) Act** (*a precursor to the POTA*), out of over 76,000 persons detained from 1985 to 1995, less than 1% of the detainees were convicted, and out of these, about 80% of the conviction took place on the basis of the confessions made by the accused. In many cases, confessions were extracted after being subjected to torture.

- The police and armed forces enjoy virtual impunity under Section **197(2)** of the **Criminal Procedure Code**, which states "No Court shall take cognizance of any offence alleged to have been committed by any member of the Armed Forces of the Union while acting or purporting to act in the discharge of his official duty, except with the previous sanction of the Central Government." Most State governments have adopted similar provisions under **Section 197(3)** of the **CrPC**.
- **Section 6** of the **Armed Forces Special Powers Act, 1958**, which is applicable in most insurgency-prone States, also provides that "no prosecution, suit or other legal proceedings shall be instituted, except with the previous sanction of the Central Government against any person in respect of anything done or purported to be done in exercise of powers conferred by this Act."
- In addition, under **Section 19** of the **Human Rights Protection Act, 1993**, National Human Rights Commission cannot intervene in the allegations of human violations by the armed forces.

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Box 6.4 outlines some actual case histories of victims of torture.

Box 6.4 Case Studies in Torture

Case 1: Mr P is a 55-year-old man from mid-eastern Nepal. He is married and lives with his wife and two children. Mr P was a political activist, and participated in armed activities against the government. One day, he was arrested along with some of his friends, charged with anti-government activities, and kept in police custody for several days.

He was handcuffed and kept in fetters while in custody. During this period, he was repeatedly whipped and beaten with sticks on the thighs, shoulders, and the soles of his feet. He was boxed on both ears, and chilly powder was forced into his nostrils. His fingers and toes were burnt with smouldering cigarettes. He became unconscious several times when electric shock was applied to his body. Threats on his life, and the lives of his family members were repeatedly made. He was humiliated and kept in total isolation. He was not allowed to go to the toilet and was held incommunicado throughout his period in custody. He was given contaminated water to drink and stale food mixed with stones and glass pieces to eat. Later he was transferred to a prison where he was kept in detention for 3 years. Mr P was referred to the Centre for Victims of Torture (CVICT), Nepal, by one of his friends. At the time of his examination, he complained of diminished vision, joint and muscle pain, low back pain, and burning and pricking sensations over the soles. He found it extremely difficult to lead a normal life. At the CVICT, his complaints were thoroughly investigated, and he was put on analgesic therapy, psychotherapy, and physiotherapy. Today his condition is much better, and he is now leading a normal life with his family.

Case 2: Mr B, a 32-year-old university student, was arrested in 1980 from his residence on the charge of being an active member of a political party. He spent 15 days in police custody and 3 months in jail. During this period, he was kept in a cold storage unit for one night. Unable to bear the cold, he became unconscious after two hours. He was then subjected to electric torture. He was kept naked throughout the process. After his release, Mr.B was arrested a second time, from the university campus. The police tied his neck with a rope and made him crawl to the police station. In custody, he was kicked all over the body with boots till his body was soaked with blood. He was later transferred to a prison where he was beaten every night. Police repeatedly threatened to kill him, and told him that if he changed his political ideology they would stop torturing him.

contd.

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Upon his release after several weeks, Mr B was unable to sleep at night and had nightmares of torture practically every night. He became mentally unstable and had to be taken to a psychiatric hospital many times. He frequently quarreled with his family members. He did not like to dress properly, and talked to himself most of the time. He used to get tired easily and had difficulty in thinking clearly and making decisions. He had problems with his concentration, and experienced feelings of hopelessness. He felt himself defeated in every aspect of life – political, social and family life. On examination by a psychiatrist at the psychiatric hospital, he was diagnosed as a case of schizophrenia. Treatment for schizophrenia was begun, but he showed no improvement.

Mr B was referred to the CVICT on April 12, 1991, where he was seen by the consultant psychiatrist who diagnosed his condition as one of *post-traumatic stress disorder*. He was given appropriate treatment, and was fully informed about the therapeutic principles of the centre. The CVICT carried out an integrated program of physiotherapy, social counseling, psychotherapy and pharmacotherapy. Today, Mr.B is able to adjust himself in society, and has regained his concentration and memory power. He is still under medication, but manages to lead a fairly normal life.

Case 3: Ms M, a 26-year-old girl, left her village for the city, where she was employed in one of the carpet factories. At 7.00 p.m. on December 1, 1993, while she was preparing her evening meal at home, two policemen knocked on her door and informed her that she had been called to the police station by the Sub-Inspector. Ms M refused to go with them as she had not committed any crime. On failing to convince Ms M, the police went back, but returned later in the night and forcibly took her to the police station, where the Sub-Inspector asked her why she had refused to come the first time. He then caught her by her hair and dragged her into a room. He slapped her several times and randomly beat her all over the body with stick and rifle butt. He abused her and raped her. Three other policemen also raped her. She then fell unconscious.

The next day, some friends of Ms M began enquiring about her whereabouts and surrounded the police station. Ms M was taken to a hospital in a police van. No visitors were allowed to see her or talk to her. From the hospital, she was again taken back to police custody. This time, she was verbally humiliated and charged falsely with prostitution. After three days, two policemen took her to another town. On the way, she spent several days in various police stations. On different occasions, she was stripped completely, and raped repeatedly. After 35 days, she finally reached home. The police threatened to kill her if she took any legal action.

Five months after the event, she was brought to the CVICT for treatment. She was referred to the centre by an organisation and a human rights lawyer. At the time of referral, she was suffering from physical and psychological problems. She complained of irregular, excessive menstrual bleeding, and generalised bodyache. She re-experienced her traumatic events in her mind constantly, and felt terrified at the sight of police and army personnel. She suffered from severe insomnia.

At the CVICT, she was assessed thoroughly by a joint team comprising a psychiatrist, a social worker, and a physiotherapist. She was also seen by a gynaecologist and treatment begun immediately. She was placed on regular counselling, and antidepressant treatment. Later on, desensitization was carried out by exposing her to the police and army personnel in a graded manner. At first she was very disturbed, but after continuous treatment over a period of several months, she gradually developed self-esteem, and finally went back home with her family members. She was diagnosed as a case of *post-traumatic stress disorder*. At present, she is with her parents and leading a functional life. She has been successfully running a small restaurant in her village with capital provided by the CVICT.

Adapted from ***Shrestha NM, Sharma B****. Torture and Torture Victims: A Manual for Medical Professionals.* ***1995****. Centre for Victims of Torture, Nepal.*

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Section II

Forensic Pathology

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CHAPTER 7

Thanatology – Postmortem Changes

The body dies, but the spirit that transcends it cannot be touched by death.
—**Ramana Maharshi** (1879-1950; Indian philosopher)

Death is not the greatest loss in life. The greatest loss is what dies inside us while we live.
—**Norman Cousins** (1915-1990; American author)

PART ONE: DEATH AND ITS MEDICO-LEGAL IMPORTANCE

Thanatology is a branch of science that deals with the study of death. The term 'thanatology' is derived from '*Thanatos*', the Greek God of Death (Fig 7.1), and the suffix '*-ology*' derives from the Greek suffix '*-logia*' meaning 'study of'. Death is an inevitable reality and in the past was considered to be a simple and straightforward phenomenon. The doctor would declare a person dead once he was convinced that there was cessation of life in the patient. This meant that the patient had stopped breathing, his heart had stopped beating, there was unresponsiveness, and his body had turned cold.

Though cessation of heartbeat was enough to consider a person as dead in the past, it is no longer an evidence of death today since the heart is now able to be substituted with that of a 'just deceased donor' or a mechanical one. Moreover, modern biomedical innovations like the resuscitator and cardiac pacemaker have made it imperative to establish a set criteria by which the moment of death could be identified. The basic concept is that death is the irreversible loss of the capacity for consciousness and capacity to breathe. Since both the functions reside in the brain-stem, the modern concept of diagnosing death is to identify whether a person's brainstem is alive or not.

| Fig. 7.1 Sculpture of Thanatos – Temple of Artemis at Ephesos, 325–300 BC |

Brainstem Death

The brainstem is the posterior part of the brain, adjoining and structurally continuous with the spinal cord. It provides the main motor and sensory innervation to the face and neck via the cranial nerves.

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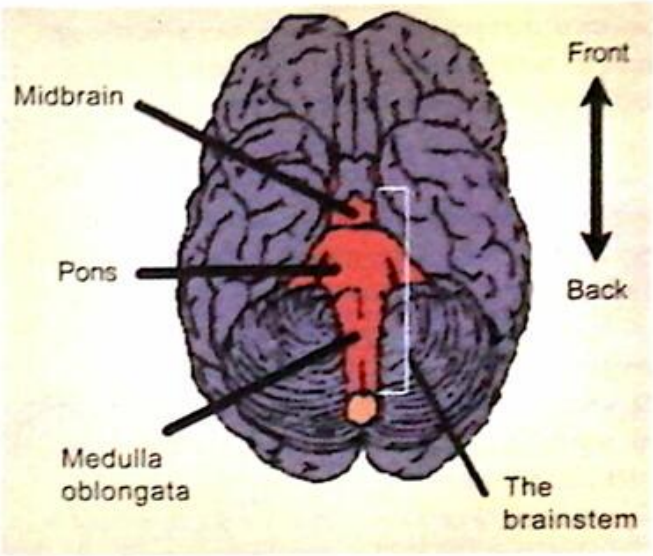
Though small, this is an extremely important part of the brain as the nerve connections of the motor and sensory systems from the main part of the brain to the rest of the body pass through the brain stem. This includes the corticospinal tract (motor), the posterior column-medial lemniscus pathway (fine touch, vibration sensation and proprioception) and the spinothalamic tract (pain, temperature, itch and crude touch). The brainstem also plays an important role in the regulation of cardiac and respiratory function. It also regulates the central nervous system, and is pivotal in maintaining consciousness and regulating the sleep cycle. The term "brainstem" includes the following: medulla oblongata, pons, and midbrain. If this small area is dead, the person becomes irreversibly unconscious and irreversibly apnoeic.



| Fig. 7.2 Location of brainstem |

Diagnosis of Brainstem Death

The diagnosis of brainstem death involves three steps:

1. The patient is comatose and unable to breathe spontaneously, and therefore unconscious and on a ventilator. The cause of coma must be 'irremediable structural brain damage.'
2. Exclusion of the cause of coma as due to drugs, hypothermia, or profound metabolic disturbance which may reversibly impair brainstem function.
3. Establishing that all the brainstem reflexes are absent and that the patient fails to breathe, even when taken off the respirator, after performing the ***apnoea test***.

Testing the Brainstem Reflexes

- **Pupillary response to light** (afferent 2nd and efferent 3rd cranial nerve) – making the pupil constrict.
- **Corneal reflex** (afferent 5th and efferent 7th cranial nerve) – blinking response to corneal stimulation.
- **Vestibulo-ocular reflex** (afferent 8th and efferent 3rd & 6th cranial nerves) – Doll's eye movement in response to irrigation of the tympanic membranes of the ears with ice-cold water.
- **Grimace** (afferent 5th and efferent 7th cranial nerve) – in response to painful stimulus over face, and
- **Gag or cough reflex** (afferent 9th and efferent 10th) – in response to intubation.

If all the above-mentioned reflexes are tested properly and are found to be absent, it means that one is examining the brainstem slice by slice, in a series of tests whose results reinforce one another in confirming the fact that the brainstem is dead.

Apnoea Test

- The **apnoea test** aims at proving that the patient is incapable of breathing. In doing this test one disconnects the patient from the ventilator, and allows the carbon dioxide to build up to a point where it would trigger off respiration if there were any cells still alive in the respiratory centre of the brainstem.
- The ventilator is disconnected for a period of ten minutes, but to prevent anoxia developing, one must pre-oxygenate the patient thoroughly before the test. This is done by administering 100% oxygen for 10 minutes, then making the subject breathe a mixture of 95% oxygen and 5% carbon dioxide which ensures that one starts with high oxygen and reasonably high carbon dioxide. At the end of the disconnection period, one should estimate the carbon dioxide in the arterial blood to ensure it has reached a level of 50 mm Hg (Fig. 7.3).

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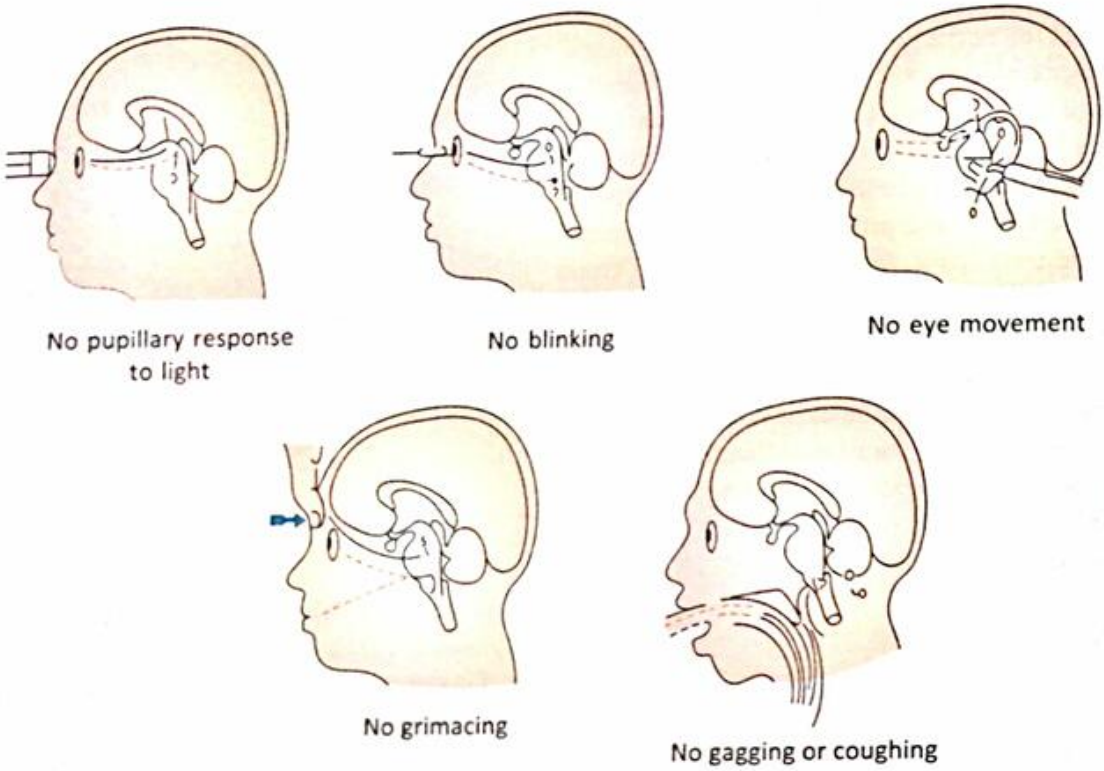

| Fig. 7.3 Brainstem Reflexes |

The time of death is the time at which ***brainstem death*** is established, and not some later time when the ventilator is switched off, or the heartbeat ceases. Clinicians should emphasize this when explaining the situation to the relatives and they should make it clear that ventilation is not being withdrawn to let the patient die, but because continued ventilation is immaterial for a patient who is already dead. The only justification for maintaining ventilation for a short time is to preserve the condition of the organs when it has been agreed that they are to be made available for transplantation.

British Code (Harvard Criteria) for Diagnosing Brainstem Death

1. *Preconditions*
   - Comatose patient on a ventilator
   - Positive diagnosis of cause of coma (irremediable structural damage)
2. *Exclusions*
   - Primary hypothermia
   - Drugs
   - Severe metabolic or endocrine disturbances
3. *Tests*
   - Absent brainstem reflexes
   - Apnoea

Board of Medical Experts to Certify Brainstem Death

- The registered medical practitioner treating the patient whose brainstem death has occurred.
- The registered medical practitioner in charge of the hospital in which brainstem death has occurred.
- Neurologist/Neurosurgeon nominated from the panel of names approved by an appropriate authority, and
- An independent medical specialist nominated from the panel of names approved by the appropriate authority.

Somatic and Molecular Death

- Although the heart may have stopped, the respiration has ceased, and the brainstem is function-

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less, tissues retain the 'vital principle of life' for some time. This is known as ***somatic death***. The body is dead as a whole, but the biological properties of the component parts may still be demonstrable. The muscles contract to mechanical or electric stimulus. The pupils respond to appropriate pharmacological stimuli.

- But the time during which these properties persist soon runs out. When these individual tissues and cells die it is termed ***molecular death***. The whole body is now dead.
- In this way, a person dies in bits and pieces. Therefore death is a process, not an event.
- The legal certification of death depends on the diagnosis of somatic death. Organ transplantation depends on the persistence of the properties of living matter in the component parts before we die in bits and pieces, i.e., before molecular death sets in.

Tissue and Organ Transplantation

An unfortunate feature of organ transplantation ever since its commencement has been the shortage of available organs. Supply has never satisfied demand, and this has led to the continuous development of procedures and systems to increase supply. Rational argument can be made to the effect that shortage has led to the rise of commercial traffic in human organs, particularly from living donors who are unrelated to recipients.

- On May 13, 1991, the World Health Assembly endorsed a series of guiding principles on organ transplantation. These guiding principles are intended to provide an orderly, ethical, and acceptable framework for regulating the acquisition and transplantation of human organs for therapeutic purposes.
- In India, the **Transplantation of Human Organs Act 1994** came into force in **1995** for the regulation of removal, storage, and transplantation of human organs for therapeutic purpose and for the prevention of commercial dealings in human organs.
- The term *human organ* is understood to include organs and tissues not related to human reproduction, and accordingly does not extend to reproductive tissue – namely, ova, sperm, ovaries, testicles or embryos – nor is it intended to deal with blood or blood constituents for transfusion purpose.
- **Sources of Organs**
  - *Homologous donation* – relocation of tissue from one part of the body to another in the same patient, e.g., skin grafting, bone grafting. This has no legal implications.
  - *Heterologous donation* – includes transfusion of blood and bone marrow, which because of their regenerative capacity, pose no threat to the donor. Live heterologous donation can also extend to paired organs such as kidney.
  - *Cadaveric donation* – This is obviously the only means of obtaining unpaired organs. This is the area where recognition and accurate diagnosis of brainstem death acquires great importance, because organs taken out from 'beating donors' have more chances of successful grafting.
- Organs from dead bodies can be removed if the donor had left a witnessed authorization. In the case of minors, one of the parents can authorize.
- For live, unrelated kidney donation, approval by the relevant state authorization committee (*Appropriate Authority*) is necessary. "Related" donation extends only to spouse, son, daughter, father, mother, brother or sister.
- The sale of organs from the dead or living is absolutely illegal.
  - Punishment for conducting, associating with, or helping in removal of human organs without authority will be imprisonment up to 5 years, and fine up to Rs 10,000.
  - Whosoever engages in commercial dealings in human organs will be punished with imprisonment for a term varying from 2 to 7 years, and fine ranging from Rs 10,000 to Rs 20,000.
  - When a registered medical practitioner is convicted under the Act, the Appropriate Authority will report the name to the State Medical Council for taking necessary action, which may include removal of his name from the Register

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for a period of 2 years for the first offence, and permanent erasure for subsequent offence.

- The government is now mooting the idea of amending the Transplantation of Human Organs Act. Among the changes being considered are mandatory declaration that patients are brain dead by all intensive care units (ICU) of hospitals to help address the shortage of organs for donation in the country.
- The High Court of Delhi in its order dated 6.9.2004 set up a Committee to examine the provisions of Transplantation of Human Organs Act, 1994 and the Transplantation of Human Organs Rules, 1995. The report was submitted on 25 May 2005. A National Consultation was held on 18 May 2007 and the report was submitted in the second fortnight of August, 2007. The recommended changes required amendments in the Transplantation of Human Organs Act, 1994 and the Rules framed there under. These changes are intended to facilitate genuine cases, increase transparency in transplantation procedures and to provide deterrent penalties for violation of the law.
- In so far as the Act is concerned, the following amendments have been proposed:
  - To empower Union Territories, specially Government of NCT of Delhi to have their own appropriate authority instead of DGHS and /or Additional DG (Hospitals).
  - To make the punishments under the Act harsh and cognizable for illegal transplantation activities to deter offenders from committing this crime.
  - To provide for registration of the centers for removal of organs from the cadavers and brain stem dead patients for harvesting of organs instead of registration of centers for transplantations only.

(Also see Brainstem Death and Organ Transplantation on page 46).

PART TWO: POSTMORTEM CHANGES AND TIME SINCE DEATH

- The paramount medicolegal issue in any postmortem examination relates to the determination of time since death (***postmortem interval***). This question arises most commonly in cases of unwitnessed or unreliably witnessed deaths.
  - Accordingly, the accurate determination of the postmortem interval applies not only to civil law, in which ascertaining the exact time of death is of practical necessity in settling family, social, and business matters, but also to
  - Criminal law, wherein the accurate determination of the time since death may either exonerate or inculpate a suspect accused of a particular homicide. Such determination is an indispensable component of ***corpus delicti*** (i.e., the body of evidence which proves the commission of a crime), and may serve as a basis for deciding whether to extend investigative effort in a particular line or direction. Therefore it is extremely important to accurately interpret the changes that occur after death.
- **Corpus delicti** is one of the most important concepts in a murder investigation. When a person disappears and cannot be located, the police will file a 'missing person' case. If, during the course of the investigation, it is believed that he/she has been murdered, then a 'body' of evidentiary items, including physical, demonstrative, and testimonial evidence, must be obtained to establish that the missing individual has indeed been murdered before a suspect can be charged with homicide. The best and easiest evidence establishment in these cases is the actual dead body of the deceased. However, in the event that a dead body is not present or has not yet been discovered, it is possible to prove a crime took place if sufficient circumstantial evidence is presented to prove the matter beyond a reasonable doubt. For e.g., the presence at a missing person's home of spilled human blood, identifiable as that person's, in large quantity, demonstrates - even in the absence of a corpse - the possibility that a crime has occurred.

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- For convenience, **postmortem changes** are being described under the following headings:
  - **Immediate changes,** which result in irreversible cessation of functions of the brain, heart and lungs. Muscles of the body become flaccid, and corneal reflexes are abolished.
  - **Early changes,** which take place between the first 12 to 24 hours. They comprise:
    - Changes in the skin
    - Changes in the eye
    - Algor mortis
    - Livor mortis
    - Rigor mortis
  - **Late changes** include:
    - Putrefaction and its modifications
      - Adipocere
      - Mummification.

Suspended Animation

- The immediate changes after death mentioned above may also be seen in cases of suspended animation, which is a state where the metabolic needs of the body are at such low ebb that the person appears apparently dead.
- His pulse is not palpable, heart sounds are not audible, respiratory movements are not visually perceptible, and reflexes are either absent or not possible to elicit.
- The person is not actually dead, and he can be revived in most cases by resuscitation.
- Recognizing this condition is important in order to prevent premature certification of death.
- Newborn babies and victims of electrocution, drowning, hypothermia and sedative poisoning may go into a state of suspended animation.
- Some 'sanyasis' (Hindu ascetics) are supposed to have the power to induce in themselves a state of 'suspended animation' voluntarily.
- Some practitioners of yoga are also said to have the capacity to induce in themselves a state resembling suspended animation (Samadhi).

Early Changes

Changes in the Skin

- Elasticity is lost soon after death. Skin that was translucent in life becomes pale.

Changes in the Eye

- The cornea loses its lustre with the passage of time. It becomes dull, hazy, and finally opaque and wrinkled (Fig. 7.4). Desiccation of the conjunctiva causes it to become discoloured, which is called "**tache noire**" *(pronounced 'tash nwar', which in French means 'black spot')* (Fig. 7.5).
- Intraocular tension falls so rapidly that by two hours after death, the tension is nearly zero and the eyeball appears sunken.
- If the retina could be viewed through an ophthalmoscope, the columns of blood in the vessels may be seen to be broken up into segments, which is referred to as 'trucking.'

| Fig. 7.4 Opacity of Cornea |

| Fig. 7.5 Tache noire
(Pic 7.4 & 7.5 : Dr Shashidhar C Mestri) |

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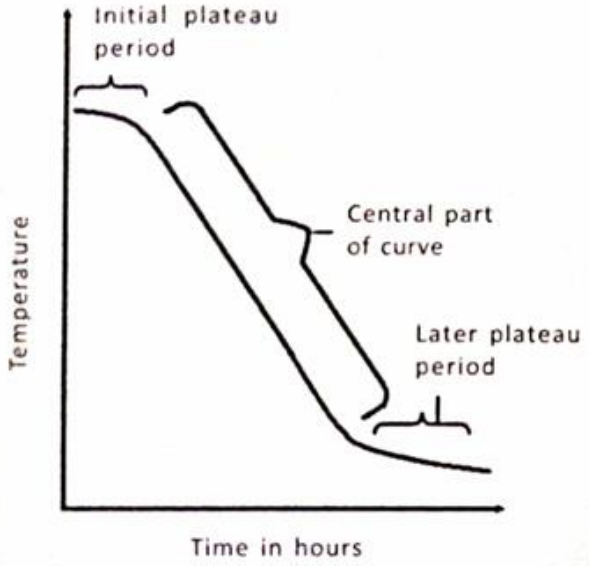
Algor Mortis (Postmortem Cooling; Chill of Death)

- There is a constant balance between heat production and heat loss during life. After death, heat production is lost and therefore the body starts cooling. The dead body loses its heat by conduction, convection and radiation.
- Measurement of the rate of cooling helps in estimating the time since death. When the rate of cooling is plotted on a graph the pattern of the curve assumes a sigmoid shape (Fig. 7.6).



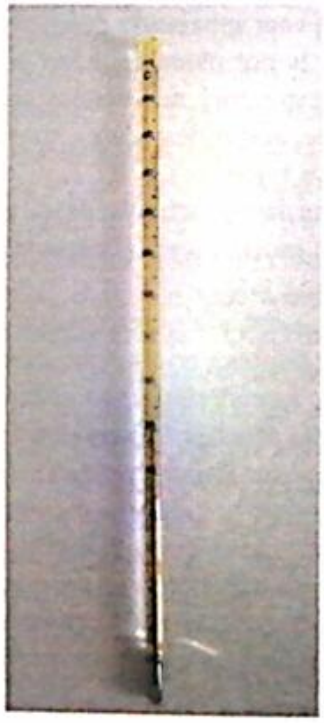
| Fig. 7.6 Typical Double Exponential Cooling Curve with three Distinct Phases *(Pic : Dr Rajesh V Bardale)* |

- The body surface starts losing heat rapidly, but the core body temperature does not alter until a gradient is established between the core body temperature and the surface. As there is no significant change in the core body temperature for sometime which may be up to 2 to 3 hours after death, an initial plateau is seen. When once the gradient is established between the core body temperature and the surface, the rate of cooling is approximately proportional to the difference in temperature between the body and the surface.

  This aspect is in accordance with the Newton's law of cooling. That means after the initial plateau the curve dips down progressively before it becomes nearly flat at the bottom. The curve may even rise before becoming flat due to heat produced by putrefactive changes.
- The preferred site for measuring the inner core body temperature is either the rectum or the abdominal cavity. A chemical thermometer (Fig 7.7) with graduations from 0 to 50° Celsius is introduced deep inside the rectum (to about 10 cm), or alternatively, the thermometer may be kept in contact with the undersurface of the liver through a slit made in the anterior abdominal wall in the right hypochondrium. At the same time, the environmental temperature is also measured. The time since death is then calculated (after taking two readings at an interval of one hour), by the following formula:

Normal body temperature:

$$\frac{\text{Rectal temperature}}{\text{Rate of fall of temperature/hour}} = \text{Time since death}$$



| Fig. 7.7 Chemical Thermometer *(Pic : Dr Rajesh V Bardale)* |

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However, there are a number of variables which need to be taken into account:

1. The body temperature at the time of death is presumed to be normal. This may not be the case. In fact in some cases, there is a slight rise in the temperature of the body after death. This is known as **postmortem caloricity**, and may be seen in
   a) bodies which at the time of death had suffered violent muscular contractions
   b) asphyxial deaths such as strangulation
   c) septicaemic deaths
   d) strychnine poisoning
   e) pontine haemorrhage, etc.
2. If the environmental temperature is extremely cold, the process of cooling of the body is hastened, while in very hot climates the body may not cool at all.
3. Obesity lessens the heat loss, as fat is a bad conductor of heat.
4. Ratio between the body surface and the body mass – children and old people cool more rapidly.
5. Presence of thick clothing at the time of death slows the rate of heat loss.

- In addition to the commonly employed sites for measuring the body temperature mentioned above, other sites have been proposed by various investigators, including the trachea, nasal cavity, middle ear cavity, etc.
- Electronic thermometer and thermocouple (Fig 7.8) have been employed in the place of chemical thermometer by some investigators.

| Fig. 7.8 Thermocouple (Pic : Dr Rajesh V Bardale) |

Livor Mortis (Postmortem Lividity; Postmortem Staining; Hypostasis)

- With the stoppage of functions of the heart after death, active circulation of blood in the body ceases. The blood which is fluid in nature, gradually settles down in the toneless capillaries of the dependent parts of the body, seen externally as patches of purplish discolouration through the skin (**postmortem lividity**).
- This settling of blood in the dependent parts is in accordance with the law of gravity.
  - Thus if the body is in supine position the postmortem lividity will be seen on the back (Fig 7.9).
  - In deaths due to hanging, lividity is seen on the hands, feet, and the lower parts of the face above the ligature (Fig. 7.10).

| Fig. 7.9 Postmortem Lividity on the Back with Contact Flattening (Pic : Dr Rajesh V Bardale) |

| Fig. 7.10 Postmortem Lividity of Lower Limb in a Case of Hanging (Pic : Dr Rajesh V Bardale) |

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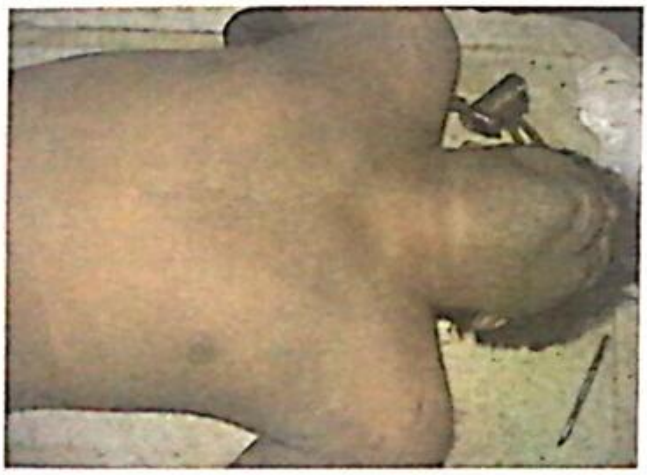
- In drowning where the body usually floats with the back facing up and the limbs hanging down, the lividity is seen over the limbs, abdomen and the face (Fig 7.11).

Distribution of the lividity thus is useful in indicating the position of the body after death.

- Those parts of the body which are in actual contact with the surface they lie on, do not show the colour as the toneless capillaries are pressed by the weight of the body. Such areas are known as areas of ***contact flattening***. Thus in the body which is lying supine, postmortem lividity is not seen over the shoulder blades, buttocks, calves, etc.



| Fig. 7.11 Postmortem Lividity over Face and Front of Trunk in a Case of Drowning *(Pic : Dr Rajesh V Bardale)* |

- If the deceased was wearing a tight collared shirt, a band of pale area may be seen around the neck where lividity does not develop, and this could be confused with a strangulation mark by an inexperienced person. Proper interpretation of such findings is important.
- Postmortem lividity begins as mottled patches ranging from 1 to 2 cm in diameter. These patches gradually increase in size with the passage of time and coalesce with each other till they become one uniform area of staining.
- Though the time of the appearance of these patches is variable, they are generally seen 2 to 3 hours after death. If the position of the body is altered, these patches gradually disappear, and appear in the new dependent part.
- If the body is left undisturbed for a certain length of time (usually 6 to 8 hours), lividity becomes well developed and ***fixed***, and does not alter in position even with subsequent alteration in the position of the body.
  - This was till recently thought to be due to clotting of blood in the blood vessels. In fact, the word 'fixation' itself is erroneous. If the position of the body is altered after 'fixation' and left in the new position for some longer time, the intensity of the lividity gradually fades, even though some colour, probably due to haemolysis staining the tissues, may sometimes remain in the primary position.
  - Blood is always found fluid in capillaries and venules, and this blood is responsible for postmortem lividity. Thus, clotting of blood is not responsible for the colour.
  - 'Fixation' is an apparent phenomenon. If pressure is applied over the area of lividity in the early stages, it blanches (Fig 7.12). Once fixation occurs, the area of lividity will not blanch.

| Fig. 7.12 Postmortem Lividity: Blanching on Pressure *(Pic : Dr Rajesh V Bardale)* |

- Colour of the lividity in certain cases helps in arriving at the cause of death. For example, it is:

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- cherry red in carbon monoxide poisoning
- bright (brick) red in cyanide poisoning

- Patches of lividity may sometimes be seen over non-dependent areas. The possible mechanism for this is the squeezing of column of blood in the deeper veins against gravity, towards the skin surface, by the muscles developing rigor mortis. Such patches could be mistaken for **contusions**.
  - This confusion is easily resolved by making an incision over the discoloured area.
  - If it is contusion, staining of the tissue is seen which can not be washed off.
  - If it is lividity, the blood oozes out from the freshly cut blood vessels, and the fresh stain can be easily washed off with water.
  - If still doubt persists, microscopic examination of the tissue from the suspected area clinches the diagnosis.
- As the process of formation of postmortem lividity is purely a physical phenomenon, it is seen in the dependent parts of the internal organs also (Fig 7.13).

  It is important to bear this in mind, lest the appearance of it in the organs may be mistaken for some significant condition of medicolegal bearing.
- Significance of lividity in postmortem clocking is not very reliable. However, scientists have tried instruments utilizing light, to measure PM lividity and its application to establish the time since death, with some significant correlation between them. Evaluation of PM lividity using colourimeter-measuring system has also been tried with some success in postmortem clocking.

| **Fig. 7.13** Postmortem Lividity: Intestines *(Pic : Dr EJ Rodrigues)* |

Note

- PM lividity disperses with the onset of putrefaction.
- PM lividity may not develop at all if the body is tossed and turned continuously as seen in fast flowing waters of rivers or the sea.
- PM lividity cannot be appreciated well in dark coloured subjects.
- PM lividity may not be appreciable even in fair skinned bodies if they have bled profusely or were severely anaemic.

Rigor Mortis

- During life, muscles are supple, and in a slightly contracted state. After passing through a phase of ***primary flaccidity*** soon after death during which they are totally relaxed, the muscles over a period of time, gradually stiffen (Fig 7.14). This stiffening is known as rigor mortis (Box 7.1 is a light hearted look at the consequences of ignorance about this phenomenon).
- Rigor mortis affects all the muscles in the body, both skeletal and smooth.
- Rigor mortis is a physico-chemical phenomenon. Recalling one's memory of the elementary structure of the muscle is necessary to understand the mechanism of its formation.
  - A muscle mass is made up of a number of bundles of long fibres.
  - Each muscle fibre in the bundle consists of densely packed myofibrils, which are the contractile elements.
  - These myofibrils are made up of two protein filaments, actin and myosin.
  - Separation of actin and myosin is responsible for extensibility and softness of the muscles.
  - Coming together of these actin and myosin filaments, which results in contraction is dependent on the energy provided by adenosine triphosphate (ATP). Constant supply of ATP is maintained in life.

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Box 7.1 The Diagnosis

The casualty was crowded when the patient was brought in,
The students gathered round him, their faces all a grin.
The patient was unconscious and they rushed all round the place
To examine and percuss him – to diagnose his case.
Each gave his own opinion of the patient's present state
I'll quote you just a few and leave the patient to his fate.
One shouted to his partner – "Oh, come and listen Charles.
He's got whispering pectoriloquy and lots of crackling rales.
His stomach is dilated, his clavicles are straight.
His PMI is beating at a rate of twenty eight.
He's got a haemic murmur at the apex and the base.
I think I see a palsy on the right side of his face.
His pupils are unequal which suggests a case of tabes,
But he's foaming at the mouth which makes me think of rabies."
Another spoke of syphilis, on principle no doubt,
And said a dash of iodide would drive the symptoms out.
Some spoke of laparotomy and tumour of the brain,
While others bet on typhoid fever, haemorrhage and strain.
The seniors condescended to express their views thus-wise,
"The man's got meningitis, you can see it in his eyes."
But one thing puzzled all of them, it was pitiful to see,
His arms and legs and body were as rigid as could be.
They eliminated poisoning and tetanus by degrees,
And spastic paraplegia by the straightness of his knees.
At last in desperation, with sad and downcast face,
They asked the Senior Physician to diagnose the case.
At first he too was puzzled by the rigid form in bed,
But soon his face lit up with smiles and loftily he said,
"This case is very difficult in very many ways,
The man's got rigor mortis, he's been dead about three days!"

*(*Adapted from The Leech 1931; 3(2): 35. Edited from the original.)*

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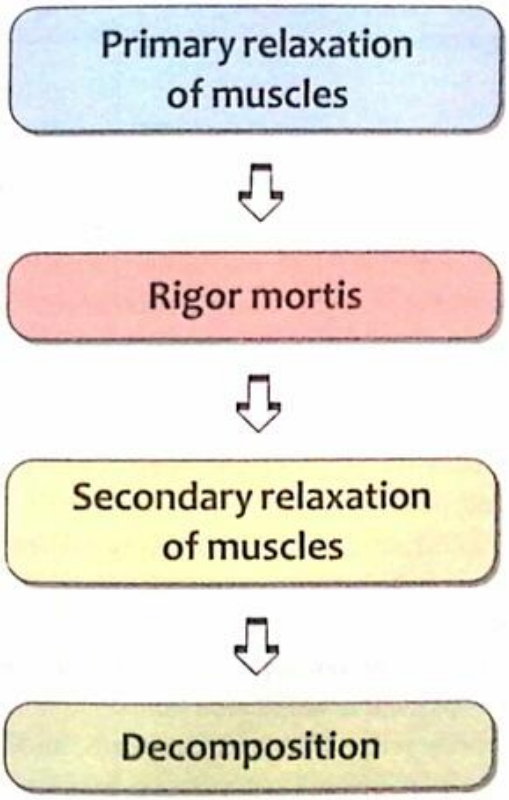
- Failure of resynthesis of ATP after death results in the muscles becoming hard and rigid. However, some amount of ATP is still available after death till the glycogen reserve lasts. When once this glycogen reserve is depleted, there is no more ATP available, and the contractile elements are converted into dehydrated, stiff, gel-like mass resulting in the muscles themselves becoming hard and rigid (*rigor mortis*).



| Fig. 7.14 Flow Chart Showing Muscle Changes after Death *(Fig : Dr Rajesh V Bardale)* |

- Rigor mortis becomes noticeable first in the eye lids, then the muscles of the face, jaw and neck (Fig 7.15). Then it is seen to affect the upper limbs, thorax, abdomen and the lower limbs. Though rigor mortis is basically due to chemical changes, the physical aspect is responsible for this apparent proximo-distal progression, *viz.*, smaller muscles having less glycogen reserves than the larger muscles are first to be affected.

| Fig. 7.15 Rigor Mortis of Face, Neck and Trunk *(Pic : Dr Rajesh V Bardale)* |

7

- It is generally considered that by the first 12 hours after death, rigor affects the whole body. It is retained for another 12 hours, and passes off in the next 12 hours with the onset of putrefaction. This ***rule of 12***, also known as the ***march of rigor***, is only a generalization of the time since death. In some locations in India (e.g., Kerala), it has been shown that rigor mortis may actually follow the ***rule of 6***, i.e., it sets in, remains, and disappears from the body in 6 hours respectively.
- Rigor passes off in the same order in which it made its proximo-distal progression.
- With the passing away of the rigor, the muscles once again become softened. This is the phase of ***secondary flaccidity***.

Cadaveric Spasm

- Another condition, rarely seen but commonly talked about, is **cadaveric spasm** or **instantaneous rigor**, where instead of primary flaccidity after death, the muscles usually belonging to small groups go into a sudden state of stiffening (Fig 7.17).
- This condition, though of unknown cause, when seen, is usually associated with violent deaths coupled with emotional disturbance at the time of death, as in
  - drowning (where grass or weeds may be clutched in the hands)

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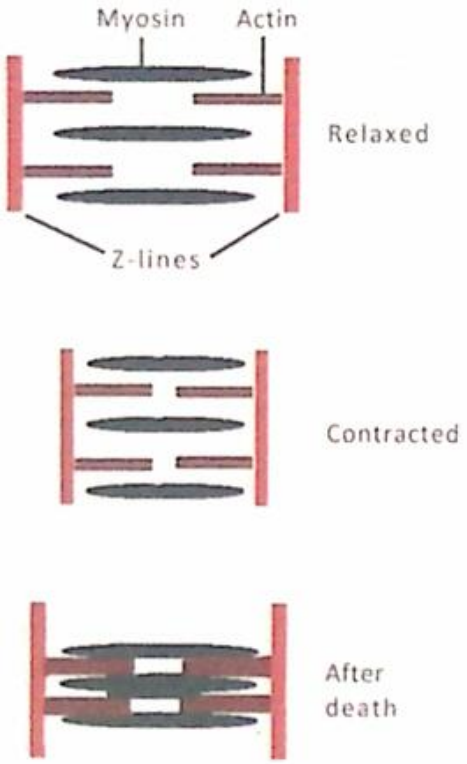
- suicide by shooting (where the weapon may be tightly grasped in the hand), etc.



| Fig. 7.16 Diagrammatic Representation of Muscle Contraction and Relaxation *(Fig : Dr Rajesh V Bardale)* |

| Fig. 7.17 Cadaveric Spasm of Hands in a Case of Drowning *(Pic : Dr Geetha O)* |

Other conditions that result in the body becoming stiff after death include:

- Thermal deaths (***pugilistic attitude***, *page 274*): The stiffening of the body in deaths due to burns (***heat stiffening***) is due to coagulation of muscle proteins, while in exposure to severe cold (***cold stiffening***), the body becomes stiff due to freezing of the subcutaneous fat and the water content in the body, forming icicles.
- Putrefaction: Gases evolved during the putrefactive process also stiffen the body (***gas stiffening***), but poses no problem in distinguishing it from rigor mortis.

Note

- Application of force results in breaking of rigor, which does not set in again when once broken.
- As rigor is a chemical phenomenon, any condition that depletes ATP fast, will hasten its early development. For example, violent muscular contractions at the time of death due to epilepsy, strychnine poisoning, tetanus, electrocution, etc.
- In robust, healthy young individuals, it appears late because of good glycogen reserve in the muscle mass.
- As rigor mortis is not functionally related to the nervous system, it can develop in paralyzed limbs also.
- As rigor is also not dependent on blood supply, it develops even in amputated limbs.
- If a body is frozen soon after death, and such a body is brought back to normal environmental temperature, rigor mortis which had been arrested till then, will appear subsequently. Estimation of time since death from such thawed bodies becomes erroneous.
- Apart from postmortem clocking, rigor mortis helps in identifying any alteration in the position of the body, if the position in which the body has undergone rigor is incompatible with the position in which it was discovered at the scene.

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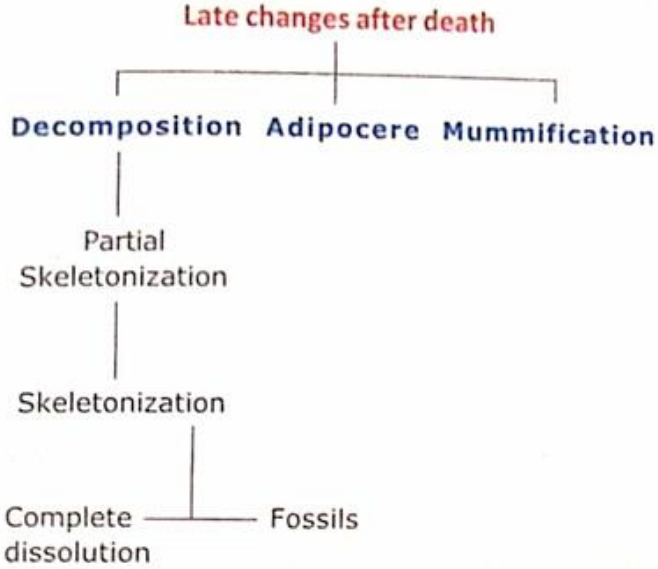
Late Changes (Fig. 7.18)



| Fig. 7.18 Flow Chart Showing Late Changes after Death *(Fig : Dr Rajesh V Bardale)* |

Putrefaction

- Onset of putrefaction initiates the breakdown of complex organic constituents of the body into simpler inorganic substances. Such breakdown of complex structure is facilitated by ***autolysis*** and ***bacterial action***, while the destruction of the body tissues by various fauna expedites the process of disintegration.
  - ***Autolysis***: The digestive action of various enzymes released by the cells after death leads to softening and liquefaction of tissues. Soft tissues like the brain, lungs, pancreas, gall bladder, and stomach are affected earliest. Architectural patterns of the organs are lost. Maceration of the dead foetus inside the uterus is a classical example of autolytic putrefaction. This means the process of autolysis is independent of any bacterial action. It is an aseptic chemical process.
  - ***Bacterial action***: Any condition conducive for rapid bacterial growth results in early onset of putrefaction. Bacteria disseminate and multiply fast after death, as stagnant blood offers an excellent medium for their growth. Apart from the normally inhabiting bacteria of the body, bacteria from outside also may enter the body through open wounds. These bacteria generally comprise *Streptococcus* sps, *Staphylococcus* sps, *Escherichia coli*, *Proteus* sps, and *Clostridium welchii*.
- While autolysis produces limited gross change, bacterial action is the major component of putrefaction.

Changes Occurring Due to Putrefaction

- **Greenish discolouration in the right iliac fossa is the earliest external manifestation** of the onset of putrefaction, which occurs around **12 to 24 hours** after death (Fig. 7.19). This is the area where the caecum lies, the contents of which are more fluid and rich in bacteria. Hydrogen sulphide produced by the bacteria acts on the haemoglobin (that has now become extracellular due to haemolysis), to produce sulphaemoglobin. This imparts the greenish hue.
- With the passage of time this greenish discolouration, which is very obvious in fair skinned bodies, subsequently spreads to the abdomen, and also makes its appearance in the chest, face, and the limbs. Coalescence of these coloured areas results in the entire body becoming greenish or greenish-black.

| Fig. 7.19 Greenish Discolouration of Right Iliac Fossa *(Pic : Dr Rajesh V Bardale)* |

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- Later, in about **36 to 48 hours**, a network of veins becomes visible in the form of a characteristic mosaic-like pattern (**marbling**), over various parts of the body like the root of the neck, shoulder, etc (Fig. 7.20). This results from staining of the vessel walls due to diffusion of haemoglobin.
- By the time the colour changes become visible externally, evolution of gases would have started internally. These gases possess very unpleasant smell. They include hydrogen sulphide, ammonia, carbon dioxide, carbon monoxide, methane, etc. These gases by themselves are not of any medicolegal significance, but the pressure effects they produce when they accumulate in sufficient quantity are so much as to bring about gross changes in the appearance of the body. Evolution of gases results in (a) **ballooning effects** and (b) **dispersion of postmortem lividity**.

| Fig. 7.20 Marbling over Thigh
(Pic : Dr Rajesh V Bardale) |

- ***Ballooning effects***: Gases easily collect in the hollow viscera resulting in their voluminous expansion.
  - The stomach and the intestines which balloon out, increase the intra-abdominal pressure resulting in distension of abdomen, and pushing of the diaphragm upwards.
  - Lungs are squeezed by this pressure, and froth oozes from the mouth and nostrils.
  - The gases not only accumulate in the hollow viscera, but also penetrate into every tissue and organ. Soft tissues of the body like the breast, scrotum, periorbital tissues, etc., increase in their size enormously.
  - Eyeballs protrude out of the sockets, the cheeks puff out, and so also the lips.
  - The tongue protrudes through the mouth, and on exposure to air becomes dark in colour.
  - The facial features alter so much that even the resemblance to a normal human face is lost (Fig. 7.21). At this stage, identification by external features becomes extremely difficult even to the closest relatives.

| Fig. 7.21 Advanced Putrefaction
(Pic : Dr Rajesh V Bardale) |

  - Percolation of putrefactive gases into the undersurface of the skin results in the epidermal layer ballooning out, which resembles blisters caused by scalding (Fig. 7.22). In contrast to protein-rich fluid present in the blisters caused by scalding, putrefactive blisters contain only air.
  - The epidermal layer from the hands and feet slip off like glove and stocking. It is important to retain and preserve this part of the skin as it can yield a full set of fingerprints that may help in establishing identity.

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| Fig. 7.22 Postmortem Blisters *(Pic : Dr Prateek Rastogi)* |

- Increased pressure inside the abdomen may result in the expulsion of foetus in the case of a pregnant deceased (*postmortem delivery*).
- Uterus and rectum may protrude out due to pressure.
- Though the evolution of gases may commence as early as 18 hours after death, a full-blown picture to develop may take 48 to 72 hours.
- ***Dispersion of postmortem lividity***: Evolution of gases moves the blood in the blood vessels. If the blood is clotted, it now liquefies, and haemolysis takes place. Movement of this blood results in dispersion of postmortem lividity in any direction. Therefore, assessment of the position of the body at the time of death based on lividity at this stage, becomes difficult.

- **Colliquative putrefaction**: In 3 to 5 days after death, the nails and the hair become loose and can be pulled off with ease. The teeth become loose and can be pulled out from their sockets. The abdomen and the thorax may burst open. The sutures on the skull get loosened (Fig 7.23), the liquefied brain matter oozing out through these deficiencies. With further progression of putrefaction, from 5 to 10 days, *colliquative putrefaction* ensues, resulting in the tissues & organs being converted into a soft, thick, black, pultaceous mass, totally losing their architecture. However, even at this stage, organs such as the prostate and non-gravid uterus can be identified, as they resist putrefaction, thus helping in the identification of the sex.

| Fig. 7.23 Postmortem Separation of Skull Sutures *(Pic : Dr Rajesh V Bardale)* |

- This liquefied unrecognizable pultaceous mass gradually falls off from the bony attachments leaving the skeleton exposed. If a dead body is lying in the open, it may take 1–3 months for complete skeletonisation. If the body is buried, skeletonisation may take place in two to six months. If the body is encased in a coffin, more time is required for skeletonisation.
- **Odour mortis**: The intermittent nature of chemical evolution from decomposing human remains from soil associated with older human remains (10-60+ years) from different environments around the globe was analyzed in one study using gas chromatography-mass spectrometry (GC-MS). After comparison to relevant soil controls, approximately 50 volatile chemical compounds were identified as being associated with human remains. The study reports these findings and identifies when and where they are most likely to be detected showing an overall decrease in cyclic and halogenated compounds and an increase in aldehydes and alkanes as time progresses. This research identifies the "odour signatures" unique to the decomposition

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of human remains with potential ramifications on cadaver dog training procedures, and in the development of field-portable analytical instruments which can be used to locate human remains in shallow burial sites.

- Sometimes the environmental conditions may arrest the progression of putrefaction and may deviate it to either **adipocere** formation or **mummification**.
  - ***Adipocere (Saponification; Grave Wax)***: This arrests the further progression of putrefaction.
    - Adipocerous change is due to hydrogenation and hydrolysis of body fat.
    - The prerequisites for adipocerous change of the body fats include:
      - abundant body fat,
      - humid climate,
      - still air,
      - warm temperature, and
      - bacteria producing fat-splitting enzymes, like *Clostridium welchii*.
    - Thus a body lying on damp soil, in a shady place, with optimum environmental temperature, and no free air current blowing over it, undergoes adipocerous change.
    - Adipocere has the appearance of rancid butter, and gives off a sweetish but disagreeable smell.
    - Transformation of the body fat into adipocere is usually seen over areas such as cheeks, breasts, buttocks, or limbs, though rarely the whole body is affected (Fig 7.24).
    - It takes generally about 3 weeks for adipocere to develop fully.
    - As the progression of putrefaction is arrested, the facial features are recognizable, which helps in identification of the deceased by friends or relatives.
    - Similarly, as the wounds are also preserved without much alteration, the weapons used (and to a certain extent the cause of death), can be identified.
    - The approximate time since death can also be estimated.

| Fig. 7.24 Adipocere Involving Almost the Entire Body *(Pic : Dr Rajesh V Bardale)* |

  - ***Mummification***:
    - In hot and dry climate, where there are warm air currents freely flowing over the body, putrefactive process becomes arrested and the body becomes mummified due to dehydration and desiccation of the tissues and the organs.
    - The skin is dark and tightly adherent to the skeletal frame (Fig 7.25).
    - Mummification usually requires 3 to 6 months.

| Fig. 7.25 Mummified Hand *(Pic : Dr Shashidhar C Mestri)* |

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- A mummified body does not emanate any foul smell.
- Mummification helps in identification, as the general facial features are preserved.
- It also helps in recognizing the presence of wounds.
- Estimation of the approximate time of death and place of death is possible.

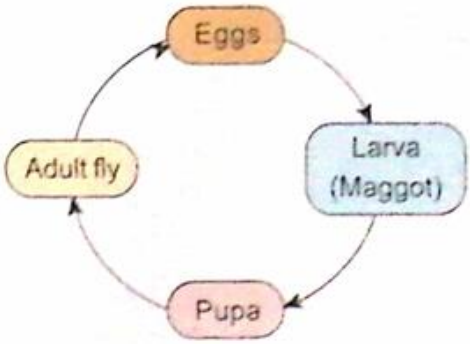
Note

- Rate of putrefaction varies depending on whether the body is in an open place, buried, or in water. It is generally presumed that if the rate of putrefaction is considered as 1 unit of time on open ground, it is 2 units in water, and 8 units in deeply buried bodies. This is known as ***Casper's dictum***.
- Putrefaction occurs rapidly at temperatures between 20°C and 40°C. Therefore, bodies exposed to the sun, especially in summer, decompose faster. Putrefaction will be arrested below 0°C. A dead body can be kept in a cold chamber, or covered with ice and salt to slow down decomposition. If the body has to be preserved for weeks, it has to be embalmed.
- Evolution of gases in solid organs like liver leads to an alteration in the architecture visible to the naked eye. In such cases, the liver on cut section has a honeycomb appearance (***foamy liver***) (Fig 7.26).

| **Fig. 7.26** Foamy Liver
(Pic : Dr Shashidhar C Mestri) |

Entomology of the Cadaver (Box 7.2)

- Foul-smelling gases that emanate due to putrefaction attract various insects.
- The study of the life cycle of these insects, which infest dead bodies, is known as **Forensic Entomology** (Fig 7.27).



| **Fig. 7.27** Life Cycle of a Fly
(Fig : Dr Rajesh V Bardale) |

- There are eight successive waves of invasion from the beginning of putrefaction right up to skeletonization.
- Initially, two-winged flies predominate, but later there will be involvement of several other kinds of insects including beetles.
  - Two-winged flies such as blue bottles, flesh flies, house flies, etc., lay their eggs in about 18 to 36 hours (sometimes as early as 6 to 10 hours).
  - Mostly these eggs are laid in the mucocutaneous junctions such as lips, nostrils, anus, vagina, or even in open wounds (Fig. 7.28).

| **Fig. 7.28** Fly Eggs Among Moustache Hairs
(Pic : Dr Zachariah Thomas) |

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- The eggs hatch into larvae (*maggots*) within 12–24 hours (Fig. 7.29). These larvae are very voracious eaters and they grow in size up to 4 to 5 days, during which time they devour the tissues and hasten the process of disintegration of the body.

| Fig. 7.29 Maggots Crawling on the Skin (Pic : Dr Rajesh V Bardale) |

- The maggots then enclose themselves inside shell-like structures (*pupae*), which in another 4 to 5 days break open to release young flies (*nymphs*).

- The role of the doctor while doing autopsies on such maggot-infested bodies is only to pick up these maggots, preserve them properly, and send them to a qualified entomologist for species identification. Maggots immersed in boiling absolute alcohol die instantly in extended position, which facilitates measurement of their length.
- Calculation of time since death is done as follows:
  Time since death = **A + B x (cd)**
  Where: **A** is the stage of invasion (in hours, days, weeks, or months), **B** is the stage of life cycle (in hours, or days), and **cd** represents climatic factor correction.
- Study of insect's life cycle is the job of an entomologist. The doctor should not guess the postmortem interval from his very limited knowledge of entomology.
- Usefulness of chemical analysis of maggots for poisons, which are not destroyed by the putrefying process, should be kept in mind. This type of study has come to be called **Forensic Entomo-toxicology**.

Box 7.2 outlines some Indian cases where-in entomological study was successfully accomplished to arrive at the time of death. Box 7.3 outlines details of a **'body farm'**, a revolutionary research facility established for the first time in 1981 by anthropologist Dr. William M. Bass in the state of Tennessee, USA, where human decomposition could be studied experimentally in a variety of settings.

Estimation of Time Since Death

The time since death or *postmortem interval* is the period that has elapsed between death and the actual performance of the postmortem examination. The significance of such estimation of the time has been mentioned at the beginning of the chapter. Though the exact time of death can rarely be estimated on the basis of autopsy findings, an approximate range can usually be deduced by intelligent interpretation of the various changes that take place after death. Estimation of the time since death within a narrow range is possible only in the early period. Once putrefaction sets in, this range becomes wider (Fig. 7.30). However, entomological study can help in narrowing the range considerably.

Evidence for estimating the time since death generally falls under the following three categories:

- Corporal evidence – that which is present in the dead body.
- Environmental and associated evidence – that which is present in the vicinity and general surroundings of the deceased.
- Anamnastic evidence – that which is based on the deceased's ordinary habits, movements and day-to-day activity.

Assessing the time of death by environmental evidence and anamnastic evidence is mostly the responsibility of the investigating officer, in India. The doc-

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Box 7.2 Forensic Entomology: Some Indian Case Studies

Case No. 1: Two elderly widows (both sisters) aged 80 years and 70 years, were found dead in their residence on Kingsway Road, Secunderabad (Telangana), on the morning of 8 March 1984, by their brother who immediately notified the police. Both women had been living alone for several years. Since stab injuries were noticed on the bodies, a case of double murder was registered. Both bodies were in an advanced stage of decomposition, and numerous maggots were crawling over them. The bodies were subjected to autopsy during the course of which some maggots were collected, killed instantly in boiling alcohol, and sent for entomological study. The larvae were subsequently identified as belonging to flesh flies (*Sarcophaga* species). Based on their development, and taking into account prevailing climatic factors, the time since death was computed to be 6 to 8 days. This information helped to convict the arrested suspect who had committed the murders in the course of robbery.

Case No. 2: An unidentified male aged about 70 years, was found dead inside a stationary railway carriage in the workshop yard at Secunderabad Railway Station, on 4 August, 1985, at about 10.30 a.m. by the Railway Protection Force. A case of unnatural death was registered initially by the Railway Police, and the body was subjected to autopsy which however disclosed natural causes (heart disease). In order to fix the time of death, a few maggots which were found crawling around the natural orifices were collected and submitted for entomological study. This revealed the insect species to be blue bottle flies (*Calliphora* species). Based on the stage of development and prevailing climatic factors, the time since death was computed to be 24 hours to 60 hours.

Case No. 3: A male aged about 35 years was found dead among some shrubbery, in the campus of the Central University of Hyderabad, at Ramachandrapuram, on the evening of 25 July 1985. The police was notified who registered a case of murder, since there were stab wounds on the body. During autopsy, maggots crawling around the injuries and natural orifices were collected and submitted for entomological study. The flies were identified as belonging to *Sarcophaga* species, and the time since death was calculated on the basis of the stage of development and environmental factors, to be 4 to 6 days. This helped to convict the suspect who had murdered for revenge, since the deceased had been having an illicit affair with the former's wife.

Case No. 4: The deceased, a middle-aged male who was suffering from tuberculosis, proceeded to Gandhi Hospital, Secunderabad, from his residence on the morning of 28 August 1985, since he had developed abdominal pain. He was accompanied by his daughter. At about 12 noon, both of them reached the hospital, where-upon the young girl was despatched by her father to fetch some articles from the nearby market, while he himself went towards the outpatient department. However on returning from the market, the girl could not locate her father, and went home alone. Later that night at about 8.00 p.m, a Municipal Corporation worker noticed the body of the deceased lying on an isolated stretch of footpath, at the rear of the hospital, and notified the police. A case was registered, and the body was subjected to autopsy the next day. While the cause of death could not be determined with certainty, it was presumed to be related to a worsening of his underlying

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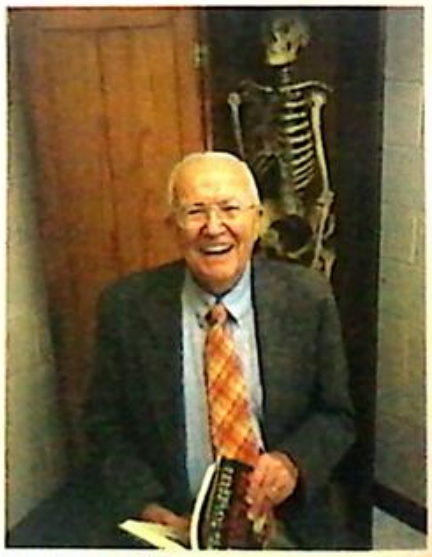
condition (tuberculosis). Since some fly eggs were seen around natural orifices and in the scalp hair, entomological study was carried out to fix the time of death. The eggs were identified as those belonging to *Calliphora* species (*Calliphora erythrocephala*). This fly generally does not lay eggs during the night. The size of the eggs coupled with the fact that larvae had not emerged, indicated that the eggs could have been laid 6 to 8 hours prior to the autopsy (held at about 2.00 p.m). Hence the eggs may have been laid between 6.00 a.m. and 8.00 a.m. on the morning of the autopsy.

In this particular case, all that could be deduced by the application of entomological knowledge was that the eggs could not have been laid the previous day as larvae would have been observed at the time of the autopsy. Hence death may have occurred sometime between 6.00 p.m and 8.00 p.m the previous night.

(Case No.1 is taken from the case files of Dr VK Kashyap, former Director (Plan), Directorate of Forensic Science, New Delhi. The remaining cases were part of doctoral (MD) research carried out by Dr V V Pillay.)

Box 7.3 The Body Farm

A Body Farm is a research facility where human decomposition can be studied in a variety of settings in order to gain a better understanding of the decomposition process, permitting the development of techniques for obtaining information such as the time and circumstances of death from human remains. Body farm research is an important aspect of forensic anthropology, and has applications in the fields of law enforcement and forensic science. Five such facilities exist in the United States. The original "Body Farm" is the University of Tennessee Anthropological Research Facility located in Knoxville, Tennessee. It was first started in late 1981 by anthropologist Dr. William M. Bass (Fig 1) as a facility for the study of the decomposition of human remains. It consists of a 2.5-acre (10,000 m2) wooded plot, surrounded by a razor wire fence. At any one time there will be a number of bodies placed in different settings throughout the facility and left to decompose (Fig 2). The bodies are exposed in a number of ways in order to provide insights into decomposition under varying conditions. Detailed observations and records of the decomposition process are kept, including the sequence and speed of decomposition and the effects of insect activity.



Dr William Bass

Over 100 bodies are donated to the facility every year. Some individuals pre-register before their death, and others are donated by their families or by a medical examiner. The University of Tennessee Body Farm is also used in the training of law enforcement officers in scene-of-crime skills and techniques.

The second human decomposition facility to open in the United States is located at Western Carolina University in North Carolina and is known as the Forensic Osteology Research Station or

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more commonly as the FOREST. It was opened in 2006 and is run by WCU's Forensic Anthropology program on a small plot on the rural mountain campus. The facility studies decomposition in the western North Carolina mountain habitat and has been used for cadaver dog training.

A View of the Body Farm – Tennessee

The third facility was commissioned by the Texas State University-San Marcos Department of Anthropology and is part of the Forensic Anthropology Center at Texas State (FACTS). The Forensic Anthropology Center at Texas State accepts body donations for scientific research purposes under the Uniform Anatomical Gift Act.

The 4th facility, Southeast Texas Applied Forensic Science Facility (STAFS) is a state-of-the-art research and training facility designed to advance academic and technical knowledge in the application of forensic science disciplines to crime scenes and criminal activities, and is located within the Center for Biological Field Studies at Sam Houston State University, adjacent to the Sam Houston National Forest. Contained within the outdoor facility are a variety of various environmental conditions, including a fluvial environment. Web cams are located within the outdoor facility to monitor timing of various post-mortem activities from on and off-campus computers. The building is designed as a morgue with cooler and freezer units, modern morgue equipment and tools and digital radiograph and microscope capabilities.

The 5th facility, Complex for Forensic Anthropology Research (CFAR) opened at Southern Illinois University in October 2010 working with pigs as human proxies. The co-founders, Gretchen R. Dabbs and DC Martin, built the facility to examine the rate and pattern of decomposition in the unique environment of southern Illinois. In comparison to the other facilities open at the time, CFAR has the lowest average temperature, highest average wind speed, second lowest elevation, the most acidic soil, and the worst soil drainage. Since climate and environment are major factors affecting the rate and pattern of decomposition, these differences between southern Illinois and the other established facilities were expected (and have proven) to heavily influence the rate and pattern of decomposition. Additionally, researchers at CFAR attempt to mimic clandestine body disposal situations and understand how the process of decomposition is altered by those postmortem treatments and how the postmortem treatment can be identified after skeletonization. The first human

Roma Khan doing Preliminary Work on Decomposition of Cattle

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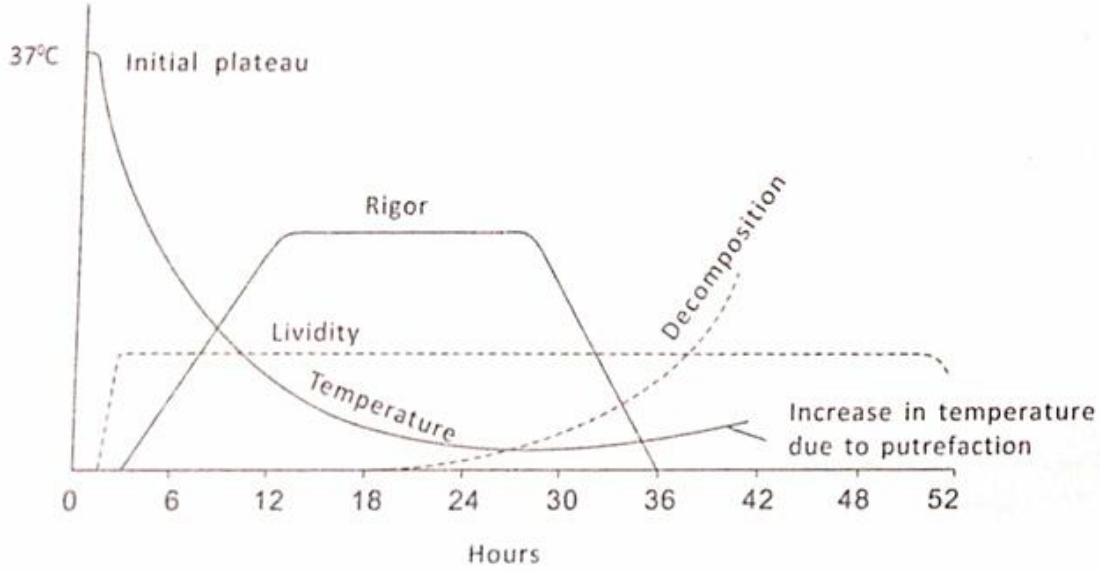
donation was accepted at CFAR in January 2012.

There have been proposals to open body farms in other locations in the U.S. and elsewhere. Work has begun on a new body farm near Yarramundi in the outskirts of Sydney, Australia in 2015 on a patch of land owned by the University of Technology, Sydney. The facility is the first body farm outside the United States. It is being established as research has demonstrated that differing environmental conditions mean that the findings of body farm analysis in the United States are frequently not relevant to Australia.

Roma Khan (Fig 3) of India was reported in 2010 to be taking initial steps toward establishing a body farm in India along the lines of those in the U.S. Further details are not available.



| Fig. 7.30 Graph Showing the 'Time Since Death' Based on Postmortem Cooling, Lividity, Rigor Mortis, and Putrefaction |

tor is generally not involved. The doctor's assessment of time since death is almost exclusively dependent on the evidence that can be deduced by the findings on careful postmortem examination. Naturally he relies upon the changes that take place after death such as postmortem cooling, postmortem lividity, rigor mortis, and putrefactive changes, bearing in mind all those factors that alter the outcome of these individual changes. Box 7.4 summarises the changes useful in computing the time since death.

Additional Methods

- *Gastric emptying time*: If the time of the last meal is known, presence or absence of food and the state of digestion in the stomach helps to a certain extent in estimating the time since death. But the rate of emptying of the stomach depends on many variables including the type of food eaten, the emotional state of the person, any surgical procedure done on the stomach such as gastrojejunostomy, etc. Therefore this method must be used only as corroborative evidence.
- *Bladder content*: It is usual to empty the bladder before going to bed. On the morning of the death, if the body is found to be warm and supple and the bladder is full, it means that the person has died in the early hours of the morning, and hence the time since death is very short, probably within the last 1 or 2 hours. On the other hand, if the body has developed a certain amount of rigor and is cold

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Box 7.4 Postmortem Changes and Postmortem Interval

Condition of the body	Time since death
Warm supple body, transparent cornea, no patches of postmortem lividity	*within one hr*
Patches of lividity on the dependent parts, rigor mortis appreciable in the muscles of the face.	*2 to 3 hr*
P.M. lividity well developed and 'fixed', rigor mortis at least in the upper part of the body, body surface cold	*6 to 8 hr*
Rigor mortis all over the body, with or without greenish discolouration over the right iliac fossa, body cold	*around 12 hr*
Body cold and stiff, greenish discolouration over the right iliac fossa, eggs of flies	*12 to 24 hr*
Body is cold, rigor has receded, greenish discolouration over the abdomen and chest, distension of the abdomen with evolution of gases	*24 to 36 hr*
Marbling, distended abdomen and thorax, presence of maggots, postmortem blisters	*36 to 48 hr*
Whole body bloated, face unrecognisable, nails and hairs easily pulled off, grown maggots or pupae all over the body	*3 to 5 days*
Colliquative putrefaction where the internal organs are reduced to black unrecognisable pultaceous mass	*1 wk*
Most of the soft tissues gone, organs that putrefy late like prostate and non-gravid uterus recognizable	*2 wk*
Skeleton exposed bare	*1 to 3 months*

to touch, and the bladder is full, it means that the person must have died the previous night, probably before going to bed. This is fairly good corroborative evidence.

- ***Biochemical changes***: Though a lot of research work has been undertaken to estimate the time since death based on biochemical changes such as changes in the potassium content of the vitreous humour, pericardial fluid enzymes, level of lactic acid and non-protein nitrogen of CSF, and a plethora of other chemical parameters, they are mostly only of academic interest. As the antemortem values of these chemicals vary substantially, they are of limited practical value.
- ***Circumstantial evidence***:
  - If the body is found in an open place, the state of grass underneath the body helps in the estimation of time since death. As the grass becomes deprived of sunlight for photosynthesis they gradually turn yellow, due to conversion

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of chlorophyll to xanthophyll. The usual time required for such a change in colour is 3 to 5 days.

- Uncollected mail or newspapers, recent purchases of household materials with dated bills, condition of the food in the kitchen, etc., are other factors which can be taken into consideration in assessing the time since death.

Numerous other methods have been propounded to estimate the postmortem interval, which are however beyond the scope of this book.

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CHAPTER 8

Medicolegal Autopsy

A surgical operation is attended with pain, and is for the benefit of the individual,
An autopsy is free from pain, and is for the benefit of humanity.

—**Paul Brouardel** (1837-1906; French pathologist)

INTRODUCTION

- Though **necropsy** is the most accurate term for the investigative dissection of a dead body, the term **autopsy** is used more commonly. **Postmortem examination** is an alternative expression, but it unfortunately suffers from a lack of precision about the extent of examination, for in some countries many bodies are disposed of after external examination without dissection.
- The first autopsy is said to have been performed in the year **1559**, when King Henry II suffered a fatal injury and died; eleven days later **Dr Ambroise Pare**, a celebrated French surgeon, dissected the body and discovered a subdural haematoma.

Box 8.1 is a shortened version of a song written as part of a musical comedy that was performed by medical students of George Washington University, and became a cult hit. It is actually a spoof on cadavers used for dissection during the anatomy course, though it can very well be applied in a forensic situation also!

TYPES OF AUTOPSY

1. **Medicolegal Autopsy**
   a. Performed only on the instructions of a legal authority responsible for the investigation of sudden, suspicious, obscure, unnatural or criminal deaths.
   b. In India, such legal authority may be represented by a police officer or a magistrate. The information so obtained is invaluable in the administration of justice, in convicting criminals, and in protecting innocent suspects.
   c. Consent of the next of kin (closest relative) is not necessary for conducting the autopsy, but an official requisition from police or magistrate is essential.
   d. The main objectives include identity fixation (if the identity is unknown or uncertain), cause of death, manner of death, time of death, etc.
2. **Clinical or Pathological Autopsy**
   a. Performed in death due to natural causes, in order to ascertain the exact cause, if the diagnosis made by the treating physician is to be confirmed or refuted, or if diagnosis could not be arrived at all while the patient had been alive.
   b. The consent of the next of kin is essential, while there is no need for a requisition from the police or the magistrate.
3. **Psychological Autopsy**
   a. This is not really an autopsy at all, but instead refers to the perusal of medical and personal history, and other background information of a deceased person who had committed suicide, in order to arrive at the motive for the act.
4. **Endoscopic Autopsy**
   a. It has been suggested that if a conventional autopsy is difficult or impossible to undertake for any reason, a postmortem endoscopic examination can be performed with the help of a trocar and telescopic device coupled to a video camera. This is referred to as **endoscopic**

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Box 8.1 Cadaver's Song

This song which was performed by medical students of George Washington University begins with the students sitting around in the dissection hall, cracking jokes. After they leave the stage, the lights dim, and four "cadavers" get up and start singing.

When you're a stiff,
You're a stiff all the way
From your first night in here
To your last smelly day.

When you're a stiff,
If your guts hit the pan
You got students around
You're a cadaverous man.

Then you are cut
With a capital K
Which you'll never forget
Till they cart you away.
When you're a stiff,
You stay a stiff!

When you're a stiff,
You're the low cat in town,
You're the gangrenous kid
With a formalin crown.

The stiffs are in gear,
Our abdomens are drippin'.
The knives will stay clear,
Cause every first year student's
A lousy chicken.

Here come the stiffs
Like a bat out of hell
Someone cuts our insides,
Someone don't feel so well.

Here come the stiffs,
Freshmen class step aside.
Better go underground,
Better run, better hide.

We're drawin' the line,
So keep your noses hidden.
We're hangin' a sign,
Says "Visitors Forbidden"
And we ain't kiddin'!

Here come the stiffs-Yeah!
And we're gonna rule
Every last freshman kid
In the whole crummy school.
In the whole crummy
Scalpel lovin' school!

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autopsy. But there are serious limitations to this technique, and hence is not generally recommended.

5. **Virtual Autopsy (Virtopsy)**
   a. Of late, some forensic pathologists in Western countries are beginning to consider modern cross-sectional imaging techniques to supplement and even partially replace traditional autopsy. Computed tomography (CT) is the imaging modality of choice for two- and three-dimensional documentation and analysis of autopsy findings including fracture systems, pathologic gas collections (e.g., air embolism, subcutaneous emphysema after trauma, hyperbaric trauma, decomposition effects), and gross tissue injury.
   b. Various postprocessing techniques can provide strong forensic evidence for use in legal proceedings. Magnetic resonance (MR) imaging has had a greater impact in demonstrating soft-tissue injury, organ trauma, and nontraumatic conditions. However, the differences in morphologic features and signal intensity characteristics seen at antemortem versus postmortem MR imaging have not yet been studied systematically.
   c. The documentation and analysis of postmortem findings with CT and MR imaging and postprocessing techniques is claimed to be investigator-independent, objective, and noninvasive and will lead to qualitative improvements in forensic pathologic investigation.
   d. Future applications of this approach include the assessment of morbidity and mortality in the general population and, perhaps, routine screening of bodies prior to burial.

OBJECTIVES OF A MEDICOLEGAL AUTOPSY

1. To identify the cause and manner of death.
2. To identify the deceased, if unknown.
3. To determine the time of death and injury.
4. To collect evidence from the body that can be used to prove or disprove an individual's guilt or innocence, and to confirm or deny the account of how the death occurred.
5. To document the injuries or lack of them.
6. To deduce how the injuries occurred.
7. To document any natural disease present.
8. To determine or exclude any contributory or causative factors to the death.
9. To provide expert testimony if the case goes to trial.
10. In a charge of infanticide, to decide whether the infant was born alive.

In view of the tremendous importance of medicolegal autopsies as listed above, it has been jokingly suggested that a new speciality of "Postmortem Medicine" be created (Box 8.2).

RULES OF A MEDICOLEGAL AUTOPSY

1. Every registered medical practitioner who is called upon to undertake a medicolegal autopsy is legally obliged to do so at the earliest possible time.
2. No fees must be charged for conducting a medicolegal autopsy.
3. **Permission or authorization**: In India, a police officer or a magistrate can give authorization for a medicolegal autopsy. Without such permission, a medicolegal autopsy must not be performed. There is no need to take permission or consent from the relatives of the deceased.
4. Whenever a body is sent for autopsy, it must always be accompanied by a *dead body challan* and an *inquest report*.
   a. A **dead body challan** is the formal requisition submitted to the medical officer by the investigating police officer for performing a medicolegal autopsy.
      i) It contains the name, address, age, sex, religion, etc., of the deceased.
      ii) It also contains information about the time, and location from where the body was recovered, distance from the site to the mortuary, and name and address of the police official and the relatives accompanying the corpse.

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Box 8.2 Postmortem Medicine – An Essential New Subspeciality!!

—**Berril Yushomerski Yankelowitz**

With increasing technical knowledge, medical care has necessarily become more and more subspecialised. Both the local community and the government have tried to approach the problem of delivering this care to as broad a segment of the population as possible. Especially notable are the heavily funded programmes in geriatrics research, as all segments of society have come to recognise the increasing proportion of old people in the population. The time has now come for us to focus on the medically most under-served population in the world today - the deceased. The urgency of this is quite apparent. There are more people who have already died than are alive today, and their number is increasing at an alarming rate. Physicians have not adequately focused on the problems of the dead. Aside from anatomy, it is not a subject taught in most medical schools; as a result, early sensitivity of the medical student to the needs of the dead is never formally developed. Postmortem medicine is not a mere extension or subspecialty of geriatric medicine, but a major specific and unique problem in health care delivery. We have therefore undertaken a pilot project to determine how the medical profession might better serve the dead patient.

This pilot project on postmortem medicine is a broad-based multidisciplinary undergraduate and postgraduate study programme designed to investigate all aspects of diagnosis and care for the dead patient. Early in their training, our medical students are given a one-semester course in psychosocial problems of the deceased human. In addition to didactic sessions, students are taken on field trips to graveyards and cemeteries, because we feel that classroom sessions alone depersonalise the dead patient in the student's mind. The members of our psychiatric faculty have responded enthusiastically and like this subject because they get to do most of the talking during patient interviews. Psychoanalysts are especially happy because of the long, meaningful silences they get when treating a dead patient.

In the second year of medical school we provide courses in pharmacology and physiology in the dead patient. We have found that the pharmacokinetics of drugs in formalinised patients are quite different from those in the living.

At the postgraduate level, we have a pilot postmortem ward (separate from the mortuary), which is staffed by two trained personnel, who are supervised by a senior attending physician, who is himself dead, and therefore has an in-depth understanding of the specialty. House surgeons who have just been on a ward with live patients have responded enthusiastically to the leisurely pace of the postmortem ward.

Research projects are going on, and we are fortunate to have received extensive grant support for such studies as postmortem wound healing, the impact of embalming on social acceptability of the dead, management of the person who died before penicillin was available, and so on.

A series of new subspecialties is already appearing - postmortem endocrinology, postmortem cardiology, and postmortem neurosurgery to name a few.

We have made substantial inroads in a neglected area, and it is our hope that other universities will benefit from billions that our government now wants to spend on this exciting new subspecialty.

Modified from British Medical Journal, 1979; 2: 1639-1640.

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iii) The medical officer has to fill in the column indicating the time of receipt of the case at the mortuary, and the time of commencement of the postmortem examination.

b. An **inquest report** or **panchanama** is the preliminary investigation report of the investigating police officer. It contains
   i. The available history of the case
   ii. The details of the belongings of the dead body, and
   iii. A provisional opinion of the police officer, as well as two respectable inhabitants of the locality (*panchas*).

5. **Place**: Ideally an autopsy should be performed in a well-equipped mortuary. But depending upon the circumstances, it can well be performed at the site itself without undue delay, as in the case of exhumation and mass disasters. But this should be done only on requisition by a magistrate.
6. **Treatment or hospital records**: These should accompany the inquest report and the dead body challan. If they are not supplied, the medical officer can ask the investigating officer to procure them. By studying the treatment history, a doctor can avoid unnecessary investigations, e.g., a fruitless search for a broken piece of weapon which has already been removed surgically, can be avoided. Availability of these records will also serve as a check against future manipulations or tampering of treatment records, especially in deaths due to alleged negligence.
7. Before beginning the autopsy, the body must be identified by the police officer concerned. In case of unidentified bodies, photographs and fingerprints should be taken by the police.
8. The medical officer should always ascertain the circumstances surrounding the case before beginning the autopsy. Inquest reports and hospital records must be scrutinized thoroughly.
9. The medical officer should try to limit the number of those present in the autopsy hall to the barest minimum. Not only is there a greater risk of loss of confidentiality, but sheer numbers can make the mortuary overcrowded. This will hamper movement, cause distraction, and add to the risk of infection and contamination. No one should be present merely as a casual observer, not even senior police officers (unless they are directly involved in the investigation).
10. When the deceased has been under medical care before death, it is acceptable practice to allow and encourage the physician concerned to be present at the autopsy, as he is in possession of relevant (and sometimes vital) medical history.
11. All persons present at an autopsy should be listed and named by the medical officer in a separate register, or in the autopsy report.
12. Autopsies are best done in daylight, otherwise colour changes relating to bruises, jaundice, etc., are likely to be missed.
13. Detailed notes must always be made at the time of autopsy. It is better to dictate the notes to an assistant while the autopsy is in progress. Subsequently, the medical officer must verify the notes and sign it. All corrections should be initialed. Nothing should be erased. If no assistant is available, the doctor should prepare the report immediately after completion of the autopsy. A tape recorder may be used. Sketches should be made of all major injuries and lesions.
14. **Verification of injuries noted in the inquest report**: All injuries mentioned in the inquest report must be verified as being present or absent while doing an autopsy. A mismatch is not infrequent, mainly due to wrong interpretation of lesions by the police. For example, a postmortem abrasion in the neck may have been interpreted by the investigating officer as an antemortem injury due to assault. Conversely, a delayed bruise or "come-out bruise" may not be recorded at all by the police. So if a doctor fails to find the injuries recorded in the inquest report, he should mention that the injuries are either absent, or were misinterpreted, or merely comprise postmortem artifacts.
15. **Number of doctors required**: In most cases, a single registered medical practitioner empowered by the state government is all that is required to perform a medicolegal autopsy. But, if requested by the magistrate, as in dowry death cases and custodial deaths, a team of two doctors may be required to perform an autopsy.

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16. **Video recording**: As per the recommendations of the National Human Rights Commission, all autopsies in the case of death occurring in police custody or prison have to be videotaped. So if arrangements have not been made by the police, the doctor must insist on it in order to avoid possible controversy in future.
17. **Visit to the scene of crime**: If a visit to the scene of crime is possible, it should be undertaken without delay, especially in cases such as murder, poisoning, traffic accidents, sex crimes, and firearm injuries. Examination of the scene can provide certain important clues to the nature and circumstances of the crime, and can help in the reconstruction of the sequence of events.
18. The body should never be embalmed before autopsy as it will alter the toxicological evidence completely.
19. Every medicolegal autopsy must be thorough, meticulous, and complete. A partial autopsy should never be done. Useful information can be obtained through careful observation, even in grossly decomposed bodies.
20. The information obtained during an autopsy is not privileged. The question of professional secrecy does not arise when an autopsy is done under legal obligation. Hence a doctor conducting an autopsy has to divulge all the relevant information to the investigating authorities.
21. The postmortem report should ideally be submitted within 24 hours of completion of autopsy.

REQUIREMENTS OF A MEDICOLEGAL AUTOPSY

Minimum requirements of a mortuary for performing medicolegal autopsies include the following:

1. *Autopsy table* – stainless steel or masonry type, with adequate running water and drainage facility.
2. *Instruments*:
   a. Scalpels
   b. Cartilage knives
   c. Dissecting knives
   d. Amputation knife
   e. Enterotome
   f. Large and small dissecting scissors
   g. Forceps (toothed and serrated)
   h. Large clamps
   i. Bone saw
   j. Chisel
   k. Hammer
3. *Other materials*
   a. Aprons
   b. Surgical and heavy duty gloves
   c. Sponges
   d. Swabs
   e. Microscope slides
   f. Syringes and needles
4. *Glassware*
   a. Wide-mouthed glass bottles (1 litre and 50 mL capacity), with screw caps
5. *Chemicals*
   a. Rectified spirit
   b. Common salt (powder)
   c. Formalin
   d. Sodium fluoride
6. *Almirahs* with locking facility

PROCEDURE OF A MEDICOLEGAL AUTOPSY

External Examination

External examination is a vital part of autopsy. Often, it provides more information than internal examination, but it is always desirable to observe both external and internal appearances closely, and attempt to correlate all the findings to get a cohesive picture. External examination of the body is traditionally done in **three steps**: identification of the body, estimation of the time of death, and determination of the cause of death.

1. *Identification*

a. A general and brief description of the body with regard to sex, age, weight, height, complexion, general condition of the body, nutritional status, gross deformities, and description of hair regarding colour, nature, length and distribution are essential in every medicolegal autopsy, irrespective of whether the identity is known or not.

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b. If the body is that of an unknown person, in addition to the above descriptions, details must be given of the clothing, identification features such as moles and old scars, and the police must be requested to record fingerprints, and take photographs of the body.

2. *Estimation of Time of Death*

a. The various methods that help in deducing the time of death have been described in detail in the chapter on thanatology. If the exact time of death is known, or hospital records are available, a general description of the body in relation to the condition of the eyes, postmortem lividity, and rigor mortis (or features of decomposition), is sufficient.

b. As per the recommendations of the National Human Rights Commission in relation to custodial deaths, rectal temperature must also be recorded (by means of a chemical thermometer).

c. If the body was preserved in cold storage or refrigerated, estimation of time since death is obviously going to be difficult. So this fact must be recorded in the postmortem report, along with a brief description of the body.

d. Entomological evidence is important in decomposing bodies, and the medical officer must be familiar with the procedures relating to collection of specimens, preservation, and despatch.

3. *Determination of Cause of Death*

a. **Examination of wrappings**: The body may be brought to the mortuary enclosed in plastic or cloth wrapping. It should be examined carefully for trace evidence which may have been dislodged from the body.

b. **Hospital dressings**: These should be described in detail, with particular mention of their nature and position. Any application of ointment, medication, etc., should be noted, as also the position of catheters and drainage tubes.

c. **Clothing**:

(1) These should be examined in situ for evidence of any tear, loss of buttons, or general disarray.

(2) Cuts and tears if present, have to be corelated with the external injuries on the body.

(3) In the case of firearm injuries, burns or blackening of the clothing must be described and correlated with the external body injuries. The area of blackening must be measured, which could give an idea about the range of fire.

(4) Stains in clothing due to blood, semen, saliva, vomit, poison, vitriolage, faeces, mud, grass, etc., must all be recorded meticulously. If it is decided to take photographs, two photographs are essential: one of long range to indicate the exact location of the stain, and another of close range to record the details of the stain itself.

(5) In death due to poisoning or burns, an attempt must be made to detect characteristic odours.

(6) Clothing should be carefully removed by unbuttoning or unzipping. Special care must be taken to ensure that the clothing retains its evidentiary value, right up to the time of the trial. In all cases, it must be air dried, preserved, sealed and handed over to the investigating police officer.

d. **Examination of the body**

(1) The entire body surface from head to toe must be examined thoroughly before washing the body.

(2) Traces of blood, semen, saliva, or any foreign material if present, should be collected by swabbing or scraping as required.

(3) Any characteristic odour emanating from the body must be noted. In the case of immolation by fire, smelling the scalp hair may help in finding out whether an accelerant such as petrol or kerosene was used.

(4) After completing the survey of the body surface, the cadaver is washed thoroughly using running water, so that the wounds obscured by stains will be rendered more prominent.

(5) Any deformity in the normal body structure has to be described in detail. Fractures must be ruled out by handling suspected regions manually. Confirmation can be done by incising the area.

(6) Signs of disease such as oedema, ascites, icterus, anaemia, eczema, etc., must be looked for. Special note must be made of cyanosis, congestion, or pallor, if present.

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(7) The status of natural orifices (mouth, nose, ear, urethra, vagina, anus) is to be carefully observed, and any abnormality or discharge if present, must be recorded. The mouth in particular must be examined closely for evidence of salivary dribble, discolouration due to poisoning, peculiar odour, foreign bodies, etc. In a suspected drug-related death, the nasal orifices must be examined for evidence of "snorting," i.e., intake of drug by insufflation.

(8) **Documentation of injuries**

i. Great care must be taken to examine and record injuries. Sometimes, a tiny puncture in the skin may be the only sign of the cause of death, e.g., snakebite. Such inconspicuous injuries may be even more difficult to appreciate in dark skinned people. Similarly, injuries of the scalp may be difficult to appreciate as the scalp hair frequently obscures them. Suspect regions must be shaved cautiously, and the injuries noted both by inspection and palpation. A hand lens is sometimes needed to differentiate an incised wound from a split laceration.

ii. In a case of hanging or strangulation, the ligature used must be described properly before removing it and documenting the ligature mark.

iii. In the case of stab and firearm injuries, the exact location of the wound as measured from the heel must be recorded.

iv. All external injuries must be described as to their nature, dimensions, exact location, and direction, whenever possible. While taking measurements, a flexible measuring tape is to be preferred for accurate recording of dimensions in regions with undulating surface. Injuries must be described as far as possible in centimeters or millimeters, and not in inches or feet, although the police appear to be more familiar with the inch/foot system than the metric system.

v. Description of old scars and lesions is also important. An old scar on the inner aspect of the wrist may indicate a previous attempt at suicide. Similarly, scars over the back of the hand or in the bend of the elbow may indicate intravenous drug abuse.

vi. Written descriptions of external wounds should ideally be supplemented by suitable sketches and photographs.

Internal Examination

- The three major body cavities must always be examined in detail.
- However, the spinal column need not be opened if there is no specific indication.
- In case of suspected poisoning, certain viscera and body fluids must be preserved for chemical analysis (*page 526*).
- In general, it is better to begin by examining that part or cavity suspected to be affected most.
- However, before dissecting the neck, it is ideal to drain away the blood by opening the cranium and other body cavities, in order to avoid artefacts.

Incisions (Fig. 8.1 & 8.2)

- **For the trunk**

i) *I-shaped incision:* The usual incision is a straight line from the chin to the pubis (symphysis menti to symphysis pubis), with a deviation at the umbilicus in order to avoid cutting through it. The skin over the neck and trunk can thus be reflected laterally on either side.

ii) *Y-shaped incision:* Begins at a point close to the acromial process and extends down below the breast, and then medially across to the xiphoid process. A similar incision is made on the opposite side of the body. From the xiphoid process, the joint incision is carried downwards in a straight line to the pubis.

iii) *Modified Y-shaped incision:* This incision begins behind each ear from the mastoid, and extends down to the mid-point of the clavicle, and then progresses medially to the sternal notch from where it continues downwards to the symphysis pubis. Such an incision is preferred in strangulation, hanging, and any other condition where the larynx has been traumatised, as the skin of the neck can be

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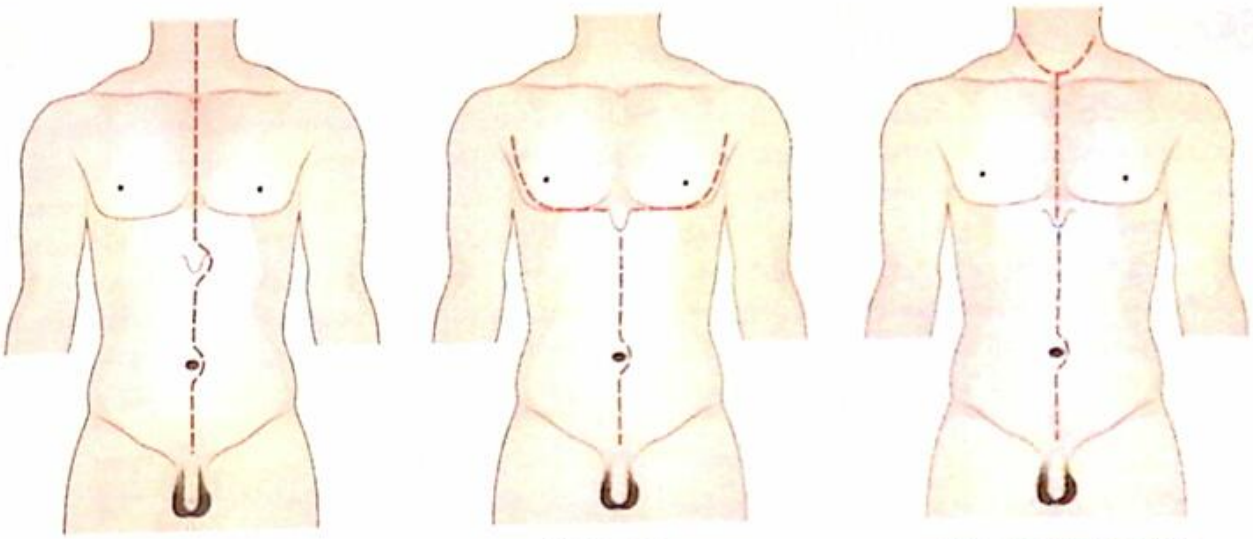
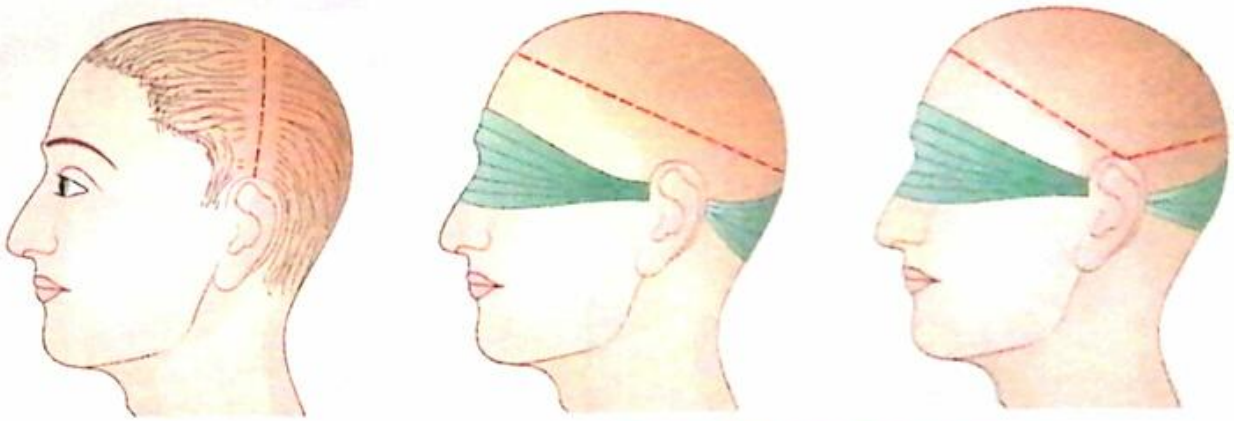


a) I incision b) Y incision c) Modified Y incision

| Fig. 8.1 Trunk incisions |



| Fig. 8.2 Scalp and Skull Incisions *(Fig 8.1 & 8.2 : Dr Rohan Monis)* |

dissected upwards up to the mandible, and raised clear to provide an excellent view of the neck structures. However, this incision should not be made until the skull cap and brain have been removed, to avoid artificial haemorrhages in neck structures which can be confused with true antemortem trauma.

iv) A fourth type of incision has been suggested (*cosmetic autopsy incision*), mainly to avoid disfigurement of the body by the anterior-type incision employed in the three conventional incisions, which can be distressing to the relatives and friends when the body is displayed for viewing after the autopsy (Box 8.3).

- **For the scalp**

  Coronal incision – The incision for access to the skull begins from behind each ear, and extends upwards on either side to meet over the crown of the head.

Opening the Body Cavities

- The skin, subcutaneous tissue, and fat are flayed laterally from the main incision, taking care not to extend beyond the lateral edge of the neck, or the outer third of the clavicles.
- Over the thorax, the tissues (including the pectoral muscles), are flayed to the mid-axillary line in the upper part, and in the lower part, even further posteriorly towards the costal margins.

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Box 8.3 Cosmetic Autopsy Incision

In this incision technique, the body is first placed prone, and the scalp is incised in the usual manner (coronally, mastoid to mastoid), following which the skin is cut down to the posterior aspect of acromion, through the posterior border of the sternocleidomastoid, and then trapezius bilaterally. A curved incision is then made bilaterally from the tip of the acromion up to the mid-axillary line, just below the axilla, and then extended down to the iliac crest through the mid-axillary line bilaterally. The posterior flap of the scalp is reflected back up to the occiput, and the anterior flap up to the frontal ridge. The posterior flap is then reflected back all down the trunk up to the superior border of the sacrum. The whole of the back of the neck, chest and abdomen is thus laid bare.

(a) Lateral view of the incision on the back

(b) Reflection of the posterior flap up to the lumbo-sacral region

(c) Anterior view of the incision

(d) Reflection of the anterior flap

(e) Suturing the anterior and posterior flaps

(f) Close-up of the neck and chest after suturing

| Fig. 8.3 Cosmetic Autopsy Incision |

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The body is now turned over (supine), and a curved incision is made from the acromion to the mid-axillary line bilaterally, as in the case of the posterior incision. Another incision is now made from the mid-axillary line on the iliac crest bilaterally, over the inguinal ligament, to meet at the symphysis pubis. The skin and superficial tissues are reflected superiorly up to the root of the neck, and thence to the lower margin of the mandible. This way the whole of the front of the body is exposed.

To open the abdominal cavity, a para-medial incision is made on the rectus near the symphysis pubis which is extended upward up to the xiphoid process, using scissors or an enterotome.

The thorax is opened by removing the sternum after cutting through the costo-chondral junctions, and separating the sternoclavicular joints. The whole of the chest and abdomen are now open for inspection.

At the end of the autopsy, the sternum is first replaced, and then the abdomen is closed by sewing up the rectus. The flap of the skin is then folded back, and the incision over the inguinal ligament is stitched first, followed by the bilateral mid-axillary incisions up to the axilla. The stitching is continued up the front to the mastoid on either side. The scalp is then sewed up, and the body is turned over to sew the curved incision on the back.

In this way, incisions are not visible on the entire front or back of the neck and trunk at the conclusion of the autopsy, except near the shoulders. Also, unlike in conventional autopsies, the skin over the back of the trunk is also reflected, which enables proper visualization and analysis of bruises, postmortem lividity, etc.

*(Concept, Description, Pictures: **Dr AJ Patowary**, Dept of Forensic Medicine, Assam Medical College, Dibrugarh, Assam)*

- The anterior abdominal wall is similarly separated, stripping back the skin and fat to expose the muscles – or the full thickness of skin, fat and muscle can be reflected together. Muscles must be cut from the costal margins, and if thick fat overlies, a few transverse relieving incisions can be made on the peritoneal surface of the lower abdominal wall.
- **Thorax**
  - The thorax is opened by first disarticulating both sterno-clavicular joints. The ribs are cut through (lateral to the costochondral junctions) from a point on the lower costal margin, up to the sterno-clavicular joints.
  - When the sternum and medial ends of ribs are free, the sternum is lifted and dissected away from the mediastinum, keeping the blade of the knife close to the bone, in order to avoid cutting the pericardium.
  - The sternum is examined for fractures or other lesions, before it is put aside.
  - The whole of the thorax and abdomen is now open for inspection. The degree of inflation of the lungs should be assessed, noting complete or partial collapse, emphysema, and over-distension.
  - If pneumothorax has been suspected beforehand, a postmortem radiograph is the best confirmation. Alternatively, the chest wall can be punctured in the mid-axillary line, after filling the pocket between the ribcage and reflected skin, with water. If bubbles escape into the water, it is indicative of pneumothorax. The test cannot succeed if there is a patent communication between pleural cavity and the bronchial tree. The pleural cavities are examined for adhesions, effusions, pus, blood, fibrin, and even for extravasated gastric contents.
- **Abdomen**
  - The abdomen is inspected for evidence of ascites, faeculent fluid, pus, or blood.

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- The omentum may show inflammation or fat necrosis, or it may be totally devoid of fat (as in starvation deaths).
- The coils and loops of bowel are examined for any abnormalities, e.g., infarction, peritonitis, distension, etc (Fig 8.4). *Beware of mistaking postmortem hypostasis for necrosis or mesenteric embolism or strangulated bowel.* Though the dark colour may be similar, hypostasis has irregular segments when the gut is stretched out, whereas in infarction, the discolouration occupies one continuous section. When well established, the bowel wall will be lustreless and friable.

| Fig. 8.4 Mesenteric Haemorrhage *(Pic : Dr Hareesh S Gouda)* |

- Finally, the bowel is gently moved aside to look at the posterior part of abdomen: a retro-peritoneal haemorrhage from a ruptured aorta may be present.

Removal of the Viscera

There are a number of methods of removal of viscera from the body, once the major cavities have been opened up:

1. **Technique of R. Virchow**: In this technique, after opening the body cavities, the organs are removed one by one. This method is widely employed, with some modifications.
2. **Technique of C. Rokitansky**: This technique is characterised by in-situ dissection and removal of organs as required.
3. **Technique of A. Ghon**: The thoracic and cervical structures, the abdominal organs, and the urogenital systems are all removed as organ blocks (en-bloc removal).
4. **Technique of M. Letulle**: The thoracic, cervical, abdominal and pelvic organs are removed as one block (en-masse removal), and subsequently dissected into organ blocks. It is widely practiced in the mortuaries of most medical colleges in India, with some modification.

Procedure

- First, the intestines are removed. The greater omentum is lifted upwards to expose the coils of small intestine. The uppermost part of the jejunum is identified, where it passes retroperitoneally to join the terminal duodenum. Here, the mesentery is perforated with a knife, and the gut is cut through between double ligatures. The mesentery is then stripped off the entire intestinal length until the ileo-caecal valve is reached.
- The caecum is then mobilised medially using traction, with minimum use of the knife (to avoid puncturing it). When the hepatic flexure is reached, the omentum is pulled downwards to draw the transverse colon tense against the mesocolon, which is cut through taking care not to open the adjacent stomach. The splenic flexure is then pulled medially and downwards, and the descending and sigmoid colon are separated from the posterior abdominal wall. The upper rectum is cut between double ligatures.

Removal of Neck Structures

- To make the removal of neck structures easier, a wooden block (10 to 15 cm high) should be placed under the shoulders of the cadaver which allows the head to fall back, and thus extends the neck. This must be done gently to avoid the well- known ***undertaker's fracture***, which is a subluxation of the lower cervical spine, due to tearing of inter-

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vertebral disc between C_6 and C_7. There is danger of misinterpreting this as an antemortem injury.

- The neck structures are now freed by passing a knife under the skin of the upper neck until it enters the floor of the mouth. The knife is then run around the inside of the mandible to free the tongue. The tissues at the back and sides of the pharynx are divided, and the tonsilar area is cut through.
- The fingers of one hand are passed up behind the mandibular symphysis to grasp the tongue, which is then drawn down, the remaining tissues behind the larynx being divided to release the neck structures. This should be done as far laterally as possible, so that the carotids can be removed along with the laryngeal structures.
- The pharynx and glottis should be examined at this stage to look for any obstruction, bleeding, or any other abnormality of the upper airway (Fig 8.5).

| Fig. 8.5 Glottic Oedema
(Pic : Dr Geetha O) |

Removal of Thoracic Contents

- The subclavian bundles of vessels and nerves are divided by passing the knife from the inside of the thorax (around the medial ends of the clavicles and first ribs), to release the trachea and oesophagus.
- With gentle traction, the neck structures are held up and pulled caudally, while carefully clearing all attachments to the thoracic spine with the knife. Traction should be minimal and, as soon as the thorax is entered, the hand should move from the neck structures to place two fingers under the upper lobes of the lungs, lifting them and the mediastinum, as the knife clears the midline structures down to the diaphragm.
- If the neck structures are pulled too hard to drag out the thoracic viscera, they may get ripped off. In addition, the descending aorta may suffer transverse intimal tears from traction, which can resemble the genuine "ladder tears" seen in many traffic accidents.
- Pleural adhesions may prevent clean removal of the lungs. If these are minimal, they can be cut through. If the whole pleural cavity is obliterated by adhesions, the lungs may be pulled away by making a cleavage plane with the hand, thereby stripping off the adhesions.

Removal of Abdominal Contents

- When the chest organs have been cleared, they are laid back in the thoracic cavity, and the diaphragm is incised. The left leaf of the diaphragm is stretched, while the knife cuts through it laterally, near the costal margin. The cut should curve posteriorly under the organs to reach the spine, where it must pass through the cruciate ligaments, and then progress caudally behind the kidney which is mobilised forwards.
- The knife cut then curves up over the psoas muscle and ends at the brim of the pelvis. The same is done on the opposite side.
- The thoracic organs are now lifted and gently pulled free of the cavity along with the abdominal viscera. Any resistance is due to incompletely cut cruciate ligaments which must be severed.
- The iliac vessels and ureters are cut through, and the whole bulk of viscera is removed to the dissecting table, where running water and adequate illumination must be available.

Removal of Pelvic Contents

- The bladder is cut open, and the mucosa and trigone inspected, before the prostate is incised for examination.

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- The testis on each side is pushed upwards through the inguinal canal, which is widened with the knife.
- In a female dead body, the ovaries are incised and the fallopian tubes are examined, before the uterus is sliced in the midline from fundus to cervix.

Removal of Cranial Contents

- After incising the scalp across the posterior vertex, from the mastoid process of one side to the corresponding mastoid process on the other side, the tissues are reflected forwards to the lower forehead, and backwards to the occiput.
- If head injury is present or suspected, the scalp should be reflected right back to the nape of the neck, paying attention to the tissues behind and below each ear to avoid damaging the vertebral and basilar arteries.
- The skull is sawn through, using either hand-saw or power tools. The sawing should preferably be angled, with a horizontal cut from the forehead to a point behind the ears, joined by a second cut passing diagonally upwards over the occipito-parietal area (Fig 8.2). This will prevent the skull cap slipping out of position, after it has been replaced and the scalp has been sutured, at the conclusion of the autopsy.
- The calvarium (skull cap) is removed by leverage after cutting through completely. Hammer and chisel should not be used in forensic autopsies, even to ensure that the dura remains intact. The risk of extending an existing fracture or even causing new fractures because of hammering, is too high merely to justify an unmarked dural membrane. A cut dura is easily recognised as such by a pathologist. What is more important is to inspect the surface of the exposed dura and brain for evidence of oedema, bleeding, or inflammatory conditions. The skull cap is carefully inspected for fractures, and the dura is peeled off from its inner apect to study the inner surface.
- To remove the brain, the superior sagittal sinus is first incised with fine scissors or scalpel, and then examined for thrombosis.
- The dura is cut all along the line of cleavage of the skull and folded back. Look for subdural or subarachnoid haemorrhage. Subdural hemorrhage can be easily washed away, whereas subarachnoid haemorrhage cannot be washed off. Examine the leptomeninges for inflammatory changes.
- Free the falx-cerebri from the cribriform plate and fold it backwards. Lift the frontal lobe of the brain by inserting the fingers of one hand under it. The optic chiasma and the cranial nerves are now identified and cut one by one, as far away from the brain as possible.
- Cut the tentorium on either side, and pass a narrow pointed knife through the foramen magnum, to cut the cervical cord well below the medulla.
- Remove the brain gently with both hands. Strip away the remaining dura from the base of the skull and inspect for fractures (Fig 8.6). The brain is weighed before dissection.

| Fig. 8.6 Base of Skull (After Stripping off Dura) *(Pic : Dr Prateek Rastogi)* |

Removal of Spinal Cord

- This is not normally done. It is undertaken only if there are specific indications.
- The posterior approach is usually preferred in an adult. The body is placed in the prone position and a midline incision is made from the occipital protuberance to about the 4th lumbar vertebra.
- The skin and underlying tissues are dissected away on either side of the vertebral spines, and the laminae are exposed. These are divided as close as possible to the transverse processes by means of an adjustable double-blade saw.

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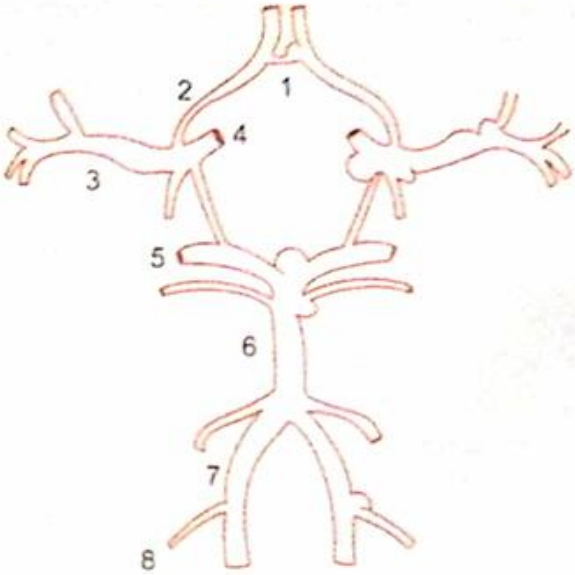
- A transverse incision is made at the lower end of the midline exposure to enable the dissector to grasp the lumbar end of the freed spinous processes with the bone forceps. The spinous processes can be lifted upwards in one piece.
- The spinal cord enveloped by the dura mater is now exposed and inspected. The dura is gripped with forceps and drawn aside gently to expose the extradural nerves, which are divided on either side.
- The dura is picked up with the forceps so as to raise the cord gently, allowing the dissector to cut the remaining connections. The spinal cord and dura mater are now divided as near the foramen magnum as possible and removed.

Dissection of Viscera

1. **Brain**
   - Examine the brain surface for evidence of injury, infection, or bleeding. Identify and scrutinise the circle of Willis (Fig. 8.7).
   - The brain is now placed on a flat board with the convexity in view, and the frontal pole away from the dissector (Fig 8.8).
   - The hemispheres are separated with the left hand. A brain knife is placed in the longitudinal sulcus, and horizontal sections are made on either side just above the level of corpus callosum.
   - The white matter of the brain is examined with particular reference to petechial haemorrhages, often seen in death from fat embolism.
   - The lateral ventricles are now opened by incising the white matter with a scalpel. Inspect the choroid plexus and locate the interventricular foramen. The fornices and corpus callosum are cut and bent backwards. Examine the thalamus and caudate nucleus.
   - The third ventricle is now exposed. Look for any abnormalities. Pass a probe through the aqueduct of Sylvius. Expose the fourth ventricle by cutting along the vermin in the midline.



1. Anterior communicating artery
2. Anterior cerebral artery
3. Internal carotid artery
4. Middle cerebral artery
5. Posterior cerebral artery
6. Basilar artery
7. Vertebral artery
8. Posterior inferior cerebellar artery

| **Fig. 8.7** Frequency Distribution of Congenital Cerebral (berry) Aneurysms within the Circle of Willis *(Fig : Dr Rohan Monis)* |

| **Fig. 8.8** Dissection of Brain *(Pic : Dr Prateek Rastogi)* |

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- With a long knife make parallel horizontal incisions, a little below the incision already made on the cerebral hemisphere. The internal and external capsule, as well as the basal ganglia are now exposed and examined.
- The cerebellum and brainstem are removed. Each cerebellar hemisphere is incised to expose the dentate nucleus.
- Serial sections are made through the pons, medulla, and the remaining cord.
- If the brain is oedematous, the gyri appear flattened and the sulci get narrowed.
- Tentorial herniation produces a groove (Kernohan's notch) on the surface of mid brain. Foraminal herniation produces indentations of medulla and cerebellum.

2. **Spinal cord**
   - The spinal cord along with its coverings is stretched out on the dissecting board.
   - The dura is opened by scissors and forceps in the midline, the cord being exposed and its membranes and outer surface inspected.
   - The cord is sectioned by a series of transverse incisions about half an inch apart and the cut surfaces inspected. It is advisable to dip the knife in water before commencing this dissection, as the cord will otherwise stick to the blade.
3. **Other viscera**
   - The thoracic and abdominal viscera are laid on a cutting bench under good illumination.
   - Wash the viscera with ample water to flush the tissues as the dissection proceeds. Some pathologists maintain that this should not be done, as water can affect the quality of histological sections, a view which is debatable. In any case, the gross appearance of organs is usually far more important than microscopic findings, in most forensic autopsies.
4. **Structures of the mouth and neck**
   - The tongue is examined for disease or injuries.
   - It should be sliced to detect deep haemorrhages (seen in strangulation), mostly at the sides and centre of the mid-part of the tongue.
   - Gross congestion, which may be due to either pressure on the neck or other congestive modes of death, is sometimes evident in the posterior part of the tongue.
   - The tonsils and pharyngeal walls are inspected.
   - The glottis is examined for mechanical or infective obstruction, and the hyoid and thyroid horns are palpated for fractures.
   - The oesophagus is opened up to the cardiac end of the stomach, and any suspicious material present such as capsules, tablets, etc., are retained for analysis.
   - The carotid artery on each side is slit-opened, and if thrombosis is suspected, the intracranial part should be examined in the cavernous sinus.
   - The thyroid gland should be sliced and inspected.
   - The trachea and main bronchi should be examined for disease or obstruction. Gastric contents are often found as a postmortem artefact; it should not be assumed that antemortem aspiration has occurred merely due to the presence of gastric contents in the air passages.
5. **Lungs**
   - The lungs are removed, and carefully examined for evidence of patchy collapse, emphysema, or petechiae (especially around the hilum and in the interlobar fissures) (Fig 8.9 and 8.10).
   - Both lungs are weighed.
   - Then each is laid on the dissecting board with the hilum facing down. Each lung is grasped by the left hand and cut across in the sagittal plane from apex to base, with a large brain knife wielded parallel to the board. This produces an antero-posterior slice, the lower medial part carrying the hilum. The two halves can now be opened like a book, and the surfaces examined for oedema, tumour, pneumonic consolidation, infarction, trauma, abscess, etc.

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- The inferior vena cava is opened from its lower end upwards.
- The pericardium is examined through a small nick for the presence of fluid or blood (Fig 8.13), then opened widely with scissors.

| Fig. 8.13 Antemortem Clot in the Pericardial Cavity *(Pic : Dr Hareesh S Gouda)* |

- The heart is delivered through the incision and inspected externally for adhesions, discolouration, pallor, or aneurysmal dilatation.
- In a child, the thymus is examined and dissected out at this stage.
- The presence of air embolism can be tested by filling the pericardial sac with water and puncturing the right ventricular wall (under water) with a scalpel. Escaping air in the form of bubbles is indicative of air embolism, provided the body is not putrefied. Gases of putrefaction will give a false-positive result. To differentiate between the two, the following method has been suggested:
  - Aspirate the right ventricle with a syringe filled with (freshly prepared) 4 mL of 2% pyrogallol solution which has been alkalinized by adding 0.5 mL of 0.5 N sodium hydroxide. The solution will turn brown in air embolism, while putrefactive gases will not produce such a change in colour.

- The heart is removed by holding it up with the left hand so that its attachment is tensed against the neighbouring structures. A long knife is passed horizontally across the reflection of the pericardium cutting through the roots of aorta and other great vessels.
- The detached heart is washed and placed in the anatomical position on the dissecting board, with the apex facing the operator and the anterior surface upwards. It should not be weighed until all blood clot contained in the chambers has been removed.
- The general size and shape should be noted. Any dilatation or thickening of the pulmonary conus should be noted as an index of right ventricular hypertrophy, especially if striae of transverse muscle fibres are present.
- The right atrium is then opened. The interior of the atrium, as well as the septum and tricuspid valve are examined.
- The interventricular septum is identified externally, and a cut is made about 1.5 cm to the right of and parallel to the septum over the right ventricle, which should be deep enough to enter the chamber. The cut must run up through the pulmonary conus and into the pulmonary artery. It is also extended downwards to the apex of the ventricle.
- A pair of fine scissors is now used to pass and cut into the tricuspid valve from the opened atrium. The whole of the right side of the heart can now be opened and displayed. It should be washed out, and the endocardium examined for lesions (Fig 8.14). The patency of the valve is tested under running water.
- A similar procedure is followed on the left side. The scissors is introduced into a pulmonary vein and passed horizontally across to an opposite vein, thus opening the left atrium. Two fingers are introduced into the mitral valve to estimate its size and detect any stenosis.
- The heart is restored to the anatomical position and a cut is made parallel to the septum on the left side, going deep as the left ventricle is thicker. Guided by the fingers still in the mitral valve, the cut is extended upwards through that valve and out from the top of the atrium.

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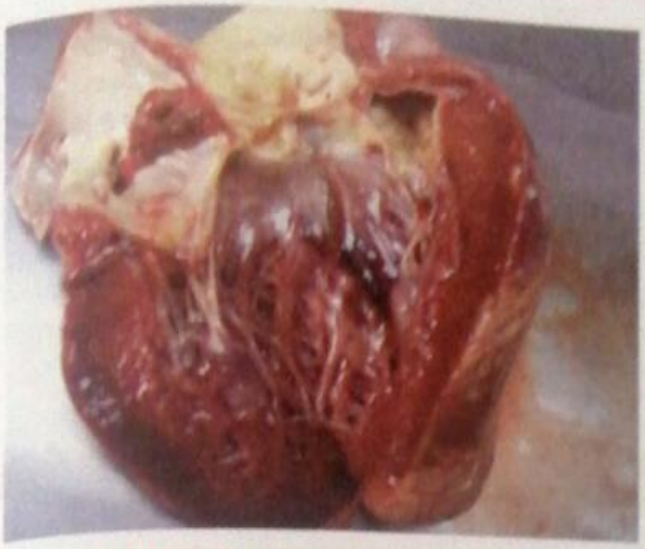

| Fig. 8.14 Sub-endocardial Haemorrhages (Pic : Dr Prateek Rastogi) |

| Fig. 8.15 Thrombus in Coronary Artery (Pic : Dr EJ Rodrigues) |

- Observe whether there is any hypertrophy of the ventricular walls. Various estimates of the normal weight exist for the human heart, but there is considersble variation depending on the sex and body weight. As a rule of thumb however, we can accept up to 380 g as normal in an adult man of average build.
- After weighing the heart, the endocardium and valves are examined in more detail.
- The coronary arteries must be scrutinised with reference to narrowing of lumen or stenosis (Fig 8.15 and 8.16). The ostia are examined for congenital variations (which are frequent), and for obstruction. Serial cuts are then made at intervals of not more than 3 mm, first into the left coronary artery, followed by the circumflex branch laterally, until the vessel becomes too small as it dips down from the epicardium to become intra-muscular. The anterior descending branch is then followed down the front of the septum to the apex.
- The right coronary artery is dealt with in the same way, beginning from the point where the right ventricle was opened, transecting the artery in its mid part. Serial cuts are made back to the aorta, and then the distal segment is followed laterally until it becomes the posterior descending branch. During this process, the dominance of right versus left vessels is noted.

| Fig. 8.16 Coronary Artery Occlusion (Pic : Dr Geetha O) |

- Difficulty arises when severe calcification exists in the coronary arteries. The only solution then is to decalcify the vessels. Postmortem angiography is the other alternative, but if the autopsy case-load is high, this can be difficult to accomplish.
- Observe the surface as well as the cut sections of the heart to look for evidence of old or recent myocardial infarction.

7. **Abdominal and pelvic organs**
   - The stomach is washed externally in a stream of water and a small cut is made in the greater curvature, which is then opened widely with scissors.

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- The contents are collected into a container and the gastric mucosa is examined for signs of inflammation, ulceration, etc (Table 8.1).
- The contents are examined with reference to the nature, quantity, state of digestion, presence of foreign matter, smell, etc.
- The liver is dissected out, weighed, and scrutinised (Fig 8.17). Serial sections are made, and the cut surfaces are examined for evidence of congestion, fatty change, cirrhosis, abscesses, haematoma, etc.
- The pancreas is not ordinarily examined in detail, unless there is a specific reason. In relevant cases, look for calculi in the duct system or acini, evidence of fat necrosis, etc.
- The adrenals are examined next, the right one being located on top of the right kidney, while the left is situated on the medial side of the

Table 8.1 The Stomach in Poisoning

Poison	Odour	Appearance
Organophosphate/Carbamate	Kerosene-like/garlicky/odourless	Congested, submucosal haemorrhages
Carbofuran (Furadan)	Odourless	Congested, haemorrhagic mucosa, violet fluid/granules
Organochlorine pesticides	Kerosene-like	Congested, submucosal haemorrhages
Zinc/aluminium phosphide	Garlicky/musty/fishy	Blackish or grayish powder/particles
Sulphuric acid	Pungent	Corrosion, blackish sloughing of mucosa, wet blotting paper consistency, perforation
Nitric acid	Acrid	Yellowish sloughing of mucosa, perforation
Hydrochloric acid	Faintly pungent	Grayish sloughing of mucosa
Formic acid	Pungent	Blackish sloughing of mucosa
Oxalic acid	Odourless	Grayish-white sloughing of mucosa, 'scalded' appearance
Carbolic acid	Phenolic (hospital) odour	Whitish or brownish discolouration of mucosa, hardened 'leathery' mucosa
Alkalies	Caustic odour	Inflammatory corrosion with slimy or soapy mucosa
HCN/Cyanide	Bitter-almond/crushed tapioca leaves	Bright red mucosa, mild corrosion
Oleander/*Cerbera odollam*	Peculiar/unpleasant	Greenish-yellow fluid, mucosal congestion

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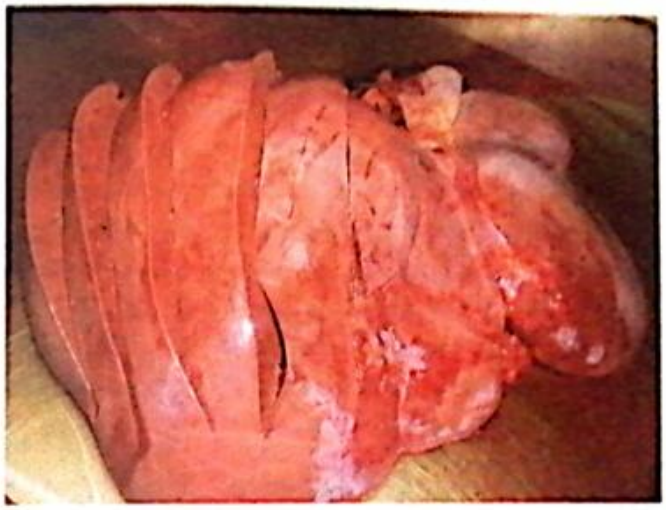
left kidney. The amount of cortical fat and presence of bleeding or other abnormality is noted in each gland.

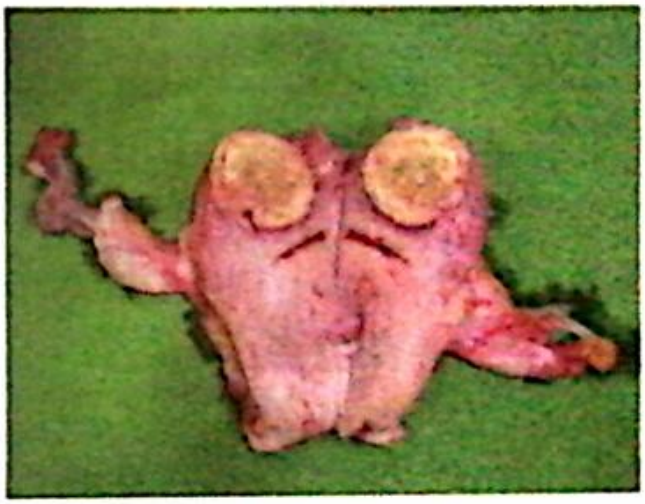


| Fig. 8.17 Dissected Liver
(Pic : Dr Prateek Rastogi) |

- The kidneys are exposed by incising their capsules. They can usually be peeled out of their capsules unless these are adherent. The renal vessels can be examined when the aorta is opened. The kidneys are detached at their hilum and weighed, then cut lengthwise to examine the interior (Fig 8.18). The width of the cortex is about 1 cm in a healthy subject. The granularity of the surface and the clarity of the cortico-medullary junction is assessed, as well as the size of the renal pelvis.

| Fig. 8.18 Dissected Kidney
(Pic : Dr Prateek Rastogi) |

- The spleen is removed by cutting through its pedicle, and is sliced after weighing.
- The small intestine can be examined now. However, it is not customary to open the entire length of the small bowel, unless there is some specific indication.
- In a female dead body, it is important to examine the uterus after removing it along with the fallopian tubes, ovaries, and a portion of the vagina (Fig 8.19).



| Fig. 8.19 Calcified Uterine Myoma
(Pic : Dr Hareesh S Gouda) |

The cervix is scrutinised for evidence of ulceration, erosion, laceration, mucosal plug, etc. The uterine cavity is examined for products of conception, blood clots, and foreign bodies. Both the ovaries must be incised to look for corpus luteum, congestion, cysts, etc.

- In a male dead body, the prostate may have to be examined, though this is not usually done. Testes must be examined in sudden, unexpected deaths, especially if the victim had died in the course of a brawl or assault. The scrotum should not be incised; instead an internal approach can be made via the inner aspect of the inguinal canal.

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Standard weights and measures for major organs are listed in Table 8.2.

FOETAL AUTOPSY

Objectives

1. Determination of live birth and viability in the case of dead new-born infants.
2. In suspicious deaths, to find out the cause of death.

Procedure

Autopsy is undertaken only after receipt of requisition.

External Examination

- This should be thorough, beginning with an examination of the coverings (if any), enclosing the foetus.
- Description regarding postmortem changes such as rigor mortis, postmortem hypostasis, and putrefaction must be given as usual (*vide supra*).
- Mummification or maceration, if present, is described in detail.
- Natural orifices such as mouth, nostrils, ears, rectum, and vagina are examined.
- Loss of alignment and over-riding of the bones of the cranial vault may be present due to shrinkage of cerebrum after death of the foetus, in cases of intra-uterine death (**Spalding's sign**).
- Look for injuries over the body, particularly in and around the mouth and nostrils, and over the neck.
- Examine the shape of the chest, noting whether it is arched or flat. Look for *caput succedaneum* over the head.
- Note down the following measurements: weight of the foetus, crown-to-rump length, crown-to-heel length, circumference of the chest, and circumference of the abdomen.
- Make an incision in the web of the foot between the 3rd and 4th toes, so as to bisect the foot longitudinally, and extend into the ankle joint. Look for the ossification centres of calcaneum (5th month), talus (7th month), and cuboid (9th month).
- Make a horizontal incision across the front of the nee joint. Reflect the skin flaps, cut the muscular attachments, and reflect them as far away from the joint as possible using a scalpel. Make horizontal slices of the lower end of femur. Look for the ossification centre which should appear at about the 9th month of intra-uterine life.
- Similarly, slice the upper end of tibia. Look for the ossification centre which appears at birth.
- When the sternum is removed, it is examined in turn as to the status of its ossification centres. Bisect longitudinally, and look for separate centres for the manubrium, and the four pieces of the body. Describe them in sequential order with reference to the number, size, etc. If the gestational age of the foetus is less than 5 months, no centre will be seen in the sternum.

Internal Examination

- All the three major cavities should be examined. The body is opened by the usual I-shaped incision. The skin, subcutaneous tissue, and fat are flayed laterally from the main incision.
- The ribs are cut through at the costo-chondral junctions, from a point on the inferior costal margin up to the sterno-clavicular joints.
- When the sternum (along with the medial ends of the ribs) is free, it is lifted and dissected away from the mediastinum, keeping the blade of the knife close to the bone to avoid cutting the pericardium. The sternal plate is placed aside.
- The whole of the thorax and abdomen is now open for inspection. After the body cavities have been examined, the organs are removed en masse. Each organ is weighed, examined, and the macroscopic findings are recorded.
- Note the position of the diaphragm in relation to the level of the ribs, which should be about the level of 4th or 5th rib if respiration has not taken place, and at the level of 6th or 7th rib if the child had breathed. This can however be affected by gases of decomposition.
- Examine the lungs. Breathing causes permanent changes in the lungs, the extent of which depends on the depth and period of respiration. Whether the child was born alive or not, the lungs will fill the thorax. However, fully respired lungs

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Table 8.2 Standard Weights, Measures, and Dimensions of (Adult) Body Organs and Structures

Organ/Structure	Weight/Measurement	
	Male	Female
Brain	1400 to 1450 g	1275 to 1300 g
Spinal cord	28 to 30 g/ 45 cm	28 to 30 g/45 cm
Heart		
Weight	300 to 350 g	250 to 300 g
Thickness of walls		
Atria	1 to 2 mm	1 to 2 mm
Rt. ventricle	3 to 5 mm	3 to 5 mm
Lt. ventricle	10 to 15 mm	10 to 15 mm
Circumference of valves		
Aortic	6 to 7.5 cm	6 to 7.5 cm
Pulmonary	7 to 9 cm	7 to 9 cm
Mitral	8 to 10 cm	8 to 10 cm
Tricuspid	10 to 12.5 cm	10 to 12.5 cm
Thyroid gland	20 to 40 g	20 to 40 g
Lung		
Rt. Lung	360 to 570 g	360 to 570 g
Lt. Lung	325 to 480 g	325 to 480 g
Trachea	11 to 12 cm	11 to 12 cm
Liver	1400 to 1500 g	1400 to 1500 g
Spleen	150 to 200 g	150 to 200 g
Kidney	130 to 160 g	120 to 150 g
Pancreas	90 to 120 g	90 to 120 g
Testis	20 to 25 g	—
Ovary	—	5 to 7 g
Prostate	15 to 20 g	—
Uterus		
Virgin	—	30 to 40 g
Parous	—	100 to 120 g
Pharynx	11 to 12 cm	11 to 12 cm
Oesophagus	25 cm	25 cm
Stomach		
Length	25 to 30 cm	25 to 30 cm
Capacity	1100 to 1200 mL	1100 to 1200 mL
Small intestine	550 to 650 cm	550 to 650 cm
Large intestine	150 to 170 cm	150 to 170 cm
Urethra	20 to 25 cm	2.5 to 4 cm
Vagina		
Anterior wall	—	7.5 cm
Posterior wall	—	10 cm
Placenta	—	500 g

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completely fill the pleural cavities, and the medial edges overlap the mediastinum and part of the pericardium. Before respiration, the margins appear sharp, which become rounded when breathing has been established. Glistening bullae appear along the margins when there has been a struggle to breathe due to mechanical obstruction. Before respiration, the lungs appear dense, firm, and non-crepitant (like the liver). After respiration, they become soft, spongy, elastic, and crepitant.

- Each lung may be weighed and subjected to the **hydrostatic test**, where-in floatation is tested in a pan or bucket of water. This is followed by individual lobes of lungs. After this, each lobe is cut into 8 to 10 pieces, and each bit is tested for floatation. If they also float, rule out the influence of putrefactive gases by pressing the lung bits in between two smooth wooden blocks. Try the floatation test again. A positive hydrostatic test in the absence of putrefaction, is a reliable sign of respiration having been established. If only a few pieces float, it indicates incomplete aeration of the lungs which could be due to feeble respiration, or artificial inflation of the lungs. Pathological conditions such as pneumonia, pulmonary oedema, and atelectasis also may give rise to mixed results. If all the lung bits sink, it indicates that respiration has not occurred.
- Collect tissue bits in 10% formalin from different areas of lungs for histological study—presence of hyaline membrane indicates live birth. Also, a respired lung will demonstrate expanded alveoli lined by flattened epithelium, and patent sections of blood vessels.
- Make a coronal incision on the head from behind one ear to the other, reflect the scalp, and examine for injuries, cephalhaematoma or caput succedaneum, and for the presence and closure status of fontanelles.
- Examine the skull bones for fractures, reflect the dura, remove the brain, and examine for evidence of injury or disease. Remove the dura from the base of the skull and examine for fractures of the base.
- Record any additional observations if present, for instance, internal signs of maceration, putrefaction, etc.
- In cases where the cause of death is not clear, preserve relevant viscera and body fluids for chemical analysis. Preserve a sample of blood for peripheral smear, grouping, etc.

ANCILLARY INVESTIGATIONS IN MEDICOLEGAL AUTOPSY

A wide range of samples may need to be taken before, during, or after the gross examination has been completed. The nature of such ancillary investigations will depend upon the nature of death, the history, and the suspicions of the pathologist.

Microbiology

- Though more common in clinical autopsies than in forensic work, culture samples for bacteriological, virological, or even mycological study may be needed.
- Plain swabs, or swabs immersed in an appropriate transport medium can be employed for sampling a wide variety of sites at autopsy.
- Tissue samples may be collected in sterile containers, and this is the usual method for virological culture of lung and brain.
- If blood culture is required to be done, it is best to take blood with a sterile needle and syringe from a large blood vessel such as the femoral vein, before starting the autopsy. Alternatively, blood can be taken from a freshly opened heart chamber using sterile instruments.
- In all autopsy investigations, unless cultures are performed soon after death, there is often widespread contamination by organisms that travel rapidly through the dead tissues, especially from the gastrointestinal tract. It requires the expertise of a qualified microbiologist to opine as to what is significant, with reference to the subsequent growth in the laboratory.

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Toxicology

- Collection of specimens should be done carefully if reliable analytical results are expected.
- Blood, urine, stomach contents, intestinal contents, organs (liver, kidney), CSF, bile, and ocular fluid may be required.
- The containers in which they are collected must be chemically clean.
- The pathologist should submit a form with the samples indicating the nature of analysis required, the personal details of the deceased person, a brief history with details of suspected toxic substances, and a statement as to whether the subject was known to suffer from any infective conditions, including hepatitis or AIDS.

Histology

- In most autopsies, the pathologist will need to carry out a histological examination on a range of tissues, even if only to exclude some occult natural disease.
- It is customary to retain samples of liver, spleen, kidney, heart, lung, thyroid, adrenal, pancreas, muscle, and brain for this purpose.
- Where there are indications to examine other parts of the body, these may be retained in addition to the routine tissues.
- The required tissue is placed in sufficient quantity of formalin, and allowed to fix for several days before processing. The volume of fixative should be six times the total volume of tissue.
- There are several specialised procedures in use at present, such as histochemistry, fluorescent microscopy, and immuno-histochemical examination, if evidence of early myocardial infarction is being sought. However, even light microscopy can be helpful in many cases.

Autopsy Radiology

- Radiology is similar to photography in the autopsy room (*vide infra*), though it requires more bulky apparatus, and someone to operate the equipment and process the films.
- The quality of radiographic assistance available will vary widely from none to the most sophisticated techniques. In many places, radiography may be scarce for living patients let alone corpses, and the same standard of assistance for the pathologist cannot be expected.
- In more affluent countries, remoteness may be the problem, for which mobile equipment is available and sometimes used by the forensic pathologist, or the corpse is taken to the radiology department of a nearby hospital for the required X-rays. There are small, portable X-ray kits that can be carried in two suitcases, and can function from an ordinary domestic power supply, or from a portable petrogenerator. For isolated organs and tissues, cabinet type radiographic equipment is available, which can be used without the assistance of trained radiographers. In major Forensic Institutes, full radiological facilities with the staff and equipment to operate and process plates is often available.
- The usual stage at which radiology is employed is after external examination has been completed, and before dissection has begun.
- Radiographs to detect bony injury are generally not required, as the skeleton can be inspected directly by dissection. The exception is child abuse, where a full skeletal survey is needed before autopsy.
- Suspected gun shot and explosive deaths, air embolism, pneumothorax, and barotrauma should necessarily be subjected to radiological examination before the autopsy, and when a traumatic subarachnoid haemorrhage is suspected, vertebral artery angiography might be necessary.
- Mutilated remains from mass disasters also need to be X-rayed, as many victims may have been involved which makes meticulous dissection difficult. Where bombs or explosives are involved, it is necessary to have radiographic facility to detect any parts of the device that may be embedded in the tissues.

Forensic Photography

- The type of camera favoured is the 35 mm SLR (single lens reflex), of which there is now a vast variety available in all grades of sophistication and price.

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- Some means of exact focussing is essential (either automatic or split screen), as picture sharpness is of prime importance. The standard 50 mm lens is most useful, but for scenes of crime, a wide-angle lens of 28 or 30 mm is preferable. A longer focal length of up to 80 mm can be useful for close-up pictures of small lesions. Many pathologists prefer to combine lenses into a single variable focus "Zoom" lens of 28–80 mm range. This saves time spent in changing lenses, and the image resolution is virtually indistinguishable from fixed focal length lenses.
- Illumination is usually by electronic flash, an integral part of the camera body.
- The type of film depends on the nature of illumination. Ultraviolet and infra-red sensitive film has been used to demonstrate surface lesions which are not visible to human eye. It is claimed that occult bruising can be revealed explicitly by ultraviolet photography.
- Some pathologists use Polaroid cameras either alone or together with conventional film. The advantage of instant prints is that a record of scene of death can be obtained before the autopsy is carried out.
- Digital cameras of varying grades of sophistication, resolution, and cost are now available that can instantly store images, which can be viewed immediately on a computer unit, or printed on a colour laser printer. The images can be manipulated in many ways to enlarge sections, or correct colour balance, and can be sent via modems to distant locations, or be incorporated within textual material and reports.
- When photographing viscera, the camera should be near enough for the frame to be almost completely filled by the queried object. The shot should be vertical to the lesion, and it is often necessary either to place the dissecting board on the floor, or for the photographer to stand on a stool or some elevation, to gain required height.
- Where isolated organs are being photographed, they should be placed on a green or blue cloth, such as a discarded operating gown. The organs should be placed on the cloth in one movement and not moved thereafter, otherwise a wet dark stain will mar the green or blue background. The organ should not be oozing blood, and should be dabbed with a dry cloth or sponge just before the photograph is taken to remove shiny wet highlights.

OCCUPATIONAL HAZARDS IN MEDICOLEGAL AUTOPSY

Medicolegal autopsies are associated with considerable risk to the personnel involved in such work, and with the deplorable conditions existing in most mortuaries across the country, the risk is even higher among Indian forensic professionals, mortuary technicians, and sanitary workers. The common hazards include the following:

Biohazards

1. **Infection**

   Transmission can occur through skin (percutaneous injury), aerosol and droplet inhalation, and eye contact with infectious or irritant fluids.

   a. Skin – Infections that can be transmitted through percutaneous contact or puncture by autopsy instruments include streptococcal sepsis, tuberculosis, AIDS, fungal infections, hepatitis B & C, rabies, viral haemorrhagic fevers, etc.

   b. Aerosol/ droplet inhalation – Can cause tuberculosis, rabies, plague, anthrax, etc.

   c. Eye contact – Can result in inflammation, and localized or generalized infection.

2. **Toxic Hazards**

   Autopsy personnel can be exposed to a number of noxious agents in the course of their work, including formaldehyde, corrosives, pesticides, etc.

3. **Radiation**

   Autopsy on a victim of radiation can expose the autopsy personnel also to the same agent. Even radiodiagnostic or therapeutic procedures which were employed in a deceased while he was alive can pose a risk.

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Environmental Hazards

1. **Poor Hygiene**
   Most mortuaries in India are badly designed, ill equipped, and poorly staffed. The result is an unhygienic environment, which gets accentuated when bodies pile up, and cold storage facility is inadequate. In many mortuaries, even basic facilities such as running water and effective drainage system are lacking. The health consequences to the autopsy personnel can well be imagined in such a scenario.
2. **Workplace Injuries**
   Apart from conventional workplace injuries that can occur in any part of a hospital, there are specialized risks in a mortuary posed by primitive dissection tables, defective instruments, dangerous chemicals, and poor lighting.
3. **Psychological Trauma**
   Constant exposure to traumatized, mutilated, decomposed dead bodies can exact a heavy psychological toll that can manifest as depression, personality disorders, alcohol abuse, etc.

PREVENTIVE MEASURES FOR MINIMIZING HAZARDS RELATED TO INFECTED/ CONTAMINATED BODIES

1. **Immunisation**: All staff involved in an autopsy or coming into contact with materials derived from it should be vaccinated against tetanus, poliomyelitis, tuberculosis, and hepatitis B.
2. **Pre-autopsy testing**: This should be considered in cases where there is reason to suspect that the body may be infected with serious infective agents such as HIV. In cases where such testing proves positive, the pathologist has a duty of care to the patient and his/her relatives and sexual partners to disclose the information.
3. **Clothing**: The currently recommended clothing for performing all autopsies includes: a cap/hood that completely covers the hair; eye protection (ideally a visor that provides full face protection); a face mask; surgical shirt and trousers; waterproof boots; a full length gown; a waterproof apron that is long enough to reach below the tops of the boots, and at least one pair of gloves.
4. **Reduce aerosol formation**: This is essential for reducing the risk of acquiring airborne infections such as tuberculosis and enteric pathogens, and for autopsies on patients suspected of having HIV. Down draught ventilation tables reduce the particle transmission of microorganisms (and have the added advantage of reducing odours). The hazards for the formation of aerosols relate principally to the use of saws (especially power saws) and opening of the intestines (which should be performed under water). Care should be taken when removing, handling and/or washing organs to avoid splashing and aerosol formation. High pressure water sprays should not be used.
5. **Equipment**: The equipment used to perform the autopsy should be kept to a minimum, and be kept in clear view at all times. Scalpels and scissors with pointed ends should not be used. Instruments (and especially sharps) should never be passed from hand to hand.
6. **Circulators**: The pathologist should be accompanied by an anatomical pathology technician, who assists in the evisceration and dissection, and a circulator. The pathologist and technician are "dirty", whereas the circulator avoids direct contact with potentially infected or contaminated tissues, fluids, and surfaces and so remains "clean". The roles of the circulator include: labelling specimen containers and holding them; completion of paperwork; recording organ weights; adjustment of overhead lighting where necessary; and ensuring that the contaminated prosector does not have to handle clean surfaces such as telephone receivers.
7. **Safe sharps practice**: Hazards are posed both by equipment used to perform the autopsy (scalpels, scissors, needles, and saws) and by the body itself (bone fragments and unsuspected objects within the body). "Blind" dissection should be avoided. For reconstruction of the infected body some authorities recommend that sutures are not used (given that protective wear will not protect

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from penetrating injuries caused by suture needles) and that the body instead be closed with staples, tissue adhesives, or even left unreconstructed and sealed in a leakproof body bag.

8. **Minimising explosive risk**: Those working in mortuaries where deaths as a result of shootings are investigated, face the potential hazard that the deceased was shot with explosive ammunition. Such bullets are designed to fragment upon contact with the victim, thus slowing the bullet and imparting more of its kinetic energy to the body. In addition to causing severe injury to the victim, such bullets pose a hazard to the surgeon and the pathologist if they fail to explode. In cases where explosive ammunition is suspected, goggles should be worn and long handled instruments used to minimise the risk of injury to eyes and fingers. Once removed, the bullet must be handled with rubber coated forceps, kept in a padded container to shield it from excess vibration and heat, and must be kept away from sources of microwave radiation.
9. **Precautions against chemical contaminants**: There have been concerns expressed in cases of autopsy on patients who have died from cyanide poisoning. It has been suggested that cyanide liberated from such bodies may poison postmortem personnel. However, in several cyanide related deaths, no increase in blood cyanide values was detected in the postmortem workers, though some have experienced headache, lightheadedness, and throat discomfort. The occupational exposure to cyanide can be minimised by performing the autopsy in a well ventilated environment, using down draught ventilation. The risk is proportional to the amount of cyanide present in the stomach. Cyanide salts liberate hydrogen cyanide when they come into contact with gastric acid. The upper GI tract should be dissected out unopened and intact and examined in a fume cupboard. One should not rely on the smell of "bitter almonds" to detect cyanide - many people are anosmic to this.

   There have been no reported cases of secondary toxicity caused by organophosphates among postmortem staff, but there is a theoretical risk (for e.g., deaths following industrial accidents or terrorist attacks). Occupationally acquired organophosphate toxicity has been reported among health care workers who failed to take appropriate precautions when treating organophosphate poisoning. Health care workers handling the bodies of those contaminated by organophosphates should use chemical barrier protection (latex gloves afford little protection).
10. **Precautions against radioactive contaminants**: Bodies may be contaminated by radioactive materials deliberately, as a consequence of medical treatment, or as a consequence of the explosion of atomic devices, or working in the nuclear industry. Staff engaging in the autopsy of such victims should liaise with their local department of nuclear medicine before starting the necropsy to seek advice and appropriate monitoring.

EXHUMATION

Exhumation is the retrieval of a previously buried body for postmortem examination. The term should be restricted to the removal of a body interred in a legitimate fashion in a graveyard (*interment* = burial), rather than the recovery of an uncoffined, clandestinely buried victim of a suspicious death. The latter is actually a "scene of crime," and the pathologist should treat it as such.

Indications

1. Where some civil legal matter needs to be investigated, such as personal injuries for insurance purpose, or civil litigation relating to negligence – usually after road traffic, industrial, or other accidents.
2. Where new information, or substantiated allegations arise to suggest that a death was due to unnatural causes, criminal abortion, or some form of injury or poison, that was not elucidated prior to burial.
3. In ancient or historical circumstances, to study either the individual, or a series of individuals, for academic interest.

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Procedure

- The body is exhumed only on written order from an executive or judicial magistrate. Under Section 176 (3) of the Criminal Procedure Code, an order for exhumation can be given by the District Collector, Additional District Magistrate, Sub Collector, RDO, Tahsildar, or Deputy Tahsildar. They are all Executive Magistrates.
- It is done under the direct supervision of the medical officer and in the presence of a police officer.
- It is advisable to conduct an exhumation early in the morning, as exposure to strong sunlight will accelerate putrefactive processes.
- Before beginning to dig, the grave should be positively identified by examining the plan of the graveyard, or by questioning the persons who had accomplished the burial.
- The grave is then carefully dug out.
- In a case of suspected poisoning, about 500 g of earth in actual contact with the body from the top, sides, and below should be collected and sent for chemical analysis as a control sample, to rule out contamination of the body by a poison present in the soil itself.
- In coffined bodies, the coffin must be identified by the person who had made it. The coffin or the body is lifted out, and the body is identified by as many persons as possible who had been present at the time of burial. Any debris in the coffin must be sent for chemical analysis.
- Exhumation of a recently buried body can be unpleasant, and sometimes hazardous.
- Disinfectants should not be sprinkled on the body.
- The examiner should wear masks and thick rubber gloves, and stand away from the direction of the wind.
- Once the body has been lifted out, postmortem examination is done in the usual way.
- Viscera should be preserved for chemical analysis. If poisoning by heavy metals is suspected, samples of bone, hair, nails etc., should be preserved.
- If skeletonisation has taken place, ascertain the age, sex, height, and cause of death. Even negative information gained, such as absence of alleged or suspected fractures may be of considerable value.

EXAMINATION OF SKELETAL REMAINS

Skeletal remains sent for examination to a Forensic Expert are usually either those recovered after exhumation, or those recovered from forests, deserted areas, dustbins, ditches, etc. The examination of skeletal remains should be undertaken with great care, in order to provide information which may be vital to the investigation. The following facts should be elucidated:

1. **Human or not**: Can be determined by noting morphological features. It is difficult when only fragments of bone are available. Precipitin test will be helpful in such cases.
2. **Male or female**: In post-pubertal bones, sex differences can be determined from an examination of pelvis, skull, sacrum, etc.
3. **One or more individuals**: This can be ascertained by sorting and assigning the individual bones to their anatomical positions. If there are no disproportionate or duplicated bones, and the age and sex of all the bones are same, it can be safely concluded that all bones belong to the same individual.
4. **Probable stature**: Can be assessed by measuring long bones and applying appropriate formulae.
5. **Age of the individual**: Can be determined by the examination of teeth, ossification status, and suture closure.
6. **Identity**: The superimposition technique can be employed for establishing identity. If tooth pulp or bone marrow is available, DNA fingerprinting can be done.
7. **Time of death**: It is difficult to tell precisely the time of death. But an intelligent guess may be made from the condition of the soft parts, ligaments, and bones. Skeletonisation generally takes place within three to six months after burial, and sooner if the body is exposed to inclemental conditions.
8. **Cause of death**: It is usually impossible to find out the cause of death from an examination of

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bones, unless there is evidence of major fractures in the vital parts of the skeleton (e.g., skull). However, it is often difficult to distinguish between an antemortem fracture and a postmortem artefact. Presence of blood clots, or evidence of reparative process at the fracture site indicates antemortem nature.

POSTMORTEM ARTEFACTS

Forensic Medicine is best learned by a judicious combination of theoretical and practical knowledge. A good Forensic Expert is one who has not merely a vast experience in conducting autopsies, but one who has trained himself to make precise and correct interpretation of findings. One must not allow dogmatism or inflexibility to cloud one's judgement. A self-opinionated expert is a poor expert.

There are several inherent pitfalls that must be avoided in the course of medicolegal autopsies which can lead to erroneous or fallacious conclusions. Every forensic pathologist must familiarise himself with these *postmortem artefacts* that are liable to misinterpretation (Fig 8.20, 8.21 and 8.22). While an exhaustive discussion on this matter is unfortunately beyond the scope of this book, some of the more commonly encountered artefacts have been mentioned in Box 8.4.

| **Fig. 8.20** Defibrillator Injury *(Pic : Dr Shashidhar C Mestri)* |

NEGATIVE OR OBSCURE AUTOPSY

When at the conclusion of a complete and thorough postmortem examination, inclusive of all relevant investigations such as histopathological, toxicological, and biochemical investigations, no cause can be attributed to the death, it is termed as a **negative autopsy**. Approximately 2 to 5% of all autopsies are negative in nature.

Causes

1. Inadequate history.
2. Natural disease which is difficult to establish as a cause at autopsy, e.g., cardiac arrhythmias, uraemia, adrenal insufficiency, etc.
3. Death due to vagal inhibition.
4. Death due to concussion.
5. Death due to anaphylaxis.
6. Death due to certain kinds of poisons, e.g., anaesthetics, snake bite, etc.
7. Electrocution deaths.

| **Fig. 8.21** Postmortem Antbite Erosions of the Face *(Pic : Dr EJ Rodrigues)* |

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| **Fig. 8.22** Postmortem Injuries by Aquatic Animals *(Pic : Dr Hareesh S Gouda)*

Box 8.4 Postmortem Artefacts

- Aspiration of gastric contents may occur as an agonal terminal event, or due to resuscitation, or handling of the body after death. This should not be confused with death due to choking.
- Defibrillator used as a part of resuscitative procedure may produce contusions over chest. Similar is the case with external cardiac massage which may even cause ribs to be fractured.
- Positive pressure breathing done through a respirator may cause emphysematous condition of the lungs.
- Fractures of skull, cervical spine (*undertaker's fracture*), ribs, or extremities may result from rough handling of a dead body.
- Abrasions may result from a recently dead victim being dragged on a rough surface.
- Rough handling can break rigor mortis leading to wrong conclusions about the time of death.
- Bodies placed in cold storage immediately after death can develop pink colouration of postmortem lividity, which may be mistaken for carbon monoxide poisoning.
- Postmortem lividity in internal organs such as the heart, stomach, intestines, etc., may be mistaken for congestion, inflammation, or disease.
- Tight clothes can produce marks resembling ligature mark (neck), or bruising (trunk).
- In a burnt body, fractures of skull or limb bones can occur due to heat, and must not be confused with traumatic fractures.
- Insect or animal bites on a dead body may be mistaken for antemortem injuries.
- Decomposition can cause a number of changes that may be mistaken to be due to antemortem violence, e.g., oozing of blood-stained fluid from mouth and nose.

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Box 8.5 The Disposal of the Dead

- **Christian** – Body is laid out after washing, and clothed in a shroud or night attire. Roman Catholic faith prefers a crucifix to be laid on the chest of the deceased, or that the arms should be folded as a cross.
- **Muslim** – Body is washed by a professional, after the head has been turned towards Mecca. It is then clothed in 3 pieces of white cloth 9 yards long, covering the upper, middle, and lower portions of the body. Generally, no coffin is used.
- **Hindu & Buddhist** – Body is washed, wrapped in a shroud, covered with flowers, & cremated.
- **Jewish** – Body is laid out with the eyes closed, and the feet pointing towards the door. A purification ritual called "Tahara" is performed by two specially qualified Jews, and the body is then buried wrapped in a shroud.

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CHAPTER 9

Mechanical Injuries

An injury is much sooner forgotten than an insult

—**Philip Stanhope,** 4th Earl of Chesterfield (1694–1773; British statesman)

INTRODUCTION

- **Trauma** is an insult to the state of well-being. This insult can be physical or mental. Usually, one is accompanied or followed by the other in negligible or substantial degree.
  - Physical trauma may manifest itself as a functional change, or structural (anatomical) change, or both.
- The kind of physical trauma which causes structural (anatomical) change is called an **injury.** Injury may be associated with loss of tissue, or without recognisable loss (e.g., redness, oedema).
- An injury which is associated with loss of tissue is called a **wound**.
- In other words, *all wounds are injuries, but all injuries are not wounds.* However, injury and wound are often described as being synonymous. For the sake of convenience, the term 'injury' will be used interchangeably with 'wound' in this textbook even though it may not be accurate.
- Injuries can occur due to natural causes (e.g., diabetic ulcer), or due to unnatural causes which may be *physical* (e.g., heat, cold, electricity, radiation, etc), *chemical* (e.g., corrosives), or *mechanical* (e.g., weapons such as knife, stick, etc). Common weapons of assault are depicted in **Plate 9.1**.
- A **mechanical injury** can be defined as "Damage to any part of the body due to the application of mechanical force." The damage referred to is loss of tissue.

CLASSIFICATION OF MECHANICAL INJURIES

1. Abrasion
2. Contusion (Bruise)
3. Laceration
4. Incision
5. Stab (Puncture)
6. Fracture

Important

- Injuries that result from **blunt force** comprise abrasion, contusion, laceration, and fracture.
- Injuries that result from **sharp force** comprise incision and stab. Abrasions (especially scratch) can also result from sharp force.
- **Bite marks** are a special category of injury that may be either an abrasion, contusion, or laceration, or a combination of all three.

ABRASION

- An abrasion is the loss of superficial layers of skin or mucous membrane due to mechanical force.
- Because of the corrugated nature of dermoid papillae, abrasions usually involve the corium of dermis. Since the blood vessels are confined to dermis, such involvement of corium seems to be the reason for the common occurrence of bleeding in abrasions. There is also oozing of lymph, which dries up after death making the abrasion firm, leathery, or parchment-like.

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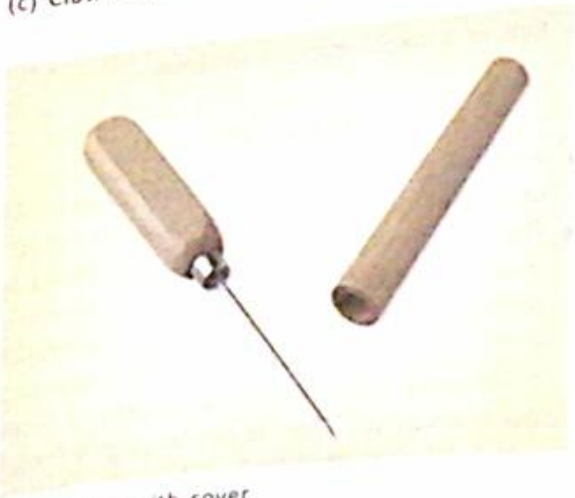
(a) Bamboo stick

(b) Hammer

(c) Claw hammer

(d) Sledge hammer



(e) Ice pick with cover

(f) Single-edged hunting knife with sheath

| Plate 9.1 Common Weapons of Assault |

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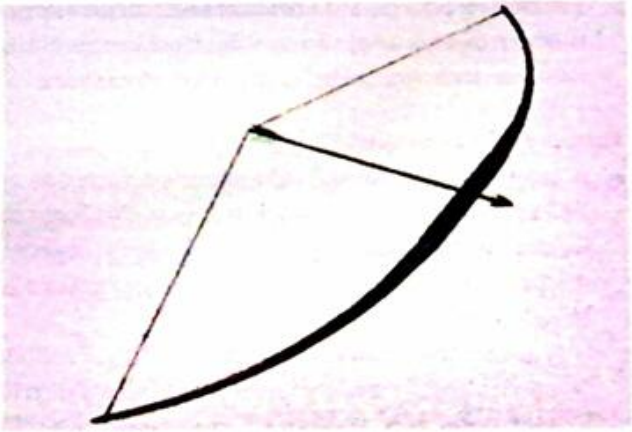
(g) Double edged dagger with sheath

(h) Axe

(i) Pickaxe

(j) Hatchet

(k) Spear



(l) Bow & arrow

| **Plate 9.1** Common Weapons of Assault |

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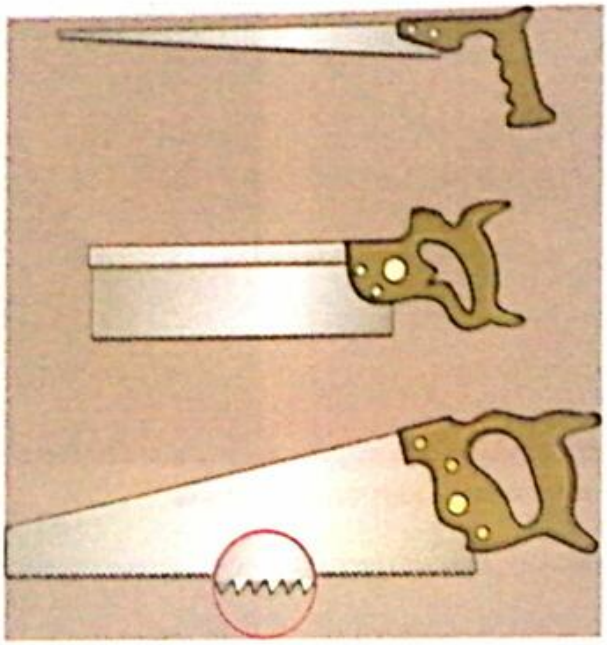

(m) Saw – different varieties

| Plate 9.1 Common Weapons of Assault |

Mechanism of Occurrence

- The mechanical force which causes an abrasion is either *friction* (sliding), or *pressure* (compression) applied on the body surface. Usually both these elements are present, with one predominating over the other.
- Friction-predominant abrasions are called **tangential abrasions**, while those which are compression-predominant, are called **patterned abrasions**.

Tangential Abrasions

- A tangential (frictional) abrasion is referred to as a **linear abrasion** or **scratch** if it is in the form of a linear mark caused by a narrow, sharp object. A wider mark caused by a broad, rough surface is a **brush abrasion** or **graze**.
  - **Linear abrasion (scratch)** (Fig. 9.1): Produced by frictional (sliding) movement of a sharp object such as a fingernail, pin, thorn, etc. The object causing the linear abrasion carries the torn superficial layers of skin in front of it as it slides forward. This heaping up of superficial layers, often visible at the concluding end of a linear abrasion, is an indicator of the direction of movement of the causative agent.

| Fig. 9.1 Scratch Abrasion
(Pic : Dr Prateek Rastogi |

  - **Brush abrasion (graze or brush burn)** (Fig. 9.2 and 9.3): This is produced when a rough object scrapes over the skin, or when the skin moves against a broad, rough surface (e.g., fall

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on a road). The terminal end of injury often shows a serrated border with piling of torn layers of skin, again giving a fair indication of the direction of sliding movement.

| **Fig. 9.2** Grazed Abrasion (Front of Trunk) *(Pic : Dr Jagadish Rao PP)* |

| **Fig. 9.3** Grazed Abrasion (Back of Trunk) *(Pic : Dr Jagadish Rao PP)* |

Patterned Abrasions

- This is caused by pressure of an object on the skin resulting in a patterned injury.
  - When the impact is vertical, the epidermis gets crushed, and an imprint of the impacting object is stamped upon the surface. Such an injury produces a replica of the patterned surface of the causative object, and is called an **impact or imprint abrasion** (e.g., radiator grill impression on the skin of a victim of vehicular impact).
  - In the absence of an impacting force, if there is merely sustained pressure, the resulting abrasion can still reflect the pattern of the object, and is referred to as a **pressure or contact abrasion** (e.g., ligature mark of hanging or strangulation).
  - In such **patterned abrasions** (Fig. 9.4), the pressure of the object is mainly vertical, with the frictional (tangential) force being negligible.

| **Fig. 9.4** Patterned Abrasion |

  - As the element of frictional force gradually increases, the abrasions begin to fail to exhibit the weapon pattern and are referred to as **non-patterned abrasions.**
  - Depending on the presence and extent of crushing, a contused area can surround these abrasions to such an extent that in some cases, the contused area will be more marked than the abrasion, which is then called an *abraded contusion*. Alternatively, if the abraded part is more prominent, it is more appropriately called a *contused abrasion* (Fig. 9.5).

A simple mnemonic to help remember the 4 important types of **abrasions** is **PIGS**: **P** = Pressure; **I** = Impact; **G** = Graze; **S** = Scratch

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Other Abrasions

- Abrasions can be induced after death. They are called **postmortem abrasions.**
  - They are quite common, and can occur due to mechanical force (e.g., dragging the body after death) or by animal action (e.g., ant bite). Even the normal procedures of post-autopsy reconstruction and handling in the mortuary may cause dermal changes simulating abrasions, especially after washing with hot water.
  - While an abrasion caused during life is covered by scab due to coagulation of blood and lymph, and is associated with signs of inflammation, a postmortem abrasion does not demonstrate these features. In fact it usually appears pale and dry.
  - Ant bite marks are pale and irregular in shape, and are seen mainly in moist regions such as the areas around the eyes, nose, mouth, genitalia, and axilla.
  - Abrasions produced immediately before or after death may be difficult to differentiate even by microscopic examination.
- An abrasion fabricated on the body by oneself, or with the help of another person, is called **fabricated abrasion**. In the former case, only accessible parts of the body are involved such as face, hands, etc. The motive for such fabrication can be serious or trivial.

| Fig. 9.5 Contused Abrasion |

- **Nappy abrasions** constitute a special variety of abrasion seen in infants due to excoriation of skin over areas usually covered by a nappy (groin and buttocks). They may be confused with antemortem violence when viewed at autopsy, unless the pathologist is vigilant. These abrasions generally appear yellowish or yellowish-brown, and lack apparent antemortem reaction.

Repair and Healing

- Healing involves two phenomena – contraction of the wound, and replacement of lost tissues.
  - When fresh, an abrasion is bright red in colour.
  - Scab forms by 12 to 24 hours. When fully formed, a scab is red in colour, and is moist, but it becomes reddish brown and dry by about 2–8 days.
  - Abrasions heal from the periphery by new growth of epithelial cells. Ordinarily the scab falls off by about 7–8 days, leaving a pale area which may persist for a few days or weeks.
  - A rough estimate of the age of an abrasion can thus be made from these features. Earlier stages (before scab formation) can be assessed by histology. Infiltration by polymorphonuclear cells in a perivascular formation signifies that the wound is 4–6 hours old. At 12 hours, the wound shows three layers – a surface zone of fibrin and red cells, a deeper zone of polymorphonuclear cells, and a third layer of damaged, abnormally staining collagen.

Medicolegal Significance

1. An abrasion indicates the site of contact with an object. Occasionally, an abrasion may be the only external indication of a deep-seated injury. Abrasions are normally simple wounds. They are actually three dimensional, but for practical purposes they are considered to be two dimensional.
2. The type of abrasion may reveal as to whether the manner of contact was a sliding one or compressing one. The pattern (if present), can help to some extent in deducing the nature of the object, e.g., the exact nature of vehicle involved in a "hit and

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run" case may be revealed by the radiator grill pattern.

3. The stage of healing process could help in determining the time of occurrence. However, the determination of age of an abrasion is usually only approximate and is seldom accurate.
4. The exact site of an abrasion can sometimes give valid information about the nature of crime (e.g., abrasions around the nose and mouth suggest smothering, while those around breasts and genitalia may suggest sexual assault). Abrasions on a suspected assailant may be the result of a struggle, and suggests evidence of resistance put forth by the victim. It is advisable to look for foreign material over abrasions (e.g., presence of mud particles indicates a fall in a muddy area).
5. In the case of an assault, it is necessary to examine the fingernails of the victim and the accused, and to collect the debris from under each nail. Nail scratches may have been inflicted by both the victim and the accused on each other during the assault. There is a possibility of skin fragments being retained under the nails. Significant evidentiary material may be obtained from such retained tissue by microscopy and DNA typing to link the victim and the accused.

CONTUSION

- A contusion is an extravascular collection of blood that has leaked from blood vessels damaged by mechanical impact of a blunt nature, without loss of continuity of tissues. A contusion is also referred to as a **bruise**. The blood vessels involved are usually small arteries, veins, or capillaries.
- Contusions are usually situated in the subcutaneous tissue, but can also occur in various internal viscera.
- The term **ecchymosis** is used if a contusion is smaller than a few millimeters in size, while pinpoint contusions are generally referred to as **punctate contusions** or **petechiae**. However, the latter term is usually restricted to haemorrhages resulting from bursting of congested capillaries, as in asphyxia, or bleeding points in the skin due to coagulation disorders, rather than those seen in trauma, since the nature of production is different.

Mechanism of Occurrence

- The extent of effusion of blood resulting from damage to blood vessels depends on several factors such as the:
  - *site* of wound (effusion will be greater in lax tissues such as peri-orbital area),
  - *thickness* of skin (effusion is lesser if the dermis is thick, as in the palms and soles),
  - *resilience* of the area (effusion is minimal in the well-yielding anterior abdominal wall),
  - *sex* (females contuse more easily than males due to higher amount of adipose tissue), and
  - *age* (children and aged individuals are more susceptible than young adults). Elderly people bruise easily due to increased fragility of blood vessels.
  - The degree of effusion is also directly proportional to the *vascularity* of the area, and the amount of *force* applied.
  - *Diseases* such as haemophilia, scurvy, and leukaemia can aggravate effusion.
- A bruise will be less prominent if it is situated in deeper tissues.
- Blood escaping from ruptured vessels usually percolates along the lines of least resistance. Hence, it is easily influenced by gravity. The site of a contusion therefore does not necessarily indicate the site of application of force, e.g., black eye in head injury.
  - A "black eye" can be caused by a direct injury, or by gravitation of blood from a wounded scalp, or from a fractured orbit (*see also page 247 & 259*). Contusions appearing at a site remote from the site of application of force are called **percolated contusions** or **ectopic bruises** (Fig. 9.6).
  - A deeply situated bruise may manifest externally only after several hours or days. Such a bruise is called a "**come-out bruise**." This may be due to haemolysis, wherein the freed haemoglobin stains the tissues more and more densely as time elapses.

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| Fig. 9.6 Ectopic Bruise |

- On certain occasions, the shape of a bruise may give valuable information about the causative object.
  - Oval or rounded bruises caused by fingertips over the neck in throttling represent one such example.
  - Beating by a stick will produce linear contusions. Such bruises are called **patterned bruises** (Fig. 9.7). They may also result from beating with a chain (Fig 9.8).

| Fig. 9.7 Multiple Linear Contusions—Beating with a Stick *(Pic : Dr Pratik Patel)* |

  - Sometimes, flat objects such as belts produce characteristic **tramline contusions** manifesting as two parallel linear contusions separated by a relatively pale, undamaged section of skin. Occasionally, rod-shaped objects may also be responsible. They occur because at the site of impact the blood is squeezed out from vessels without any leakage (due to lack of damage to the vessel walls), while, at the edges, the vessel walls are torn because of stretching; as a result there is leakage of blood.

| Fig. 9.8 Patterned Contusion—Beating with a Chain *(Pic : Dr Shashidhar C Mestri)* |

- The size of a contusion may roughly correspond to the object causing it. This may give some clue regarding the weapon employed. Thus a contusion caused by a stick is longer than it is broad. Its width usually corresponds to the diameter of the stick. With lapse of time however, the contusion may appear larger in size than it originally was, due to continued extravasation of blood and development of oedema.
- **Artificial bruise**: It is a lesion that is produced by applying the juice of an irritant plant, e.g., calotropis, marking nut, etc. Though it has the superficial appearance of a bruise, and may be deliberately induced by a person on himself to substantiate a false allegation of assault against another person, it can be differentiated from a true bruise by the presence of blisters which are invariably present.

Repair and Healing

- After a lapse of some time, the red blood corpuscles in a bruise will begin to disintegrate by haemolysis, liberating haemoglobin, which in turn

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gets broken down into haemosiderin, haematoidin and bilirubin, by tissue enzymes and histiocytes. These pigments impart certain colour changes to a bruise which can be visualised, especially in the case of fair complexioned individuals.

- To begin with, the injury is red in colour.
- It turns bluish in a day.
- Brownish over the next 3 days (due to haemosiderin).
- It turns greenish over the subsequent 3 days (haematoidin).
- Yellowish in the final 2 days (bilirubin).
- At the end of a fortnight, the original normal colour of the skin is restored, since these pigments get removed by phagocytosis.

  In subconjunctival haemorrhage, due to diffusion of atmospheric oxygen, these colour changes may not be noticeable.

- Postmortem lividity (hypostasis) in the early stages can mimic a contusion, posing problems in medicolegal interpretation. The important differentiating points are summarised in Table 9.1.
- Contusions can be produced after death, and are referred to as **postmortem contusions** (Fig. 9.9). This is particularly likely when moderate force is applied over those areas where the skin is immediately subjacent to underlying bone (e.g., forehead). A severe blow to the body within a few hours of death can produce contusions in other parts of the body also, especially over an area of postmortem lividity. However, such contusions are devoid of swelling, and do not demonstrate inflammatory reaction. Their edges appear sharply demarcated.

Medicolegal Significance

1. A contusion can give some clue about the contact of a body with a blunt object, and depending on the site of occurrence, to the nature of crime (e.g., contusions in and around the nose and lips suggest smothering). However, a contusion need not necessarily indicate the exact site of contact with a blunt weapon, since it can appear at an area remote to the application of force.

Fig. 9.9 Postmortem Contusion

Table 9.1 Differences Between Bruise and Postmortem Lividity

	Bruise	Postmortem lividity
1. **Cause**	Rupture of vessels and extravasation of blood	Engorgement of vessels due to pooling of blood
2. **Site**	Anywhere in the body	Only in dependent parts
3. **Surface**	Elevated	No elevation
4. **Colour**	Variable, depending on the age	Normally purple
5. **Incision**	Shows extravasated blood in the cut tissues which cannot be washed off	Blood oozes out of cut vessels which can be easily washed off
6. **Histology**	Signs of inflammation present	No signs of inflammation

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2. In several cases, the nature of the object used, and the degree of force applied can be reasonably presumed. However, the size of a contusion may be smaller or greater than the weapon producing it.
3. Colour changes can help to deduce the time of occurrence. Contusions of markedly different colours on different parts of the body of the same individual suggest different times of occurrence, and are indicative of chronic abuse (e.g., *battered baby syndrome*). Since contusions sometimes become evident after a delay of variable period, a second examination is always advisable, whether the victim is alive or dead.
4. If there is any doubt as to whether a contusion is antemortem or postmortem in nature, it is imperative that it be subjected to histopathological examination, which will reveal antemortem characteristics such as evidence of vital reaction, if the injury occurred before death.

LACERATION

- It is a type of mechanical injury where there is a rupture or tear of skin or deeper tissues, or both, due to application of blunt force.
- Lacerated injuries are three dimensional with length, width and depth, and often have abraded margins, and irregular, contused edges (**Fig 9.10**).
- Since blood vessels are crushed, bleeding is usually not severe. However, substantial bleeding can occur if blood vessels get torn partially.
- Foreign particles derived from the weapon or impacting surface are frequently present in the wound.
- The interior of the wound contains bridging strands of tissue which can be visualised clearly with a hand lens.
- Depth may not be uniform throughout the injury.

Classification

Lacerated injuries can occur from splitting, stretching, grinding, or compression force. Accordingly they are classified as:

1. Split laceration (incised-looking laceration)
2. Stretch laceration
3. Grind laceration (avulsion)
4. Cut laceration
5. Tear

Split Laceration

- In this type, the skin gets split due to compression between the weapon and underlying bone.
- The edges often appear clean cut on cursory inspection. Hence these injuries are also called **incised-looking lacerations**. However, a hand-lens examination will reveal contusion of edges and bridging of tissues.

| Fig. 9.10 Contused Laceration
(Pic : Dr Shashidhar C Mestri) |

| Fig. 9.11 Split Laceration over parietal region with 'swallow tail' appearance
(Pic : Dr Girish Chandra YP) |

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- Common areas of involvement include scalp, lower jaw, shin, etc.
- A blunt blow over the parietal region may result in a split laceration with the so-called 'Swallow tail' appearance, especially if the impact is over the parietal eminence as the bone at that point has two diverging planes (Fig 9.11).

Stretch Laceration (Fig. 9.12)

- In this type, the skin gets stretched to a breaking point resulting in a laceration at that site. For example, pressure over the thigh which stretches the skin towards the knee can cause a laceration along the inguinal line.
- Ordinarily, unless great force is used, most lacerations require a firm base to act as an anvil for the skin and underlying tissues to be pinned against. But this is not true for a stretch laceration.

| **Fig. 9.12** Stretch Laceration Due to Fractured Humerus *(Pic : Dr Hareesh S Gouda)* |

Grind Laceration (Avulsion) (Fig. 9.13)

- In this type, there is a separation of skin from underlying tissues due to the shearing or grinding action of a weight, e.g., the wheel of a heavy vehicle in a run-over injury.

Cut Laceration

- This type of laceration results from the cutting action of a weapon which is not very sharp, e.g., a broken glass piece.
- It is a lacerated wound with profound and distinct contusion of edges.
- While incised wounds divide hairs cleanly, lacerations cause some hairs to be driven into the interior.

| **Fig. 9.13** Avulsed Laceration Due to Run-Over Injury *(Pic : Dr Prateek Ratsogi)* |

Tear

- As the name suggests, this type of laceration results from tearing of tissues due to a relatively sharp force, which is not sharp enough to incise the tissues.

A simple mnemonic to help remember the 5 important types of **lacerations** is **CATSS**: **C** = Cut; **A** = Avulsion; **T** = Tear; **S** = Split; **S** = Stretch.*

Other Types

- **Patterned laceration** – Lacerations usually do not reproduce the shape of the injuring object. However, rarely the shape is recognisable, as in the case of a hammer blow to the scalp. But, calculation of the exact size of striking surface in such cases can be misleading.
- **Postmortem laceration** – Lacerated injuries may be produced by terrestrial or aquatic animal

**As stated on page 207, the mnemonic to help remember the 4 important types of abrasion is PIGS, and as stated on this page, the mnemonic to help remember the 5 important types of laceration is CATSS. Be an animal lover! They help you remember important points!*

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action (rat, fish, crab, etc.) on corpses. Absence of vital reaction will assist in distinguishing them from antemortem lacerations. The edges may also show characteristic evidence of 'nibbling' or 'gnawing.' A running vehicle or train can cause extensive postmortem lacerations of a dead body lying in its path.

Repair and Healing

- Lacerated wounds often get infected, thus delaying the healing process.
- As they do not exhibit uniform healing pattern, age estimation is difficult and unreliable.
- Healing is by second intention.
  - It begins as phagocytosis to remove debris, followed by filling of the defect by granulation tissue.
  - Specialised tissues lost are repaired, and epithelium regenerated to cover the surface. A permanent scar is therefore inevitable.
  - The time frame will depend upon the extent and severity of the laceration.

Medicolegal Significance

1. Areas of the body that are commonly the site of lacerations are those with underlying bony support, such as over the eyebrows, on the scalp and face, or over knees, shin, etc., whilst they are less common on areas of the body that are softer such as the buttocks.
2. Lacerations are usually accidental or homicidal. Self-inflicted lacerations are uncommon.
3. Foreign particles in these wounds may help to identify the causative object. Grease, mud, etc., may be seen in wounds of traffic accidents.
4. The exact type of lacerated injury may provide a clue to the nature of occurrence.
5. In the case of avulsions, the direction of force can often be ascertained.
6. The site of the injury may provide some clue about the cause of death, e.g., lacerations of internal mucosa of lips may suggest smothering.
7. Lacerated wounds of face constitute grievous hurt because of permanent disfiguration.

INCISION (INCISED WOUND)

- An incision or incised wound is a clean-cut separation of skin or deeper tissues (or both), caused by the sharp cutting edge of an object, without loss of substance (Fig. 9.14).

| Fig. 9.14 Multiple Incised Wounds *(Pic : Dr Pratik Patel)* |

- The commencement of the wound is usually deep, gradually becoming shallower, and finally tailing off towards the end. This tailing of the wound indicates the site of withdrawal of the weapon from the body, suggesting the direction in which the wound was inflicted.
- The wound is generally straight and shows maximum retraction of the edges at the centre. In other words, the wound "gapes," because of which the width of the wound is greater than the width of the weapon causing it (Fig. 9.15). The gaping is more if the incision is made at right angles to the "lines of cleavage" (*lines of Langer*), and much less if it is parallel to these lines (Fig. 9.16).
- The edges of the wound are clean cut and may be everted. Ordinarily there is no bruising of the margins.
- An incised wound is necessarily longer than it is deep. In fact, the length is the greatest of the three dimensions (length, breadth/width, depth).
- It bleeds freely, as blood vessels are cleanly cut and not crushed.

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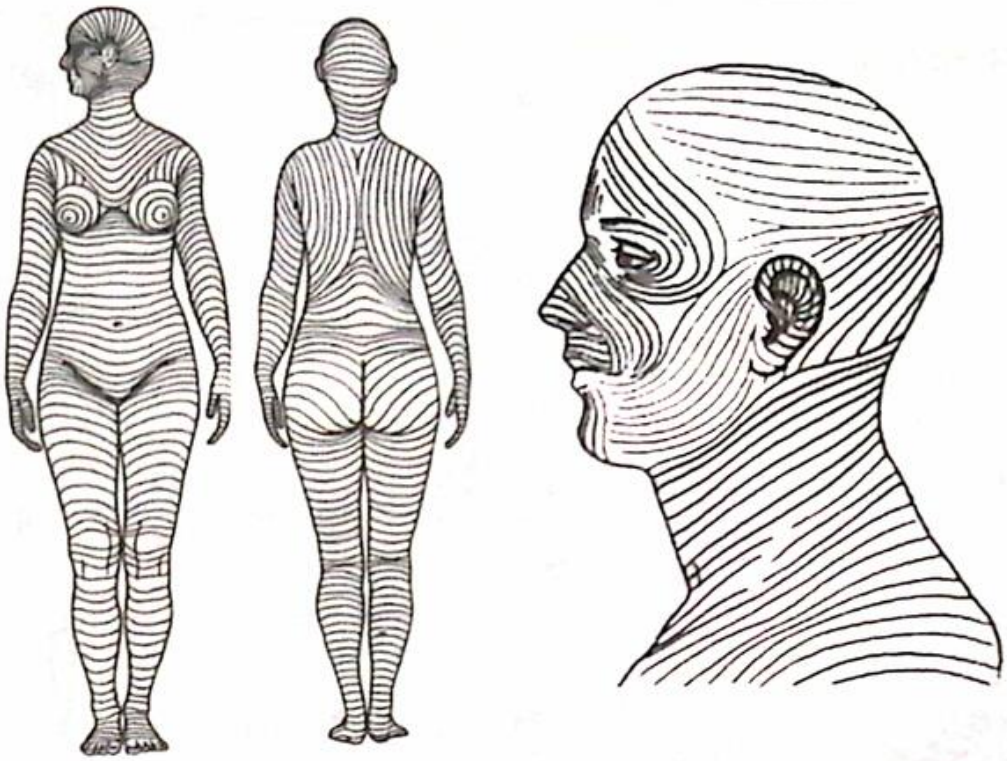

| Fig. 9.16 Lines of Langer *(Fig : Dr Rohan Monis)* |

| Fig. 9.15 Incised Wound of Neck with Gaping *(Pic : Dr Shashidhar C Mestri)* |

Classification

- An incision produced by a light cutting weapon is smooth with minimal bruising of margins. Heavy cutting weapons such as an axe or cleaver produce distinct contusion of the edges, and the resulting injury is sometimes referred to as a **chop wound** (Fig 9.17).
- Incised wounds produced over wrinkled skin may appear as lacerations, due to irregularity of edges, e.g., in the scrotum. A hand lens examination will help to differentiate them as incised wounds. Such wounds are sometimes called **lacerated-looking incised wounds**.

| Fig. 9.17 Chop Wound Over the Head with Claw Hammer |

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Repair and Healing

- In the case of an incised wound with very little damage to tissues on either side of the cut, healing occurs without delay, if the edges are apposed properly.
  - Small blood vessels which are cut get occluded by thrombosis. Fibrin precipitated locally will then link the two edges. Coagulated blood on the surface forms a scab and helps to keep the wound clean. This occurs within 12–24 hours.
  - Over the next few days, capillaries proliferate to bridge the gap, and fibroblasts secrete collagen.
  - In 3–5 days, vessels are thickened, and many of them get obliterated, which is followed by scar formation. This is usually complete by about the 6th day.
  - The scab over the wound then falls off, leaving behind a soft, tender, reddish scar, which in the course of weeks or months becomes whitish and firm.

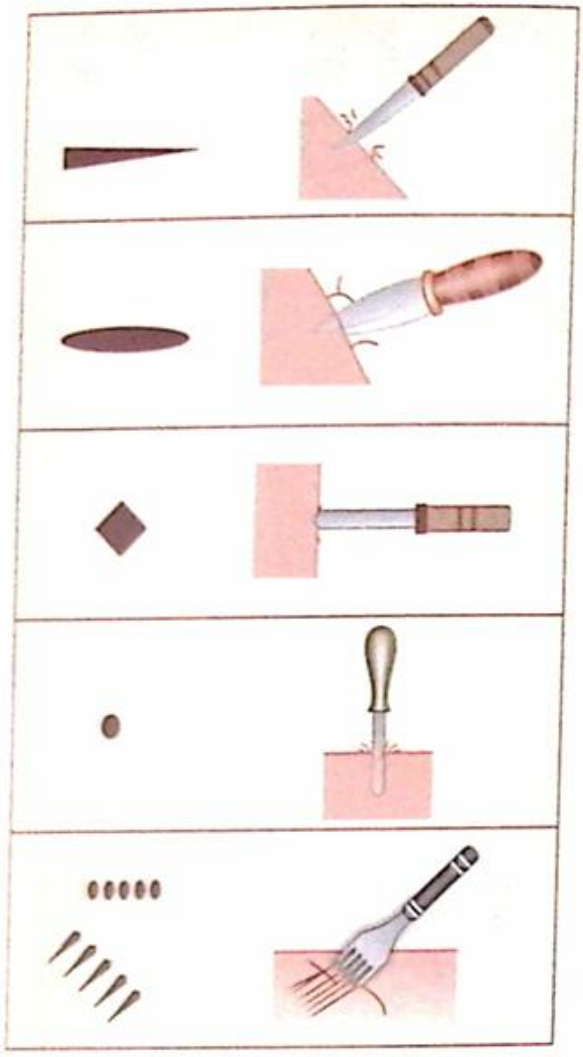
Infection can however delay the healing process.

Medicolegal Significance

1. Incised wounds invariably point to the use of a cutting weapon (light or heavy).
2. The length, width, or depth of an incised wound usually do not correspond to the length, thickness or width of the cutting object.
3. Tailing gives an indication of the direction of movement of the cutting edge.
4. The site may suggest the possible motive, intent, or even the mental status of the assailant. For example incised wounds concentrated over the genital area reveal a sex-related motive. Homicidal incised wounds sometimes suggest the disturbed mind of the assailant, which may vary from cold fury to irrational psychosis.

STAB (PUNCTURE)

- Stab wounds are piercing wounds produced by sharp-pointed objects (e.g., knife, dagger, ice pick, fork, spear, sharpened bamboo stick, etc.) (Fig. 9.18).



| Fig. 9.18 Different Shapes of Stab Wounds Produced by Different Types of Weapons *(Fig : Dr Rohan Monis)* |

- The depth is necessarily greater than the surface length. In fact, it is the greatest of the three dimensions (length, breadth width, depth).
- Stab wounds are divided into:
  - **Penetrating wounds**, if they *terminate* in tissues, organ, or cavity
  - **Perforating wounds**, if they *transfix* them (through-and-through wounds). For example stab wound piercing an upper arm completely, so that it goes in on one side, and comes out on the other side.
    - In the former, there is only one surface wound, while in the latter, there will be two separate surface wounds, one caused by the *entry* and the other by the *exit*.

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| Fig. 9.19 Elliptical Stab Wound
(Pic : Dr Jagadish Rao PP) |

- External bleeding may be slight, but internal bleeding can be very profuse.
- In perforating wounds, the wound of entry is usually larger than the wound of exit, because weapons used for stabbing usually taper towards the tip.
- The edges of the wound of entry are inverted, while they are everted in the wound of exit. Clothes may be pushed into the wound of entry.
- The direction in which the wound has been inflicted can be deduced by joining the wounds of entry and exit.

- **Incised-stab wound**: Starts as an incised wound and ends as a stab wound when there is a sudden thrust at the termination of the incised wound, or conversely, begins as a stab wound, and becomes an incised wound as the knife is pulled out with a little bit of dragging.

Medicolegal Significance

1. The external appearance of a stab wound may sometimes give a clue regarding the kind of weapon used in inflicting it. Thus, a knife which has one sharp edge and a thicker, blunt edge, produces a wound which is usually wedge shaped. On the other hand, a double-edged weapon such as a dagger will usually produce an elliptical wound (Fig 9.19).
2. The terminal ends of the injury may be sharp cut, square shaped, or rounded. If both ends are sharp-cut, in all probability the weapon used was a double-edged one, even though a single-edged weapon can sometimes produce such an appearance due to splitting, or if the weapon possesses a curved beak. It can also occur if a single-edged weapon is tilted while being withdrawn. Bruising around the stab wound may indicate that the weapon had been inserted up to the hilt.
3. A round, pointed object such as a spear often produces a circular stab wound. A pointed weapon that is square-shaped in cross section, may produce a cross-shaped stab wound. Stabbing with a fork produces clusters of 2 or 3 small puncture wounds, depending upon the number of prongs on the fork. Small, slit-like stabs are produced by stabbing with a screw driver.
4. A stab injury may not produce significant external bleeding, especially when the wound has entered a body cavity (Fig. 9.20). But there may be extensive internal bleeding which can rapidly lead to death.
5. If the weapon used to stab enters the skin obliquely, the edge of the wound on the side from which the weapon has entered becomes "bevelled," while the other edge overhangs the wound. From this, the direction in which the wound was

| Fig. 9.20 Multiple Stab Wounds of Abdomen with Little External Bleeding
(Pic : Dr Shashidhar C Mestri) |

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inflicted may be ascertained. In the case of perforating stabs, direction is more easily ascertained, as the exit wound is invariably smaller than the entry, and appears everted.

6. The depth of the wound may give an indication of the minimum length of the weapon used, provided the entry wound and the termination of the wound track are situated in non-yielding areas. If the punctured wound has made an entry through a yielding site (e.g., abdominal wall), or ends up in a cavity or a collapsible organ (e.g., lung), the deduction of depth becomes a matter of conjecture. The depth of the wound can be greater than the length of the weapon over yielding sites such as abdominal wall due to the compression of the wall downwards during the thrust, and its subsequent return to the normal position when the pressure is withdrawn. Similarly, collapse of lungs after sustaining stab injury over the chest (particularly on the front or lateral sides) may lend itself to wrong interpretation of the length of the weapon, since the distance between the chest wall and surface of lungs will be increased due to collapse.
7. The length of the entry wound may be equal to the breadth of the stabbing weapon. However, it is usually lesser by 0.2 to 0.3 cm if the skin is elastic, while it may be greater if rocking of the object occurs during the course of stabbing. The width of the entry wound is usually greater than the thickness of the weapon, due to gaping.
8. Stab wounds may be homicidal, accidental, or suicidal. The presence of such wounds in inaccessible parts can help to exclude suicide. Also, suicidal stabs are usually single, and located characteristically on the left side of the chest.
9. In some cases of stab homicides, the stabbing may have been done through a natural orifice (ear, nostril, vagina, rectum), or in unusual locations (axilla, nape of the neck) in order to conceal its presence. Such stabs are referred to as **concealed puncture wounds**.

FRACTURE

- This is a type of injury that is almost always associated with a bone or tooth, and not with any other tissue or organ. Fracture of a bone or tooth is defined as breakage due to direct or indirect force.
- The term "fracture" is not used when a cartilage, ligament or tendon is affected, owing to lack of osseus tissue. The correct term would be a "tear" or "rupture."

Classification

Direct Fractures

1. **Focal Fracture**:
   a. Also known as **tapping fracture**, and results from a small force applied to a small area.
   b. It is usually transverse.
   c. Injury to overlying soft tissues is minimal.
   d. Typically seen in regions such as the forearm or leg where two bones lie adjacent to each other, only one of the two bones being fractured, e.g., while warding off blows during an attack.
2. **Crush Fracture**:
   a. It results from application of a large force over a large area, and is typically **comminuted** in type, i.e., fragmented.
   b. Injury to surrounding soft tissues is usually extensive.
   c. If two bones lie adjacent to each other, both are involved, e.g., bumper fracture of the tibia and fibula in a pedestrian who has been hit by a car.
3. **Penetrating Fracture**:
   a. It results from application of a large force over a small area.
   b. Bullet injury to a bone is a classical example of this type of fracture.

Indirect Fractures (Fig. 9.21)

1. **Traction Fracture**:
   a. It results when a bone is pulled apart by traction, e.g., transverse patellar fracture due to violent contraction of quadriceps. It is also referred to as an **avulsion fracture**.
2. **Angulation Fracture**:
   a. It occurs due to bending of a bone. The concave surface of the bend is compressed, while the convex surface is put under traction resulting in breakage.

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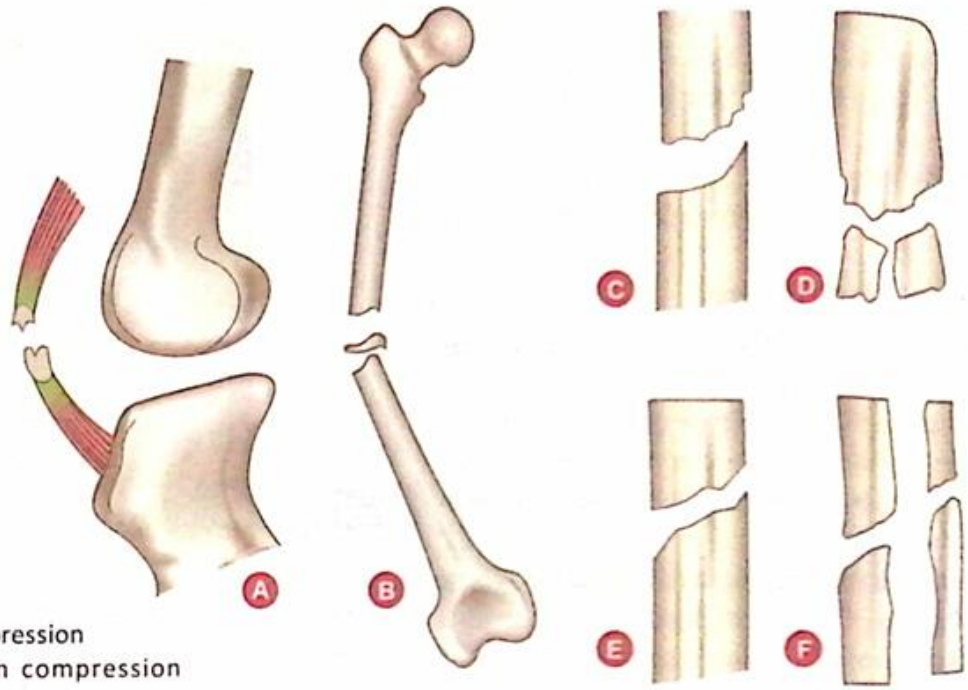

A—Traction
B—Angulation
C—Rotational
D—Vertical compression
E&F—Angulation compression

| **Fig. 9.21** Indirect Fractures *(Fig : Dr Joseph T John)* |

3. **Rotational or Spiral Fracture:**
   a. Here the bone is twisted to produce a spiral fracture.
4. **Vertical Compression Fracture:**
   a. In this type, there is an oblique fracture of a long bone such that the hard shaft of the bone is driven into the cancellous portion.
   b. It is sometimes encountered in the distal femur of a front seat passenger of a vehicle when there has been a collision, and his knee has impacted violently against the dashboard.
5. **Angulation-Compression Fracture:**
   a. Here, the fracture line is curved, with an *oblique* component due to compression, and a *transverse* component due to angulation.

Other Types

1. **Greenstick Fracture:**
   a. It is an incomplete fracture involving only part of the thickness of a long bone.
   b. It is usually encountered in children whose bones are pliant rather than brittle.
   c. The usual cause is forcible angulation.
2. **Simple and Compound Fractures:**
   a. A simple or closed fracture is one where the overlying skin is still intact.
   b. A compound or open fracture involves tearing of overlying tssues, including skin. The fractured ends often protrude through the defect. Such fractures are more prone for infection.
   c. In the case of the cranium, the term "compound" is used only when the dura is torn. It is not important whether the skin is intact or torn.

Repair and Healing

- Healing of a fracture depends upon the age and nutritional status of the individual. In general, cancellous bone unites faster than cortical bone.
- There are 5 stages involved in the healing process:
  - **Haemorrhagic phase**: There is haemorrhage at the site of fracture.
  - **Proliferation phase**: A collar is formed around the fractured ends by proliferation of cells from periosteum and endosteum.
  - **Callus phase**: Cellular elements give rise to osteoblasts and chondroblasts which produce a matrix of collagen and polysaccharide, impregnated with calcium. This is called "callus." In children, the callus is visible radiologically within 2 weeks of the fracture.

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- **Consolidation phase**: The callus is transformed into mature bone which takes about 4–6 weeks in children, and approximately 3 months in adults.
- **Remodelling phase**: This is the final phase during which the mature bone is remodelled.

Medicolegal Significance

- Fracture of a bone, however trivial, constitutes grievous hurt according to law.
- From a study of the exact type of fracture, an idea about the causative force can be estimated, i.e., whether the force was direct or indirect, rotational or angular, etc.
- The site of fracture may help to indicate the cause of death, e.g., fracture of hyoid bone suggests throttling.
- The time of occurrence of a fracture can be estimated roughly from the stage of the healing process.

BITE MARK

- **Bite mark** is a special type of mechanical injury that results from biting with the teeth, and may be the result of attack by a human or animal.
- It is either a patterned abrasion or a contusion. If it is inflicted with great pressure or force, a laceration can result. It may occasionally involve loss of tissue, e.g., biting off fingers, nose, ears, etc.
- Medicolegally speaking, bite marks are inflicted during an assault *offensively* by the accused on the victim, and *defensively* by the victim on the accused. In sexual crimes, bite marks on the victim may be the offshoot of passion (**love bite**). Even in the case of consensual sex, love bites are common, and may in fact be inflicted by the female partner on the male as frequently as the other way around (Fig. 9.22)!
- Bite marks may also be encountered on inanimate objects such as fruits, cheese, chocolate, etc., left at the scene of a crime by the perpetrator (Fig. 9.23).
- Careful examination of a bite mark can provide evidence to identify the accused. It can be photographed with a scale alongside, enlarged to actual size, and then compared with the bite mark of the accused taken on a dental mould. It is a highly specialized form of analysis, and must be under taken only by a forensic odontologist.

| Fig. 9.22 Love Bite on the Neck of a Male |

| Fig. 9.23 Chocolate with Bite Mark |

- In the case of fresh bite marks, sterile swabs can be applied to the site and subsequently tested for blood grouping or DNA profiling.

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CHAPTER 10

Firearm and Explosive Injuries

A cartridge case at the scene of offence could prove as incriminating as if the murderer had left his visiting card.
—**Sir Sydney Smith** (1883-1969; Scottish Forensic Pathologist)

PART 1

FIREARM INJURIES

Introduction

Ballistics

- **Ballistics** is the science dealing with the study of firearms and ammunition. It includes the study of the effects of discharging a firearm, projectile motion, and factors affecting the efficacy of firing. While a detailed knowledge of these is not essential for a forensic pathologist, he must nevertheless acquire an elementary knowledge of firearms for proper interpretation of the wounds caused by them.

Sub-divisions

1. **Proximal (Internal) Ballistics**: The study of firearms and projectiles is called proximal ballistics.
2. **Intermediate (External) Ballistics**: The study of the motion of a projectile after being ejected from the firearm till the time it hits the target is termed as intermediate ballistics.
   Terminal (Wound) Ballistics: The study of injuries produced by firearms is referred to as terminal ballistics, and is the exclusive realm of a forensic pathologist.

Proximal Ballistics

- In simple terms, a **firearm** is a mechanical device equipped to create an explosion, which in turn forces out a projectile at high velocity in order to hit a target.
- The term **ammunition** refers to the materials used for causing the explosion, along with the projectile. One complete round of ammunition is called a ***cartridge***.
- The projectile is pushed out through a cylindrical tube which is called a ***barrel***.
  - If the barrel is grooved internally, it is a ***rifled firearm***
  - If not, it is a ***smooth-bore firearm***.

Cartridge

- A cartridge consists of an outer ***case*** in which the explosive is stored together with the chemicals required to ignite it, and the ***projectile***. The explosive is called ***propellant*** or ***gun powder***, while the igniting chemical is called ***detonator*** or ***primer***. The projectile is either a ***bullet*** or ***pellets (shot)***. The former is used in **rifled firearms**, and the latter in **smooth-bore firearms**.

Cartridge = Case + Detonator + Propellant + Projectile

- **Cartridge Case** (Figs. 10.1a & 10.1b)
  - In rifled firearms, the cartridge case is made of an alloy of copper and zinc, while in smooth-bore firearms it is made of a special type of paper or cardboard.
  - In both types the shape is cylindrical. One end of the case is closed with a

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plate of brass and is called the base, while the other end is open.

- The cartridge case helps not only to keep the contents in place, but also provides a water-proof cover for them and protection against deterioration.
- The base is rimmed in revolver cartridge, but grooved in pistol and automatic firearm cartridges **(Fig. 10.2a & 10.2b)**.

- **Detonator**
  - It is also known as "**primer**."
  - Common ingredients comprise mercury fulminate (or lead azide), potassium chlorate, and antimony sulfide. These chemicals are capable of rapid combustion.
  - They are stored in a small compartment attached to the base of the cartridge case called ***percussion cap*** which is made of copper. Hence the detonator is also known as ***cap composition***.
  - In most of the cartridges the percussion cap is situated near the centre of the base, and are therefore referred to as ***centre fire*** cartridges, while in a few the whole of the base acts as a percussion cap and are known as ***rim fire*** cartridges
- **Propellant (Gun Powder)**
  - This is situated in close proximity to the primer within the cartridge case.
  - There are three types of gun powder – ***black powder***, ***semi-smokeless powder***, and ***smokeless powder***.
    - Black powder is a mixture of 75% potassium nitrate, 15% charcoal and 10% sulphur.
    - Smokeless powder consists of nitrocellulose alone (*single base*), or nitrocellulose combined with nitroglycerine (*double base*).
    - Semi-smokeless powder consists of 20% smokeless powder and 80% black powder.
  - While all types of gun powder produce smoke, the smokeless variety does not produce as much smoke as black powder, and is the most effective type being capable of imparting higher velocity to the projectile.
  - The ignited primer causes combustion of gun powder by which hot gases under tremendous pressure are produced within the closed confines of the cartridge, propelling out the projectile with great velocity.
  - A single grain of black powder can produce 200 to 250 cc of gas composed of carbon monoxide, nitrogen, hydrogen, hydrogen sulphide, and traces of methane and oxygen, while a grain of smokeless powder can generate 800 to 900 cc of gas.
- **Projectile**
  - This is usually either a ***bullet*** or a bunch of ***pellets*** (***shot***) **(Fig. 10.3)**. The former is used in rifled firearms, while the latter is used in smooth-bore weapons.
  - Firearms meant to propel projectiles of less than one-inch diameter are called ***small arms***. They may be hand operated, i.e., ***hand arms*** (e.g., pistol and revolver), or they may be placed against the shoulder and fired, i.e., ***shoulder arms*** (e.g., rifle, musket, shotgun, etc). Hand arms are also referred to as ***side arms***. In ***country-made firearms***, unusual projectiles are often used, e.g., pieces of glass, cork, wood, nails, stones, etc.
  - Normally, a bullet is held in the cartridge case by a groove called *cannelure*. As a result of the pressure generated by gases, the bullet gets released, and is pushed through the barrel and out of the muzzle with great velocity.
  - Bullets are usually made of lead with a coating of cupro-nickel alloy. They are invariably conical in shape, in order to offer least resistance while travelling through air. The tip of a bullet is referred to as its *nose*.

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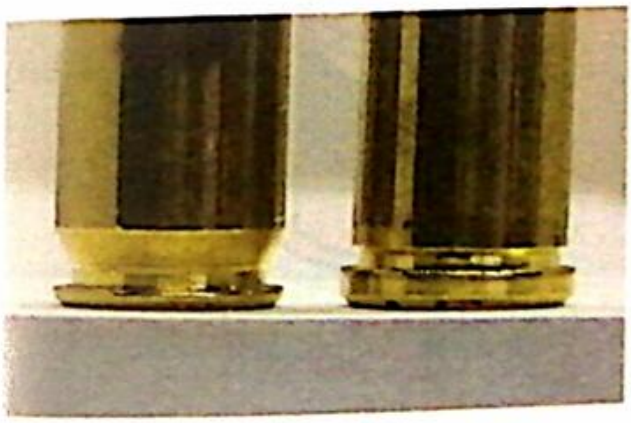
| Fig. 10.1a Pistol & Rifle Catridges |

| Fig. 10.1b Shotgun Catridges |



| Fig. 10.2a Revolver Cartridge–Rim |

| Fig. 10.2b Pistol Cartridge–Groove |

| Fig. 10.3a Bullets |

| Fig. 10.3b Shotgun Pellets–Different Sizes |

Plate 10.1

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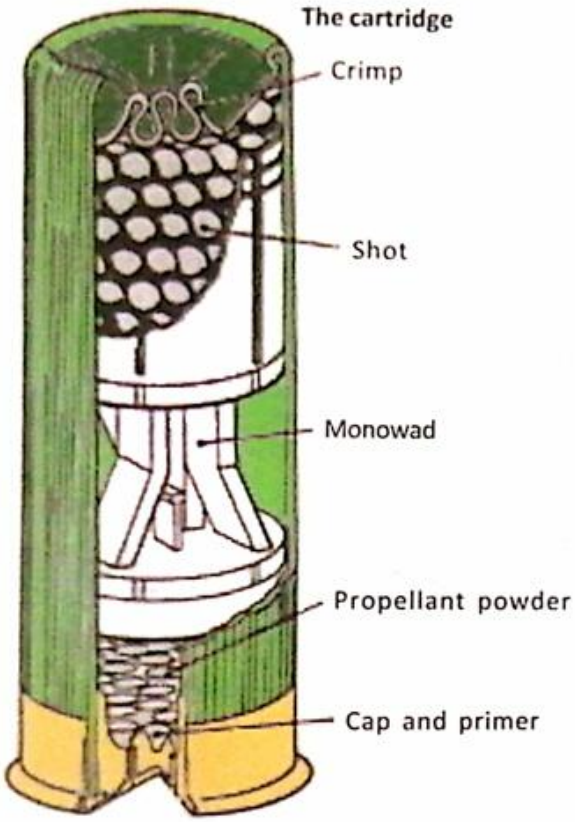
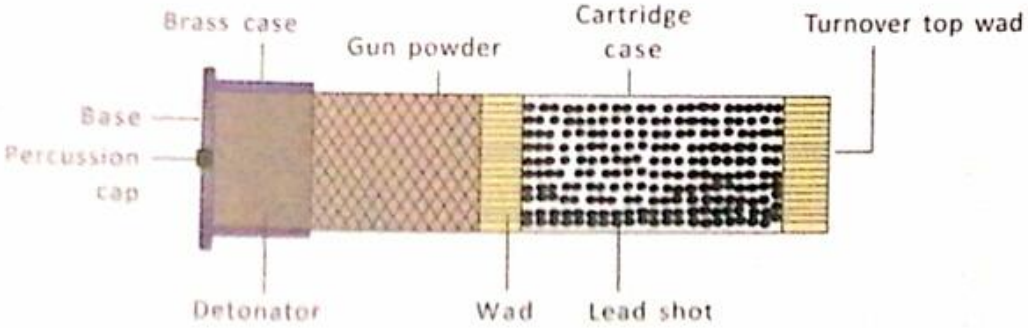
- Depending upon the size of the bullet, it can be short, medium or large, and as per the shape of the nose, it can be flat nosed, round nosed, hollow nosed or point nosed.
- Pellets used in smooth-bore firearms are collectively referred to as ***shot***. Sometimes ***slugs*** may be used instead, which are much larger. A flat felt-disc or compressed paper or cardboard called *wad* lies between the pellets and propellant. It is often called *underwad*. There is another wad, termed the *turnover wad* or *top wad*, situated over the lead shot, the purpose of which is to keep the shot in place. Wads not only hold the pellets and gun powder tightly in place, they also act as a piston sealing the bore effectively, thus preventing the expanding gases from escaping. This is known as *obturation* or *sealing* of the bore which is of vital importance. In order to lubricate the bore, wads are often impregnated with grease. In modern ammunition, plastic is being used increasingly commonly, and some of the older constituents are no longer present.

- Once a firearm has been discharged, the empty cartridge case is left behind in the chamber devoid of projectile, but with residues of primer and detonator still present. This is called ***spent cartridge***. The spent cartridge has to be extracted from the chamber manually, or it may get ejected automatically (as in automatic firearms).
- Figs. 10.4 and 10.5 show the longitudinal section of shotgun and rifled firearm cartridge respectively.



| Fig. 10.4a Longitudinal Section–Shotgun Cartridge |



| Fig. 10.4b Longitudinal Section of Shotgun Cartridge |

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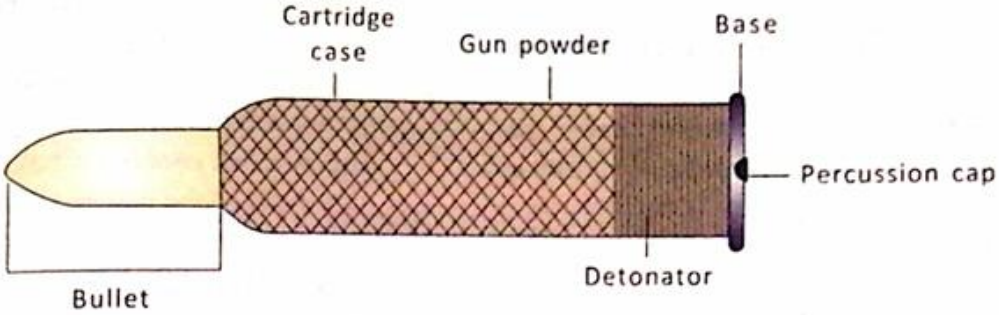
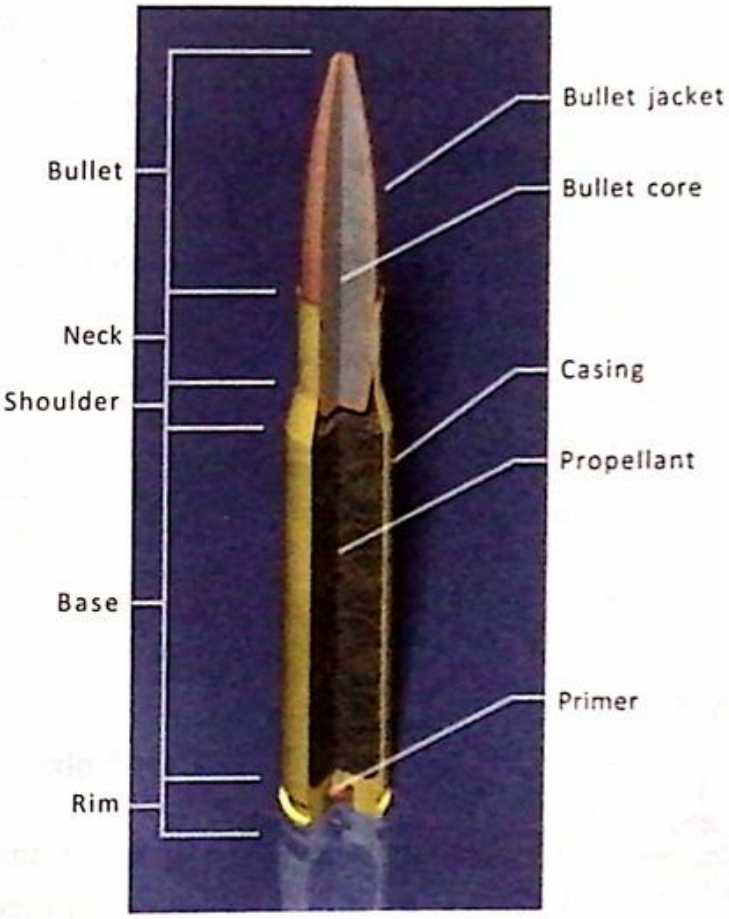


| Fig. 10.5a Longitudinal Section of Rifled Firearm Catridge |



| Fig. 10.5b Longitudinal Section–Rifle Cartridge |

earm (Figs 10.6 to 10.8)

Every firearm has a ***chamber*** in which the cartridge is normally lodged. The chamber leads into a hollow steel tube called the ***barrel***. The projectile released from the cartridge in the chamber is forcefully pushed through the barrel by the expanding gases produced by the explosion of gun powder.

The proximal end of the chamber has a minute hole, through which a ***pin*** moves forward to strike the base of the cartridge. This striking action produces heat which ignites the primer. This pin, known as ***firing pin***, is activated by a spring connected to a trigger mechanism. The spring is released on pulling the ***trigger***. The part which incorporates the firing pin, spring, and trigger is called the ***bolt***.

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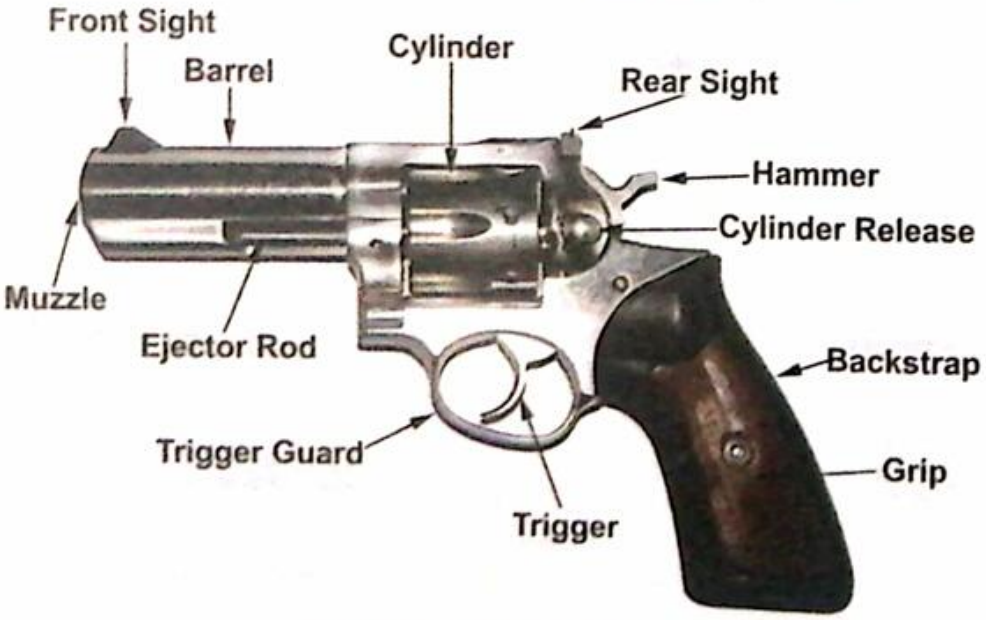
- **Barrel**
  - It is a steel tube of varying length, and may be single or double.
  - The ***chamber*** constitutes the rear end of the barrel, and lodges the cartridge. This part is called the ***breech***.
  - The front (distal) end of the barrel which is open to the exterior, is called the ***muzzle***.
  - The term ***bore*** refers to that part of the barrel through which the projectile makes its exit.
  - The barrel may measure anything from 2.5 cm (1 inch) to 90 cm (3 ft). The tapering portion connecting the chamber with the bore is called the ***leed*** (***taper***).
  - In rifled firearms, the interior of the barrel is scored by a number of parallel, spirally twisted grooves called ***rifling***, whereas in smooth-bore weapons the interior surface is smooth. The rifling may be either clockwise or anti-clockwise. A cross section of a rifled bore would reveal a series of elevations alternating with depressions (corresponding to the grooves). The former are called ***lands***. The bullet is squeezed between the lands as it travels through the bore and since rifling is spiral, it imparts a spin or rotation to the projectile by which it acquires a gyroscopic steadiness, preventing it from wobbling.
  - In some smooth-bore firearms, the barrel becomes narrower towards the muzzle end. This is called ***choking***. Choking minimises dispersion of the pellets after they emerge from the barrel. Depending upon the extent of narrowing, it may be either a *full-choke* bore or a *half-choke* bore.
    - A barrel that is not choked is called ***cylinder bore***.
    - In some firearms (**paradox guns**), the bore is only partly smooth, while the remaining part is rifled.
  - If loading of a cartridge is done through the muzzle end of a firearm it is called a ***muzzle loader***, and if it is done through the breech it is a ***breech loader***.
- **Bolt**
  - This is also called ***block*** and is situated towards the breech end of the barrel. As described earlier it consists essentially of a trigger, which when pulled releases the spring to activate the firing pin, which quickly moves forward to strike the base of the cartridge inside the chamber.
  - The trigger is usually surrounded by a trigger guard to prevent accidental firing.



| Fig. 10.6 Parts of a Revolver |

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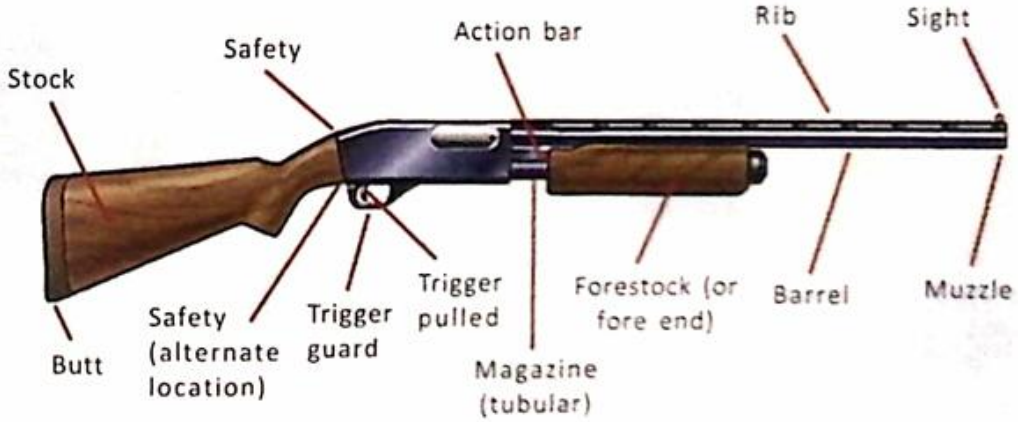
| Fig. 10.7 Parts of an Automatic Rifle |

Parts of a pump-action shotgun

Shotgun is another long-barreled firearm which is used by hunters. Below are the parts of a commonly used shotgun, the pump-action shotgun.



| Fig. 10.8 Parts of a Shotgun |

- In addition, there is a ***safety catch*** which prevents the gun from discharging even when the trigger is accidentally pulled.
- The block also contains an ***extractor*** to remove the spent cartridge, and is fashioned into a grip or butt around the trigger mechanism, for holding the firearm.
- The block can be opened to insert a fresh cartridge into the chamber manually or automatically.
    - In **automatic firearms**, the cartridges are arranged one below the other to form a ***magazine***, which is attached to the block. If the trigger is pressed and the pressure is sustained, it will cause the continuous release of all the cartridges from the magazine until the latter becomes empty.
    - In **semi-automatic firearms**, only one cartridge at a time is released each time the trigger is pulled.
    - In **non-automatic firearms**, the spent cartridge has to be extracted manually each time after firing.

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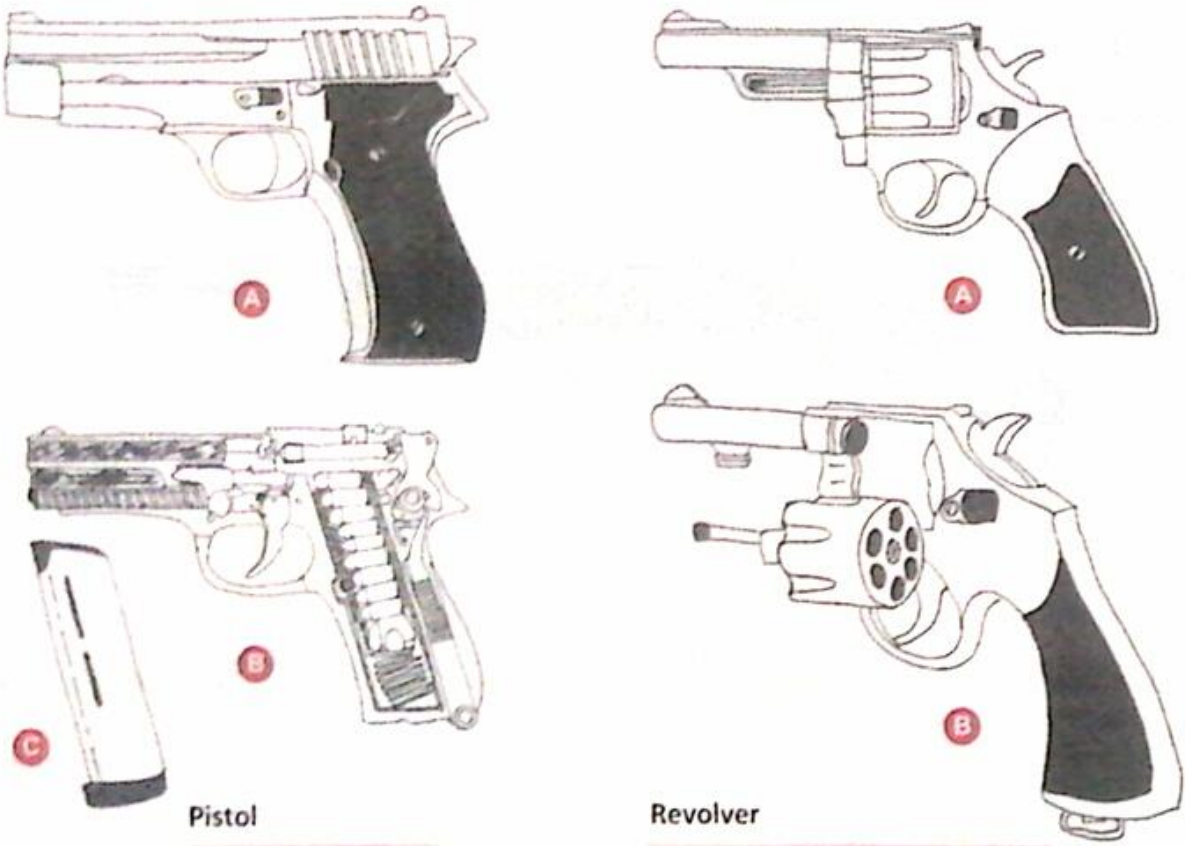
- **Classification of Firearms** (Plate 10.2)
  1. **Rifled firearm**
     - *a. High velocity:*
       - i. Shoulder arms – e.g., rifle
       - ii. Automatic weapons - e.g., machine gun, sub-machine gun, Sten gun, assault rifle, etc. Assault rifles are selective-fire rifles* that use an intermediate cartridge (i.e., more power than a pistol but less than a standard rifle) and a detachable magazine. Assault rifles were first used during World War II. By the end of the 20th century they had become the standard weapon in most of the world's armies, replacing semi-automatic rifles, battle rifles and sub-machine guns in most roles. Examples include the StG 44, AK-47 and the M16 rifle. The last mentioned was extensively used by the Americans in the Vietnam War.
     - *b. Low velocity:* hand arms – e.g., revolver, pistol (Fig. 10.9)
  2. **Smooth-bore firearm (Shotgun)**
     - *a. Single barrelled* or *double barrelled*



Pistol

A. Exterior view
B. Interior view
C. Magazine

Revolver

A. Exterior view
B. Exterior view with magazine disengaged

| Fig. 10.9 *(Fig : Dr Rohan Monis)* |

**A selective-fire firearm has at least two firearm modes, which are activated by means of a selector: burst fire mode, which limits the maximum number of shots fired automatically, and fully automatic fire mode which enables continuous firing until either the feeding mechanism is emptied or the trigger is released.*

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(a) Rifle

(b) AK-47 Automatic Rifle

(c) M16 Assualt Rifle

(d) The Editor (Dr Pillay) trying out an M16

Plate 10.2 Firearms *(contd. next page)*

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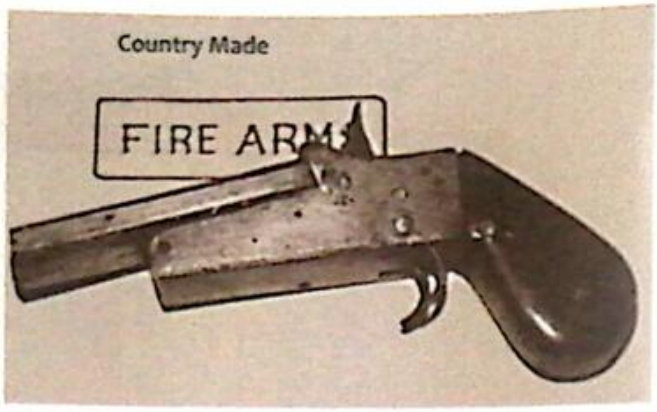
(e) Double-barrelled shotgun



(f) Typical country-made firearm
(Pic : Dr Shashidhar C Mestri)

(g) Airgun

Plate 10.2 Firearms

b. Breech loader or *muzzle loader*

c. Cylinder bore or *choke bore*

3. **Air or gas operated firearm**: Generally referred to as airguns, since most often compressed air is used to propel a projectile (usually ball bearings or pellets); these weapons are by no means innocuous as generally believed. Fatalities have been reported.
4. **Country-made firearm**: Quite common in several rural parts of North India and some southern states. They are crude, smooth-bore weapons, but can be lethal. The ammunition is usually loaded through the muzzle end of the barrel.

- **Calibre**
  - The ***calibre*** of rifled firearms is usually expressed in terms of the inner diameter of the barrel, in fractions of an inch. Thus, we have the 0.303 and 0.22 rifle, meaning that the calibre is 0.303 of an inch and 0.22 of an inch respectively. The measurement is made between two diametrically opposite lands and not between grooves (Fig. 10.10).
  - The ***calibre*** (or ***gauge***) of a shotgun is expressed in terms of the number of balls of lead which can be made out of 1 pound (450 g) of the metal, so that each fits exactly into the bore of the weapon. If 12 balls of the same size can be accommodated, the calibre is referred to as **12 bore**. The other commonly available calibre of shotgun is **16 bore**. The actual calibre (in terms of inner diameter of the barrel) of a 12-bore gun is 1.850 cm (0.729 inch) while that of a 16-bore gun is 1.685 cm (0.663 inch).

Intermediate Ballistics

This is not very important for a forensic pathologist, and is the specialised field of a ballistics expert.

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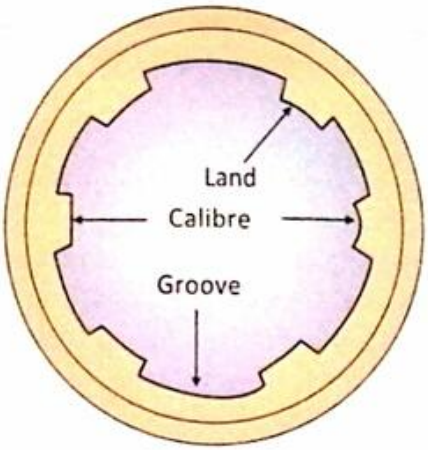


| Fig. 10.10 Calibration of Rifled Firearm (Fig : Dr Rohan Monis) |

Terminal Ballistics

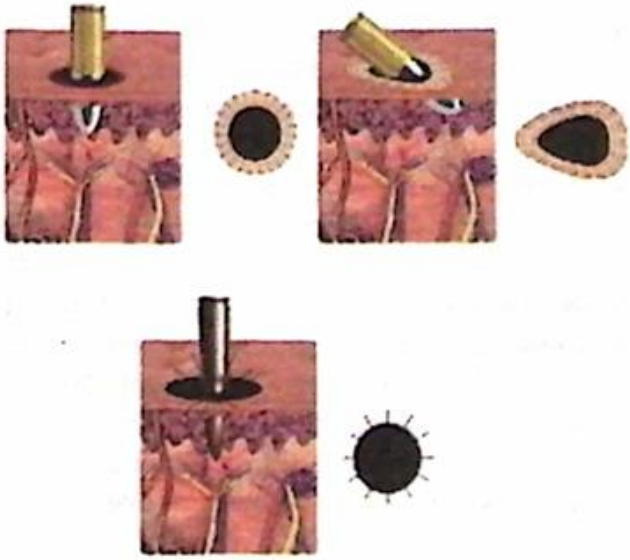
Forensic pathologists must have a thorough knowledge about terminal ballistics, which deals with the injuries resulting from firearms.

- The wound produced by a projectile (*bullet* or *shot*) as it enters the body is called the ***entry wound***, and that by which the projectile leaves the body is the ***exit wound***. The path traversed by the projectile between the entry and exit wounds is called the ***track***. Exit wound is generally absent in the case of shotgun injury, except in the region of the head.

Rifled Firearm Injury

Entry Wound (Fig. 10.11)

- The distance between the muzzle end of the firearm & the target is called the ***range***. This may be
  - ***Contact range***, if muzzle end is in contact with body
  - ***Close range***, if the range is within the distance travelled by flame
  - ***Near range***, if it is within the distance travelled by unburnt or partially burnt gunpowder, and
  - ***Distant range***, if it is beyond the range of flame, smoke, and gunpowder particles.
- During the bullet's attempt at perforating the skin while entering, due to the spin, the edge of the entrance wound may be abraded in the form of a collar, which is termed the ***abrasion collar*** or ***areola*** (Fig 10.12). In some cases there is contusion instead of abrasion, in which case it is more appropriately called the ***contusion collar***. The diameter of the entry hole together with the abrasion collar may give the approximate diameter of the bullet.



| Fig. 10.11 Shape of Entry Wound Depending on angle of Bullet Entry |

| Fig. 10.12 Rifled Firearm Entry Wound Showing Abrasion Collar |

- The barrel of a firearm is generally lubricated between use. When such a weapon is fired, the bullet as it is propelled through the barrel, would

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naturally carry this lubricant (grease) on it, which subsequently gets deposited on the skin around the entrance wound. The spin of the bullet causes wiping of its surface on the skin while entering. This is called the ***grease*** (or ***dirt***) ***collar***.

- The abrasion and grease collars normally measure only about 0.3 to 0.7 cm.
- When both abrasion and grease collars are present, the grease collar is seen as the inner zone, while the abrasion collar constitutes the outer zone.
- Burning (***scorching*** or ***singeing***) of skin and hair result from the flame that emerges from the muzzle, at the time of firing. Clothing around the entry wound may also show evidence of burning.
- ***Tattooing*** (***peppering*** or ***stippling***) results from grains of gunpowder being driven into the skin, each grain acting as a minute missile. Tattooing is seen on the skin as small, discrete, black specks which cannot be wiped off. The extent of tattooing will depend on the calibre of the weapon, the type of powder used, and the range. Tattooing may be absent if firing has taken place through clothing.
- ***Blackening*** **or** ***smudging*** results from a superficial deposit of smoke on the skin. In other words, it is only a carbonaceous deposit on the skin, and hence can be easily removed by wiping with a wet sponge. The intensity of smudging will depend on the calibre of the weapon, the type of powder used, and the range. Thus, the greater the calibre of the weapon, the wider the area of blackening and vice versa. Similarly, if black powder is used, the blackening will be more clearly visible, than if smokeless powder had been employed. Smudging may be absent on skin if firing has taken place through clothing. The presence of blackening, especially when smokeless powder has been used, may not be clearly visible to the naked eye. In such cases, infrared or ultraviolet photography will help to visualise it.
- Since carbon monoxide is evolved on explosion of gun powder, the presence of this in the blood of the injured tissues at the entrance wound imparts a cherry red colour to the tissues.
- A ***lead ring*** or ***metal ring*** around the entry wound results from the deposition of very small quantities of lead or other metal in the form of a ring or collar, as the projectile enters the skin. The lead ring can be appreciated radiologically or by neutron activation analysis.
- Firearm wounds are generally easily recognised as such. But sometimes wounds caused by red hot pokers or a burning pointed stick may simulate bullet entry. However in these wounds, there will be no evidence of tattooing or cherry red colour. Conversely, glancing injuries caused by rifled firearms may be confused with incised or lacerated wounds.
- **Contact shot** (Fig. 10.13)
  - The firearm is placed in contact with the skin or clothing, and then fired. It is also known as a ***point blank*** shot.

| **Fig. 10.13** Rifled Firearm Injury (Entry) *(Pic : Dr EJ Rodrigues)* |

  - A contact wound over a dense area such as the cranial vault is generally large and cruciate (cruciform, stellate, or star shaped), due to explosive effects of the gases liberated.
  - The imprint of the muzzle of the weapon may be found stamped on the skin (Fig. 10.14).
  - Burning, blackening (smudging), and tattooing are slight or absent in the adjacent skin, since all the components of the explosion are driven into the wound.
  - The tissues are often saturated with carbon monoxide and therefore cherry red in colour.

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- Cranial contact wounds are generally seen on the forehead or temple.

| Fig. 10.14 Contact Gunshot with Muzzle and Foresight Imprint on Skin *(Pic : Dr Girish Chandra YP)* |

- Contact wounds over thin bone, chest, or abdomen are usually circular in shape, and are surrounded by abrasion or contusion collar.
- The overall diameter of the hole plus the collar represents the approximate diameter of the bullet.
- Surrounding hair is singed.

- **Close shot**
  - It means that the firearm was fired within the range of flame and powder blast, but was not in direct contact with the skin or clothing.
  - Flame travels approximately up to 7.5 cm in the case of revolver or pistol, and 15 cm in the case of rifle. The wound appears as a circular hole surrounded by scorching, singeing, and smudging. These may be absent if firing has occurred through clothing.
  - Abrasion collar, grease collar, and tattooing are also present.

- **Near shot**
  - It means that the firearm was fired outside the range of flame, but within the range of powder blast.
  - The entry wound is circular or oval in shape.
  - Unburnt powder grains and small metallic particles travel approximately up to 60 cm in the case of revolver and pistol, and 75 cm in the case of rifle. In practical situations, tattooing is seen up to a maximum distance of about 90 cm.
  - Singeing of hair and scorching are absent.
  - Smudging can occur up to a range of 30 cm. Beyond this it is not seen.
  - Grease collar and abrasion collar are present.

- **Distant shot**
  - It means that the firearm was discharged outside the range of flame and powder blast.
  - The entry wound is circular with inverted margins.
  - Scorching, tattooing, and smudging are all absent.
  - Grease collar and abrasion collar are present.
  - Distant shot suggests a range beyond self-infliction. The range in any case of gunshot injury can be estimated accurately by test firing, using the same gun and similar cartridge at different ranges, and comparing the effects with the wound present in the victim.

Exit Wound

- Exit wounds vary greatly in size, shape, and configuration. They are usually larger than the corresponding wound of entry.
- Scorching, blackening, and tattooing are absent, as also abrasion and grease collars.

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- Edges are invariably everted. Bullet injury of the head usually causes inward bevelling of the skull at the entry, and outward bevelling at the exit wound.

Salient differences between **entry** and **exit** wounds are mentioned in Table 10.1

Table 10.1 Differences between Entry and Exit Rifled Firearm Injury

Characteristic	Entry wound	Exit wound
Size	Smaller than the diameter of the bullet	Larger
Edges	Inverted	Everted
Abrasion and grease collar	Present	Absent
Burning, blackening, tattooing	May be present	Absent
Bleeding	Less	More
Fat extrusion	Absent	May be present
Cherry red	May be present	Absent
Lead ring	May be present	Absent

Track

- This is the path traversed by a projectile inside the body of a victim of gunshot injury, between the entry and exit wounds.
- In the case of low-velocity weapons, the track can be devious instead of straight.
- An X-ray prior to autopsy will assist significantly in locating bullets or pellets lodged in the body.
- When a projectile traverses through dense tissues such as muscle, liver, or spleen, shock waves are generated causing tissue damage even at a considerable distance away from the track (*temporary cavitation*).

Smooth-bore Firearm Injury

Entry Wound (Fig. 10.15)

- **Contact shot**
  - The contact shot wound in the case of shotguns is usually a large, irregular hole, resulting from the explosive blast effect.

Fig. 10.15 Shotgun Entry Wound with Dispersion of Shot *(Pic : Dr Shashidhar C Mestri)*

  - The edge of the defect is scorched by flame, and the skin surrounding it is blackened by smoke, and tattooed by unburnt powder.
  - An imprint abrasion produced by the muzzle end may be seen.
  - The shot (comprising a bunch of pellets) passes into the body as a solid mass.
  - The injured tissue is usually cherry red in colour.
  - Shotgun injury of the cranium is large and irregular, and fissured fractures often radiate outward from the margins. Sometimes a part of the head may be blown off (Fig 10.16).

- **Close shot**
  - This produces a circular defect with irregular inverted borders.
  - The edges are scorched due to flame, and smudged by smoke.
  - A fairly wide zone of tattooing may surround the edges of the wound.
  - Tissues often appear cherry red in colour.
  - The pellets enter the track en masse.

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| **Fig. 10.16** Shot Gun Blast – Top of Head Blown off *(Pic : Dr EJ Rodrigues)* |

Sometimes a shotgun may discharge parts of the cartridge case itself, such as fragmented cardboard, plastic or primer particles. At contact and close ranges, these may contribute to the wound.

- **Near shot**
  - The wound is circular or oval in shape.
  - Smudging may be evident around the wound up to a maximum distance of 30 cm.
  - Sometimes the wad produces mild abrasions if fired within a range of 30 cm.
  - Tattooing is present over a wide area.
  - The pellets travel in a compact mass up to a distance of about 45 cm, after which they begin to disperse. The entry wound is approximately 2.5 cm in diameter. If the shot enters at an angle less than 90 degrees, the shape of the wound may become triangular or semi-circular.
- **Distant shot**
  - Beyond a range of 2 metres, there will be no burning or blackening.
  - Tattooing is also rare.
  - But wad may be present in the wound (up to 5 metre range).
  - The dispersion of pellets becomes significant at ranges over 2 metres. Thereafter, the spread increases progressively, and the central defect diminishes in size proportionately. There is an old rule of thumb which states that *the diameter of the spread in inches is roughly equal to the range in yards multiplied by 1.5.*
  - At distant ranges (beyond 6–10 metres), the central hole may shrink to nothing. At such ranges the shot may not be lethal and the pellets, if they do penetrate the skin at all, may lie just in the subcutaneous tissue.

Medicolegal Aspects of Firearm Injuries

Legally, firearms are classified as dangerous weapons, and mere possession without license or authority becomes a cognisable offence.

The following constitute some important medicolegal issues in firearm deaths:

1. The nature of firearm
2. The range of fire
3. The direction of fire
4. The place from where firing took place
5. The cause of death, and
6. Whether the firing was an accident, homicide or suicide.

The Nature of Firearm

- It is important to know whether the firearm used was a rifled weapon or a smooth-bore weapon, and if it was a rifled weapon, whether it was a rifle, pistol, or revolver (Table 10.2).
- An examination of the size of the bullet and its weight and calibre; the number, size, and direction of the rifling marks on it; and the kind of metal it is made of, will all give clues regarding the weapon used. For example, a bullet of 0.7 cm diameter generally indicates that it has been fired from a weapon with a calibre of 0.7 cm. The diameter of a bullet is measured with a micrometer.
- Bullets may be recovered at the scene of a shooting incident, or from a dead body during autopsy.
- Although a detailed examination of the bullet recovered at autopsy is within the province only of a ballistics expert, the medical officer conducting the autopsy should observe the following points (*Details mentioned under* ***Autopsy Procedure in Firearm Deaths, Box 10.1,*** *page 238*).
  - A bullet recovered from a dead body must not be washed or cleaned as this may remove the

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residue of any powder adhering to it. Instead, it should be dried without using heat and preserved for future examination by a ballistics expert.

Table 10.2 Types of Firearms

1. **Pistol** is a miniature semi-automatic hand-arm with a small barrel.
2. **Revolver** is a hand-arm with a revolving magazine filled with cartridges.
3. **Rifle** is a rifled shoulder-arm for long range firing. Effective range may extend to a mile.
4. **Submachine gun** is an automatic rifled weapon, which also can be used as a self-loading firearm.
5. **Light machine gun (LMG)** is analogous to a rifle. It is of light weight and is capable of rapid uninterrupted fire with accuracy.
6. **Musket** is a smooth-bore shoulder-arm used for military purposes.
7. **Shotgun** is a smooth-bore shoulder-arm used for hunting.
8. **Airgun** and **Air rifle** are suitable for small game hunting. Ball bearings or pellets are used, the propelling force being obtained through compressed air.

- He must handle the bullet carefully. Forceps or other metallic instruments must not be used in handling a bullet, for it will not only cause artefacts such as scratches on it, but also obliterate the existing rifling marks. Rubber-tipped forceps are best for handling projectiles.
- The size of the bullet, its weight, calibre, the number, size and direction of rifling marks on it, the kind of metal of which it is made, any blunting of its nose, and other relevant details should be noted down. If the nose is blunted, it indicates that it had hit against a hard object. When a lead bullet strikes a person wearing clothes, the pattern of the weave of the clothing may sometimes be found stamped on the nose of the bullet.
- The bullet is marked for future identification, by inscribing one's initials on its base with a sharp-pointed instrument, and not on its sides or nose, as this will obliterate other marks that may already be present.
- Bullets meant for future examination must be wrapped in absorbent cotton and preserved in empty cardboard boxes.

- The suspect weapon and the crime bullet are both examined by a ballistics expert. To find out whether the bullet recovered had been fired from the suspect weapon, *test firing* is done.
  - A test shot is fired from the weapon into a box called firing box, which is packed with cotton wool so that no distortion of the bullet occurs. The firing box is open at the side from which firing is done, and also at the opposite side.
  - The bullet so fired (test bullet) is recovered.
  - The test and crime bullets are then compared under a ***comparison microscope*** (Fig 10.17). This is a kind of microscope under which two objects can be compared simultaneously. If the rifling marks are identical on the test and crime bullets, the inference is that the suspect weapon was the weapon used for the commission of the offence.
  - The number, width, and depth of rifling marks on a bullet can be accurately examined under a Greenough type binocular microscope. The three dimensional image afforded by such a procedure enables the operator to see the impressions more clearly.
- Examination of a spent cartridge case will also provide clues in identifying the crime weapon.
  - In the case of a shotgun cartridge, the name of the manufacturing firm, and the calibre of the weapon for which it is intended, are generally imprinted on the casing.
  - Empty cases of revolvers have a rim at their base, while those of pistols do not.

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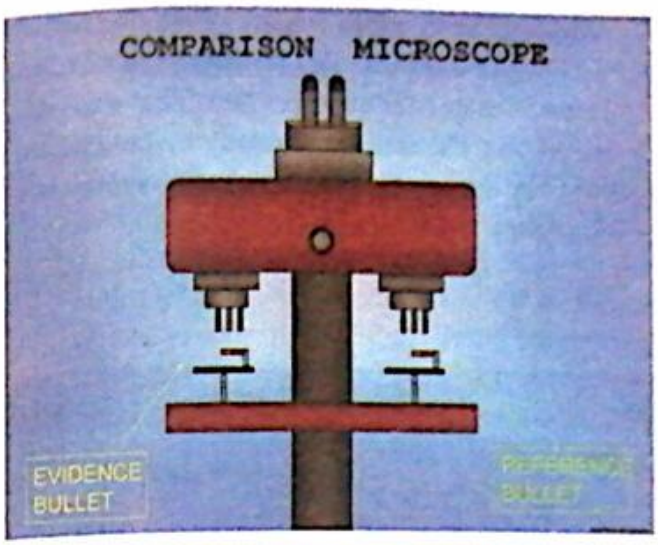

| Fig. 10.17 Comparison Microscope |

- The size of the spent case provides a clue regarding the calibre of the weapon.
- In a revolver, the empty case usually remains within the weapon, so that it is rare to find it at the scene of crime.
- If an empty case is seen at the scene of crime, as in the case of a pistol or a rifle, it is generally found a few feet to the right of the spot where the weapon was discharged.
- The firing pin will make a dent on the base, which is peculiar to that weapon. The breech may also leave its marks on it.
- The state of chemicals inside can assist in knowing whether it was recently fired or not.
- These points help to identify a crime weapon. For future identification, a spent case is marked by scratching one's initials on its side.

- In a shotgun wound, the nature of the shot, e.g., lead pellets, glass beads, or stones, may help in identifying the weapon. Factory-made shotgun cartridges use lead shot, while home-made ones employ glass beads or stones.
  - Lead pellets (and other kinds of shot), should be wrapped in absorbent cotton, placed in an empty cardboard box and preserved for examination.
  - Presence of *wad* at the scene of crime or in the dead body conclusively indicates that a shotgun had been employed. The diameter of the wad may give a clue regarding the calibre of the weapon. Wads are preserved in an empty cardboard box for future examination.
- Stains on the body of a victim can also provide help. Rifled weapons employ cartridges with smokeless powder which does not cause much blackening of the skin, because it burns up entirely, while the black powder of shotguns causes extensive smudging.

The Range of Firing

- The velocity of a rifle bullet is about 800 metres/second, and the range is 1000 to 3000 metres. The range of a revolver/pistol is up to 400–600 metres. Shotguns have an effective lethal range of only 30 to 40 metres, beyond which the pellets begin to disperse widely. However, it is the most lethal weapon at close range.
- The range of fire is deduced from the appearance of the entrance wound (*vide supra*). However, an accurate range of firing is usually better made out by test firing, than medical examination.

The Direction of Fire

- If there is no deflection of the projectile, a line joining the entrance wound with the exit wound in a dead body, or the area of lodgement of the bullet will give the direction of fire.
- Cases of devious tracks, or deflection of projectile due to hitting an intervening object (***ricochet bullet***), can cause confusion in interpretation.
- An entry wound is circular if the projectile enters perpendicular to body surface and oval if entry is oblique. In the latter case, the edge on the side of the entry of the bullet appears bevelled, while the opposite edge becomes overhanging. In cases of oblique entry, the abrasion collar becomes eccentric, being wider at the side of entry.

The Site of Firing

This will depend upon the calculation of range and direction of firing.

Cause of Death

Firearm injury can result in death due to haemorrhage, or damage to any of the vital organs such as the heart or the brain.

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Manner of Death

- It must be deduced as to whether a particular case of firearm death was *accidental*, *suicidal* or *homicidal*. The important clues which can help to resolve this are mentioned in Table 10.3.
- The usual manner of death from firearms is either suicidal or homicidal, while accidental deaths are less common.
- Suicides often expose the site of election before shooting, as for example opening the shirt before placing the muzzle over the chest. They may also ensure that the muzzle is steady by holding the barrel by the non-firing hand, which may thus sustain burns from flame.

Table 10.3 Differences Between Accidental, Suicidal, and Homicidal Firearm Wounds

Feature	Accidental	Suicidal	Homicidal
Site of entry wound	Any part	Head or chest	Any part
Range	Close	Contact or close	Any range
Direction	Any direction	Upward or backward	Usually upward
Number of wounds	One	Usually one	One or multiple
Firearm residue on hand	Present	Present	Absent
Weapon at the scene	Present	Present	Usually absent
Location	Anywhere (usually home)	Usually home	Anywhere
Sex	Usually males	Usually males	Either sex
Motive	Absent	Depression, mental illness	Robbery, revenge, etc.

Box 10.1 Autopsy Procedure in Firearm Deaths

Autopsy in a firearm death is of unique nature, where collection of evidentiary material is extremely important. It is the duty of the medical officer to meticulously collect and preserve every item that can help in the investigation. Some of the salient points to be remembered are as follows:

- Immediately after the dead body is received from the Police, an attempt must be made to detect primer residue in both the victim's hands (separately). Clean absorbent cotton buds or cotton gauze dipped in rectified spirit can be used to mop the hands. These are to be immediately transferred to clean glass bottles containing rectified spirit. Alternatively, the hands can be washed with rectified spirit, and the washings carefully collected in clean bottles.
- Punctures, stains, etc., on the clothing of the dead body are to be noted in detail, and subsequently photographed. The clothes must then be carefully removed, dried in shade, and packed in paper bags.

contd.

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- External injuries on the body should be recorded carefully and photographed. Entry wounds should be swabbed with absorbent cotton soaked in rectified spirit, which are then transferred to clean bottles containing rectified spirit.
- The dead body should be extensively X-rayed. Wet X-ray films must preferably be examined before commencing dissection. These films (after drying) should be marked with the following identifying characteristics: autopsy number, serial number, date, site, side and nature of view, and preserved as permanent records along with the autopsy report. X-rays are extremely helpful in revealing the exact path of the projectile within the body, or the extent of internal damage.
- The planned routine autopsy should immediately follow. All skin wounds as such should be dissected out carefully with surrounding tissue (minimum 2.5 cm thick). The dissected wounds should be separately covered with absorbent cotton soaked in rectified spirit, and placed in suitable glass containers (containing rectified spirit). It is worthwhile to remember that some entry wounds may be hidden or inconspicuous, and a meticulous search of the entire body may be necessary to locate them.
- A thorough search should be made to retrieve all bullets (in rifled firearm death), or as many pellets as possible (in shotgun death) from the corpse. Foreign particles from wounds, if present, should be collected, placed in absorbent cotton, and secured in clean and empty cardboard boxes.
- A bullet recovered from a dead body must not be washed or cleaned, as this may remove the residue of any powder adhering to it. Instead, it should be dried without using heat and preserved. Bullets need to be handled carefully. Forceps or other metallic instruments must not be used, for they will cause not only artefacts such as scratches on it, which will interfere with rifling marks, but may in fact totally obliterate the existing rifling marks. Rubber-tipped forceps are best for handling projectiles. The size of the bullet, its weight, calibre, the number, size, and direction of rifling marks on it, the kind of metal it is made up of, any blunting of its nose, etc., as well as other relevant details should be noted down. If the nose is blunted, it indicates that it had hit against a hard object. When a lead bullet strikes a person wearing clothes, the pattern of the weave of the clothing may sometimes be found stamped on the nose of the bullet.
- The bullet is marked by one's initials on its base with a sharp pointed instrument, to facilitate its subsequent identification in court, and not on its sides or nose, as this will obliterate other marks that may already be present. Bullets meant for future examination must be wrapped in absorbent cotton and preserved in empty cardboard boxes.
- Unfortunately, shotgun pellets cannot be traced to the offending weapon by means of ballistic markings, as in the case of bullets. However, a study of the wad used could help, since the prints on the top-wad and its diameter can connect it to the suspected weapon. The top-wad is almost always carried into the body along with the shot.
- At the end of the autopsy, all material objects collected should be packed, labeled, tied, and sealed, and forwarded to the ballistics expert through proper channel, along with forwarding notes, and samples of labels and seal used. The following items must be submitted: the clothes of the victim, skin and tissues around the gunshot wounds, and recovered projectiles. Skin and tissues must be preserved in rectified spirit.
- The medical opinion should include information about not only the cause of death, but also (if possible) the kind of firearm involved, and the range and direction of fire. Opinion about the time of death, identity of the deceased, and the manner of death may also be added.

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Box 10.2 Ballistic Trivia

Types of Bullet

- **Dum-dum bullet**—A type of bullet which is designed to explode on impact.
- **Incendiary bullet**—A hollow-point bullet which contains phosphorus.
- **Frangible bullet**—A bullet that is made of iron instead of lead, and fragments on impact.

Types of Lead Shot

Dust shot—Consists of extremely fine particles.
Bird shot—Consists of lead pellets of average diameter 3.5 mm. Used for small game hunting.
Buck shot—Consists of large pellets of average diameter 6 to 8 mm. Used for big game hunting.

Unusual Ballistic Effects

Billiard ball effect—Extensive dispersion of lead shot because of the pellets striking against each other in flight. May give erroneous impression about the range of fire.
Balling of shot—The lead shot is bunched together for some distance during flight, resulting in much less dispersion than expected for that range.
Tandem bullet—Sometimes, when a firearm is discharged, the bullet does not emerge. On pulling the trigger again, two bullets may emerge, one behind the other. This happens in faulty or disused firearms.
Tandem (Duplex) cartridge—A single cartridge contains two bullets one behind the other, so that a single shot produces two separate entry wounds. Used in military rifles.
Shored exit wound—if the skin at the exit wound is supported against a wall, the wound may appear nearly circular with a surrounding margin of abrasion, simulating an entry wound.
Yawing bullet—A bullet that has an unsteady trajectory during flight.
Tumbling bullet—A bullet that tumbles end-on-end (somersaults) during flight.
Souvenir bullet—A bullet that remains in the body of a surviving victim of gunshot injury for a long time without producing any deleterious effects.
Kennedy phenomenon—Surgical intervention and alteration of a firearm wound, causing problems in medicolegal interpretation.

Methods of finding out whether a person recently discharged a firearm:

Dermal Nitrate Test: When a person fires a gun, gunpowder residues will be invariably deposited in the hands because of leakage from the breech end of the weapon. The 'dermal nitrate test' is often done on the hands of an accused to detect these residues. A gauze cloth dipped in molten paraffin is wrapped around the hands. Later it is removed, and diphenylamine reagent is added to the inner surface of the cloth. A positive reaction is indicated by the appearance of blue colour. However, false-positive result can occur if the hands are contaminated with tobacco, urine, etc. The following tests are more sensitive and specific:

Harrison and Gilroy's test
Neutron activation analysis
Atomic absorption spectroscopy

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Box 10.3 Who Really Shot John F Kennedy?

On November 22, 1963, in an incident that is forever branded into American memory, John F. Kennedy, the debonair young President of the USA, was assassinated by gunfire in Dallas, Texas, while riding in an open motorcade with his wife, Jacqueline, and the Governor of Texas. Barely an hour after the fatal shots rang out, police arrested a 24-year-old ex-Marine, Lee Harvey Oswald, in a movie theatre in Dallas. Two days later, in a bizarre turn of events, a nightclub owner named Jack Ruby shot Oswald dead in front of millions of TV viewers watching the live telecast of police moving their prime suspect from the city to the county jail. Ruby's murder of Oswald thus sealed the mouth of the accused without him ever confessing to the crime. President Lyndon Johnson then appointed a commission headed by the Supreme Court Chief Justice Earl Warren to investigate the assassination of JFK and determine if there was a conspiracy involved. The Warren Commission, as it came to be called, heard 552 witnesses and combed through thousands of pages of evidence to submit its final report running into 26 volumes in 1964, which stated explicitly that available evidence only confirmed that Lee Harvey Oswald acted alone in the killing.

Over the ensuing decades, hundreds of books and thousands of articles would appear to dispute the findings of the Warren Commission. Forty years later, the question is still being asked: Who really killed JFK? This controversy is fuelled by the fact that Oswald could only have fired three bullets, one of which in fact missed the motorcade altogether. The Warren Report indicates that the second bullet fired by Oswald struck JFK behind the neck, passed through his body, pierced Texas Governor John Connally's shoulder, and then fractured his wrist. This shot (often referred to sarcastically as the "magic bullet") was followed by the third and final shot which actually killed the President. Dozens of investigators have claimed that the second bullet could not have inflicted all the damage that the Warren Report suggested. A fourth bullet at least would be needed, and that means a second gunman. Experts have presented diagrams indicating that the trajectory of the "magic bullet" would have required that the projectile perform a mid-air swerve after it exited the President in order to strike Governor Connally, a physically impossible manoeuvre by any stretch of the imagination.

Suspicions of a second gunman have been aided over the years by witnesses who told the Warren Commission that they saw some sort of smoke coming from behind the fence on the grassy knoll (leading up to railway tracks) of Dealey Plaza, where the assassination took place. Could the second gunman have operated from this knoll? Oswald is said to have fired his shots from a vantage point in the upper floors of the Texas School Book Depository, a multistoreyed building close to the Plaza. If the theory of a second gunman could be true, it suggests a conspiracy, rather than an individual acting alone. So the question arises, who were the conspirators? There are enough stories to fill a whole library. One of the most convincing theories is that Lyndon Johnson, bitter over his defeat by Kennedy for the 1960 Democratic nomination, and fearing that he would be dumped as Vice President on the 1964 ticket, helped orchestrate the killing. Another theory, supported by Hollywood director Oliver Stone in his 1991 award-winning movie *JFK*, is that New Orleans businessman Clay Shaw was involved in a conspiracy to kill Kennedy. But Shaw had actually been arrested after the assassination, and was in fact acquitted for lack of evidence.

Despite all the talk of conspiracy, the most likely conclusion is still that Oswald acted alone. Closer investigation of the position of Kennedy's seat and Governor Connally's seat also reveals that the path of the "magic bullet" need not have been so complex as conspiracy theorists make it out to be.

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- Accidental deaths are often non-witnessed. However, firearm deaths almost always leave trace evidence from the weapon in or about the victim's body, which can be scientifically compared with the suspect weapon. In an accidental case, examination of the weapon may reveal clues about accidental discharge, such as defective safety catch, etc. Accidents usually occur from careless handling of the gun, or unfamiliarity with operation while cleaning, loading, or inspecting the firearm.

Some other esoteric ballistic information is mentioned in Box 10.2.

Box 10.3 details one of the most sensational cases of assassination by firearm, that is mired in controversy even today.

PART 2

EXPLOSIVE INJURIES

Introduction

Catastrophic explosions of aircraft, railway trains, ships, and buildings, firework mishaps, occupational or industrial fuel explosions, terrorist bombings, and bombing due to wars, etc., have become commonplace today in the international scenario. They result in mass disasters and leave us not only mangled corpses, but also umpteen numbers of injured victims requiring large-scale medical and surgical assistance. Terrorist bombing sometimes involves dual explosions, wherein the primary explosion is aimed at the target population, while a delayed secondary explosion is aimed at the rescuers. Common explosives include (Plate 10.3):

1. Nitroglycerine
2. Trinitrotoluene (TNT)
3. Pentaerythritol tetranitrate (PETN)
4. Triacetone triperoxide (TATP)
5. Cyclomethylene trinitramine (Cyclonite/RDX)

Classification

Explosive (blast) injuries are classified into four categories:

1. **Primary blast injuries**: They are due to the direct effect of "blast overpressure." Injuries are caused by compressed air, which tends to affect air-filled organs such as the lungs, gastrointestinal tract, middle ear, etc.
2. **Secondary blast injuries**: They are caused by flying objects generated by the blast.
3. **Tertiary blast injuries**: These injuries occur when victims are thrown into the air and strike other objects.
4. **Miscellaneous blast injuries**: These comprise injuries from fire, collapse of buildings, etc., which are the consequences of the blast.

Mechanisms of Death

Firework-related blast injuries cause a significant number of accidental morbidity and mortality in India, especially during the festive season of Diwali. Industrial accidents and explosions can trigger the release of toxic agents or radioactive material, in addition to the blast effect. Terrorist explosions may be of low or high intensity depending on the nature of the organization and its resources. A minimum pressure of about 700 kilopascals (100 lb/sq inch) is needed for tissue damage in humans.

- In most explosions, pulmonary contusion, pneumothorax and abdominal injuries are the major reasons for mortality, while the middle ear is the organ that is most susceptible to the primary blast.
  - Pulmonary barotrauma is the most common *fatal* **primary blast injury**. This term encompasses pulmonary contusion, systemic air embolism, and free radical–associated injuries such as thrombosis, lipoxygenation, and disseminated intravascular coagulation.
  - ARDS (acquired respiratory distress syndrome) may be the result of direct lung injury, or shock from other organ-system damage.
- Intestinal barotrauma is more common in underwater blasts. Colon is usually the most affected.
- Generally speaking, the intensity of an explosion declines as the cubed root of the distance from the explosion. In other words, a person 3 metres from an explosion experiences 9 times more overpressure than a person 6 metres away. Therefore,

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(a) Nitroglycerine dynamite sticks

(b) TNT sticks

(c) Pentaerythritol tetranitrate powder

(d) TATP powder – crude (left) and dry (right)

(e) RDX

Plate 10.3 Common Explosives

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proximity of a person to the explosion is an important factor in primary blast injury.

- Solid surfaces reflect blast waves and increase the primary blast injury.
- Flying debris, shards of glass, metal objects, etc., impart **secondary blast injuries**, which can be lethal. They cause either blunt or penetrating injuries. Some terrorists deliberately add metal screws and nails to their explosives with the objective of enhancing lethality.

| **Fig. 10.18** Explosion Death: Marshall's Triad of Injuries - Abrasions, Contusions and Puncture Lacerations *(Pic : Dr Hareesh S Gouda)* |

- A typical mixture of punctuate bruises, abrasions and puncture lacerations may be seen, referred to as the **Marshall's triad** (Fig 10.18).
- **Tertiary blast injuries** result from the victim flying through air and hitting against walls, trees, poles, etc.
- **Miscellaneous blast injuries** involving toxic inhalations, exposure to fire, toxins or radiations, traumatic asphyxia, crush injuries, etc., add to the over all catastrophic effect. Incomplete burning of plastic can release cyanides.

Medicolegal Significance

- Most explosive deaths are either homicidal (due to terrorist activity), or accidental. A few terrorist-related blasts may involve suicide bombers (Box 10.4).
- In India, the incidence of blast injuries is varied and sporadic. States with terrorist problems report higher incidence, e.g., Jammu & Kashmir. Also, blasts related to fireworks cause a significant number of deaths in India, especially in Northern states during the festival of Diwali.
- Careful autopsy and practical use of laboratory rather than protocol tests are advisable in mass disasters.
  - Identification of the dead assumes great importance, and is unfortunately extremely complex in large-scale explosions that cause mass casualties with dismemberment or fragmentation.
  - Blood tests for carboxyhaemoglobin, cyanides, and phosphorus may be necessary, especially in closed-space explosions, or fire-related blasts.
  - Histopathology may help to detect ARDS, pulmonary contusion, or myoglobinuric renal failure resulting from crush syndrome.
  - Explosive residues will have to be collected for subsequent examination by experts in the field of explosives.
  - At the time of autopsy, the possibility of contamination of the body with chemical or radioactive material should be kept in mind.

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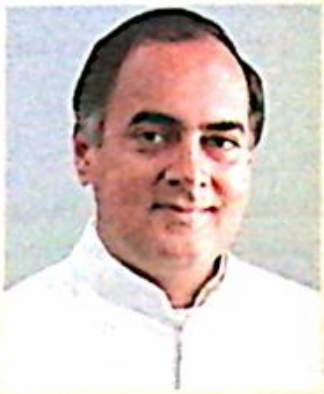
Box 10.4 The Assassination of Rajiv Gandhi and the Birth of the "Suicide Bomber"

Rajiv Gandhi was the 9th Prime Minister of India from 31 October 1984 until his resignation on 2 December 1989 following a general election defeat. Rajiv Gandhi remained Congress President until the elections in 1991. While campaigning, he was assassinated by the Liberation Tigers of Tamil Eelam (LTTE) group.



Rajiv Gandhi's last public meeting was on 21 May 1991, in Sriperumbudur, a town approximately 30 miles from Chennai, where he was assassinated while campaigning for the Sriperumbudur Lok Sabha Congress candidate in Tamil Nadu. The assassination was carried out by the LTTE suicide bomber Thenmozhi Rajaratnam also known as Tanu. Later, the real name of the suicide bomber was revealed to be Gayatri.

Rajiv Gandhi had arrived at Chennai about two hours earlier and then was driven by motorcade to Sriperumbudur. When he reached the venue, he got out of his car and began to walk towards the dais to deliver his speech. Along the way, he was garlanded by many well-wishers, party workers and school children. At 10:10 p.m., the assassin Tanu approached him and greeted him. She then bent down to touch his feet and detonated an RDX explosive laden belt tucked below her dress. Rajiv Gandhi, along with many others, was killed in the explosion that followed. The assassination was caught on film through the lens of a local photographer, whose camera and film was found at the site. The cameraman also died in the blast.

The trial was conducted under the Terrorist and Disruptive Activities (Prevention) Act (TADA). The designated TADA court in Chennai gave death sentences to all the 26 accused. This created a storm in India. Human rights groups protested as the trial did not meet standards of a free trial. Under TADA, an accused can appeal only to the Supreme Court. Appeal to the High Court is not allowed as in normal law. On appeal to the Supreme Court, only four of the accused were sentenced to death and the others to various jail terms. As per the Supreme Court of India judgment, the killing was carried out due to personal animosity of the LTTE chief Prabhakaran towards Rajiv Gandhi. Additionally, the Rajiv Gandhi administration had antagonised other Tamil militant organisations like PLOTE for reversing the military coup in Maldives back in 1988.

Velupillai Prabhakaran was the founder and leader of the Liberation Tigers of Tamil Eelam (LTTE), a militant organization that sought to create an independent Tamil state in the north and east of Sri Lanka. For over 25 years, the LTTE waged a violent campaign in Sri Lanka that led to it being designated a terrorist organization by 32 countries. Prabhakaran was wanted by Interpol for terrorism, murder, organized crime and terrorism conspiracy. He also had arrest warrants against him in Sri Lanka and India.

On May 18, 2009, the Sri Lankan Government led by President Mahinda Rajapaksa announced that Prabhakaran had been killed while trying to escape advancing Sri Lankan Army troops. On May 19, it was announced that a body found by the shore of Nandikadal Lagoon had been identified as Prabhakaran's and the body was later shown on Sri Lankan media. A week later, the LTTE admitted that Prabhakaran had died on May 17. Two weeks later a DNA test confirmed Prabhakaran's and his son Charles Anthony's deaths.

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CHAPTER 11

Regional Injuries

The optimist already sees the scar over the wound; the pessimist still sees the wound underneath the scar.
—**Ernst Schroder** (1841–1902; German Mathematician)

Mechanical injuries can assume varying significance depending on the location, and the structure or organ that is involved. It would be pertinent therefore to discuss some common injuries in a region-wise manner.

HEAD

Mechanical force applied on the head can injure the scalp, skull, meninges, brain, or related vessels, separately or in combination.

Scalp

- Wounds of scalp can take the form of abrasions, incised wounds, lacerated wounds, contusions, or puncture wounds. They are rendered more visible if the scalp hair is shaven off (Fig. 11.1).
- Abrasions are relatively uncommon over the scalp because of the presence of hair.
- Incised wounds produced by light cutting weapons, and chop wounds produced by heavy cutting weapons can be differentiated by the presence or absence of contused edges (Fig. 11.2). Incised wounds of head bleed profusely. However, wound healing is rapid when compared to other regions.
- Due to the close proximity to the skull bones, scalp lacerations are often incised-looking lacerations, which can be differentiated from true incised wounds only by using a hand lens. Crushing of hair bulbs and contusion of the edges help in confirming lacerated wounds. Like incised wounds, lacerations of scalp bleed profusely.

| **Fig. 11.1** Scalp Wound Rendered Clear after Removing Hair from the Scalp |

| **Fig. 11.2** Lacerated Wound of Scalp with Contused Edges *(Pic : Dr Prateek Rastogi)* |

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- Contusion of scalp can percolate and settle around the orbit, and be visible as a **black eye**, the so called *ectopic contusion or bruise* (**Chapter 9, Fig. 9.6**). Superficial contusions appear as localised swellings on palpation, due to limitation by the fibrofatty tissue. Contusions deep to galea aponeurotica tend to become diffuse in nature due to the loose sub-aponeurotic tissue (Fig. 11.3).

| **Fig. 11.3** Contusion Under the Scalp *(Pic : Dr Prateek Rastogi)* |

- Puncture (stab) wounds of scalp may be incised- or lacerated-puncture wounds, of which the latter are more common. Such wounds invariably enter into the skull cavity to become penetrating wounds.

Skull

- Fractures of skull could be due to direct impact (such as a blow), or due to indirect impact (such as a fall on the feet or buttocks).
- If the force of impact is less than the elasticity of the skull, in-bending of the bone at the site of impact alone is the result. The bone subsequently resumes its original position.
- A fracture results when the impact is greater than the elasticity of the bone. Experiments have proved that a force of 5 foot pounds can be sufficient to fracture the skull. However, the occurrence of fracture also depends upon the relative thickness and strength of the bone in different regions.

Classification

A. Conventional Classification*

- Fissured fracture
  - Linear
  - Crack
  - Basilar
    - Ring (foraminal)
- Comminuted fracture
  - Depressed ('signature')
  - Non-depressed
  - Expressed
- Gutter fracture
- Pond (indented) fracture
- Diastatic (sutural) fracture
- Perforating fracture
- Cut (chop) fracture

B. Current Classification (Plate 11.1)

1. **Fissured Fracture** (Fig. 11.4a & b)
   - It is a **linear fracture** involving both tables of skull, and is the commonest type of skull fracture.
   - Such fractures can be straight, curved, irregular.

| **Fig. 11.4a** Fissured Fracture of Skull *(Pic : Dr Shashidhar C Mestri)* |

A useful mnemonic to remember the main types of **skull fracture: **F**ractures **C**an **G**et **P**ainful; **D**elay **P**revents **C**ure = **F**issured, **C**omminuted, **G**utter, **P**ond, **D**iastatic, **P**erforating, **C**ut.*

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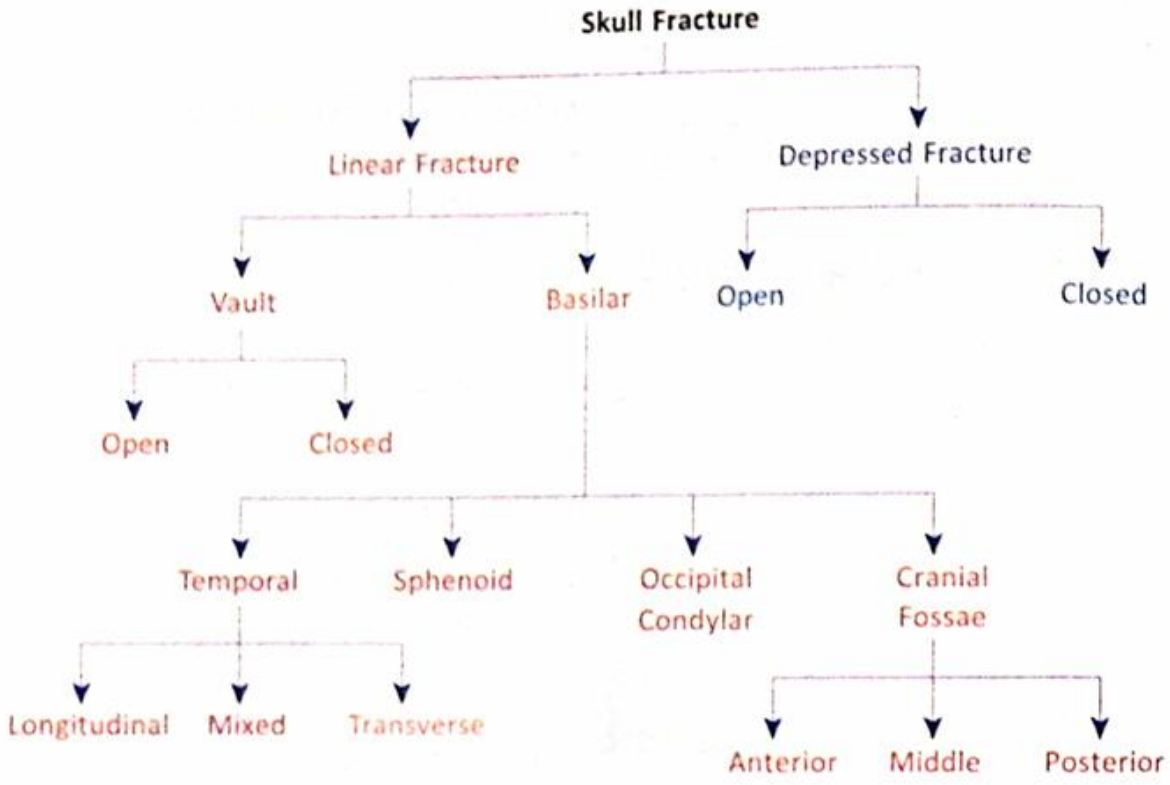
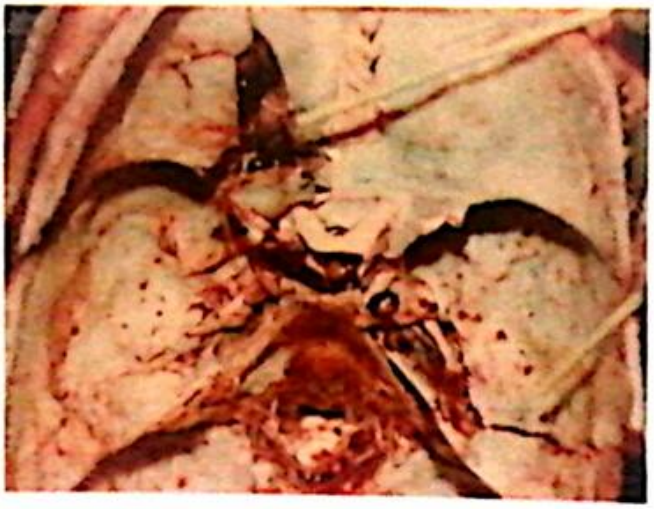


| **Plate 11.1** Current Classification of Skull Fracture |



| **Fig. 11.4b** Fissured Fracture: Base of Skull
(Pic : Dr Shashidhar C Mestri) |

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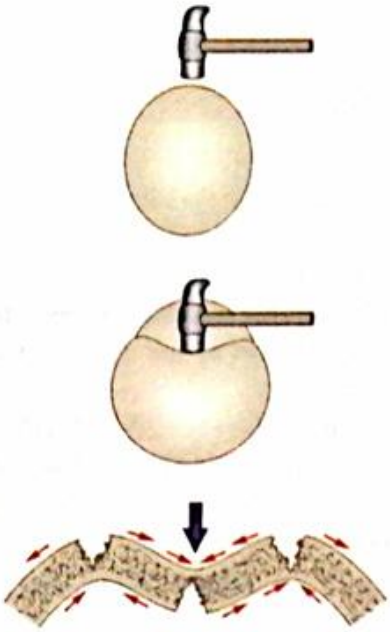
- They are produced ordinarily when the head hits against a hard surface, or when an object with a large striking surface hits the head with sufficient force.
- They can occur at the site of impact or some distance away, depending upon the temporary deformation of skull due to the applied force. They usually occur along the line of maximum stretching (Fig. 11.5).



| Fig. 11.5 Mechanism of Fracture of Skull *(Fig : Dr Rohan Monis)* |

- Fissured fractures can also occur as radiations from the sites of other types of skull fracture.
- Basilar fractures are fissured fractures that occur in the floor of the cranial vault (skull base), which require more force to cause than other areas of the neurocranium. Thus they are rare, occurring as the only fracture in only 4% of head injury patients. Basilar fractures have characteristic signs:
  a. Blood in the sinuses, or cerebrospinal fluid (CSF) leaking from the nose (rhinorrhoea), or periorbital ecchymosis ('raccoon eyes') due to bruising around the eyes that result from blood collecting there as it leaks from the fracture site, in anterior cranial fossa fracture.
  b. CSF leaking from the ears (otorrhoea) in middle cranial fossa fracture.
  c. Retroauricular ecchymosis ("Battle's sign") due to bruising over the mastoid process in posterior cranial fossa fracture.
- A type of basilar fracture in the form of a circular fissured fracture occurring around the foramen magnum is sometimes referred to as a **ring fracture**. Such a fracture results indirectly from the transmission of force through the vertebral column, as in the case of a fall on the feet or buttocks, or through the mandible as in the case of a blow to the chin.
- A fissured fracture which involves only one table of the skull is referred to as a **crack fracture**. It is usually the inner table which fractures in such cases, since it is more brittle.

2. **Comminuted Fracture**
   - The term "comminution" refers to fracture division of a bone into several fragments.
   - This results when a considerable force is applied over a relatively small area. Weapons with small striking surface like hammer are often the causative objects. Comminution can also be a complication of fissured fractures.
   - Comminuted fractures can be with or without depression of the affected area. The former is called **depressed** comminuted fracture, while the latter is referred to as **non-depressed** comminuted fracture, or merely as a comminuted fracture.
     - *Depressed comminuted fracture* (Fig. 11.6a & b): Local impact causes the outer table to be driven inwards. If the force is not absorbed in the diploe, the inner table also gets invaginated into the cranial cavity – both plates therefore get comminuted, and thus a depressed comminuted fracture is produced.
     - Such a fracture may provide a clue about the striking surface, i.e., the weapon used (**signature fracture**). For instance, a circular area of depressed comminuted fracture can indicate the application of a hammer.

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| Fig. 11.6a & b. (a) Depressed Comminuted Fracture *(Pic : Dr Hareesh S Gouda)*; (b) Depressed skull fracture - Radiological Image of Skull |

- *Non-depressed comminuted fracture*: In this type, there is no invagination of fractured segments. The fractured site appears in the form of several fissures arranged like a cobweb or "mosaic" (Fig. 11.7).
- *Expressed fracture*: Those comminuted fractures where the free fragments come to lie outside the normal curvature of the cranium (as in pericranial tissue substance, cranial cavity, or outside the head) are called "expressed fractures."

3. **Gutter Fracture**
   - If a weapon strikes the skull tangentially, the outer table alone may be fractured causing a deformity in the form of a gutter. The commonest example is a glancing bullet injury.

| Fig. 11.7 Non-depressed Comminuted Fracture of Skull *(Pic : Dr Hareesh S Gouda)* |

4. **Pond or Indented Fracture**
   - Here the applied mechanical force produces a mere indentation of the skull bones, without actual fracture.
   - This is due to the elasticity of skull, and is especially likely to occur in infants. Pond fractures can result from application of forceps during delivery.
   - Fissured fractures may be present around the periphery of the dent.
5. **Diastatic or Sutural Fracture (Fig. 11.8)**
   - This type of fracture constitutes a sutural separation occurring either alone, or in the form of an extension of a fissured fracture.

| Fig. 11.8 Diastatic Fracture of Skull *(Pic : Dr Shashidhar C Mestri)* |

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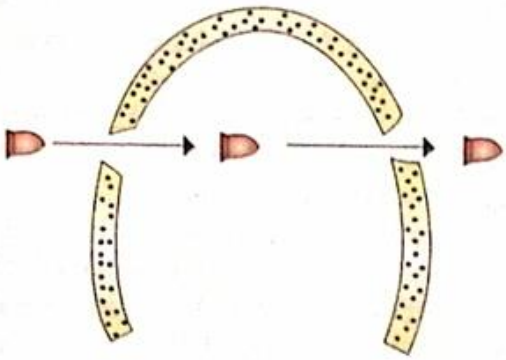
6. **Perforating Fracture (Fig. 11.9)**
   - Results from penetration of the skull by a sharp object or a bullet. In the latter case,

| Fig. 11.9 Perforated Fracture of Skull *(Pic : Dr Shashidhar C Mestri)* |

the entry causes more damage to the inner table than the outer table, while at the exit, the reverse effect is seen. Consequently such wounds are funnel shaped with the broader end formed by the inner table in entry wounds, and by the outer table in exit wounds. This is called "beveling" and can help in finding out the direction of firing (Fig. 11.10).



| Fig. 11.10 Entry and Exit of a Bullet Through Skull *(Fig : Dr Rohan Monis)* |

   - Pointed objects often produce clear cut openings, the size and shape usually corresponding to the dimensions of the causative weapon.

7. **Cut Fracture**
   - A heavy cutting weapon can cause straight chops of the skull, either involving the external plate alone, or sometimes affecting both the plates.
   - In these fractures, except for the line of contact with the edge of the weapon, there may not be any lack of continuity of the bony substance anywhere.

Meninges

- Any of the three meninges can be torn by edges of fragmented pieces of skull or by penetrating objects.
- However, pia and arachnoid can also be ruptured due to accumulation of blood from beneath.

11

Brain

- The mechanism of damage to brain is explained well by **Holbourn's hypothesis**:
  - In the case of a blow to the head, brain tissue gets injured when its constituent particles are pulled apart and do not join up subsequently. A shear strain type of deformation is thus produced in the brain tissue.
  - The forces transmitted from the skull to the brain act chiefly upon the surface of the brain. These forces are not evenly applied to the brain surface, but are maximally developed over those regions which are in close apposition to the projections of bony ridges or to the dural septa. Thus these regions of the brain usually suffer more damage than other areas.
  - The actual physical disruption of cerebral tissue is caused by one or more of the following processes: (i) compression of the constituent units while being forced together; (ii) tension in the units while being pulled apart, and (iii) shifting or shear strain which causes adjacent units to move laterally.
    - The brain can be damaged with or without skull fracture. Similarly, fracture of the skull can occur without damaging the brain.

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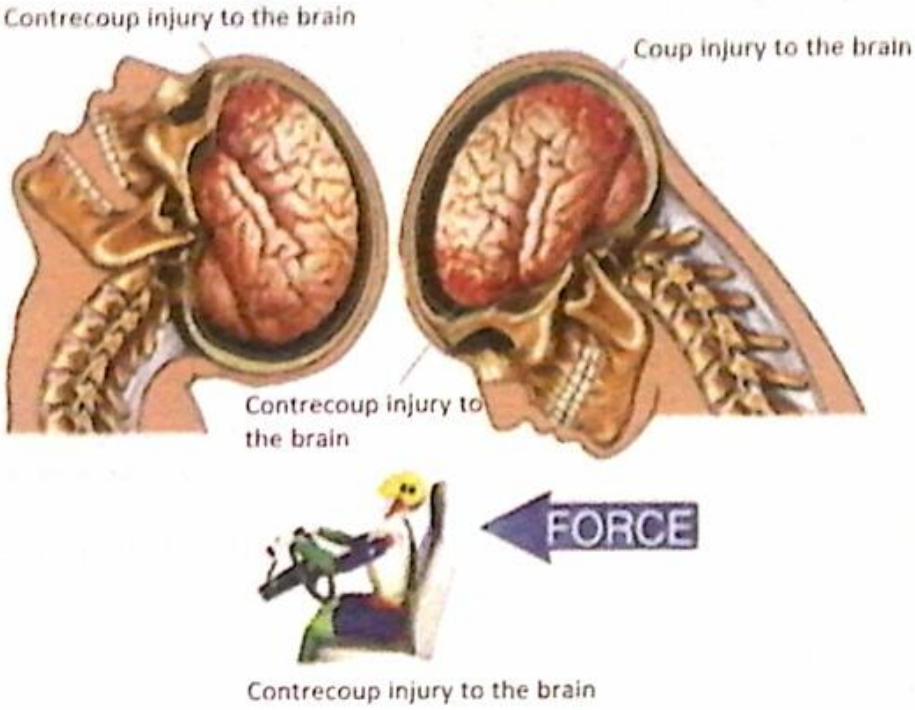

| Fig. 11.11 Mechanism of Coup and Contrecoup Injuries |

- In the case of a fractured skull, damage to the brain can sometimes result from fragments of bone.
- Air can enter the ventricles from air sinuses leading to pneumocephalus.
- Fracture of foramina can result in damage to cranial nerves.
- Intracranial haemorrhages can occur from tearing of vessels following fractures, which can further damage the brain by increasing the intracranial tension.
- Bacterial entry can result in meningitis and brain abscesses.

- It is said that in general, injuries to the brain in the back of the head are more likely to be fatal than injuries to the brain in the front part of the skull.

Coup and Contrecoup Injury (Fig. 11.11)

- A **coup injury** is one which occurs at the site of impact, while **contrecoup injury** occurs at a site opposite to the point of impact. For instance, a blow over the occiput may bruise the frontal poles of the brain.
- An impact on a stationary head causes the skull to move immediately in the direction of the force, but the brain lags behind for a brief period. The skull hits the brain at the site of impact leading to the development of a coup injury on the brain. This type of coup injury is referred to as an *acceleration injury*. At the same time, vacuum is produced at the opposite site by the space created between the static brain and the forward displaced skull. This vacuum exerts a "suction effect" pulling the brain into that space to hit against the skull bone there, and thus producing injury to that part of brain leading to contrecoup injury formation.
- Both coup and contrecoup injuries of brain can be in the form of contusions or lacerations.
- When a moving head strikes against a stationary object, the skull is suddenly brought to a stop by the impact, but the brain continues to move forward for a brief period, thereby hitting against the skull. This type of coup injury is termed a *deceleration injury*.
- Forces leading to the rotation of skull cause the brain to slide or glide against fixed structures within the skull, resulting in shear strain injuries.

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- Severe contrecoup injuries can result from a fall, even when coup injuries are absent or minimal.
- On the other hand, when the head is struck with an object, coup injuries are more common than contrecoup injuries. In a blow to a fixed head, contrecoup injuries may be totally absent.

Cerebral Concussion (Commotio Cerebri)

- This is a reversible or irreversible derangement of neuronal activity without demonstrable structural changes.
- Conventionally, cerebral concussion is clinically divided into three grades:
  - Grade I: No loss of consciousness.
  - Grade II: There is loss of consciousness, but for less than five minutes.
  - Grade III: Unconsciousness for more than five minutes, associated with memory loss for more than 24 hours.
- In severe cases there can be total derangement of physiological activities leading to immediate death.
- In reversible cases, consciousness is regained.
- The cerebral irritation often due to cerebral oedema, manifests itself as constricted pupils, and altered blood pressure and respiration. Fluctuations in the level of consciousness can occur, as also post-traumatic and retrograde amnesia.
- During autopsy, the brain does not reveal any visible structural change. Occasionally, petechial haemorrhages may be seen.

Box 11.1 recounts an interesting case history in which the issue of **retrograde amnesia** played an important part.

Diffuse Neuronal Injury

- In this case, neurons and nerve fibres sustain injury in a diffuse manner when the force of impact is transmitted through the brain.
- This may be wholly or partly reversible.
- Rotational movements due to shear strains are the probable cause for this.

Diffuse Axonal Injury

- In this case, axons and vessels are disrupted as a result of impact. Deforming effect of shear strains is the main causative factor.
- Diffuse axonal injury (DAI) presents at the moment of impact.
  - Mild grade may present clinically as cerebral concussion.
  - Severe grade is associated with unconsciousness (without lucid interval). The coma usually lasts for more than six hours.
  - Additional clinical features that may be present include neurobehavioural manifestations, persistent vegetative state, and dementia.
  - At autopsy, petechial haemorrhages may be seen microscopically, due to damage to small blood vessels accompanying the axons. Occasionally, the petechiae may be seen even macroscopically. They are generally more frequent in the corpus callosum and over the dorsolateral aspects of pons, since these are the areas where axons are more susceptible to damage, due to greater length. Septum pellucidum and fornices may show tears leading to haemorrhages into lateral ventricles.
- Diffuse axonal and neuronal injuries are irreversible, and the damaged neurons are obliterated as time passes.

It is important to remember that the absence of histological changes in the brain differentiates cerebral concussion from diffuse neuronal and axonal injuries.

Cerebral Contusion

- Cerebral contusions are caused by blunt force injury to the head, and usually occur as circumscribed areas of brain tissue destruction, resulting from extravasation of blood in traumatised tissues. They are often multiple and found mostly in the cortex, but may also occur in deeper tissues.
  - Cortical contusions are covered by a zone of intact cerebral tissue and are frequently wedge shaped. They are produced by distortion of skull, or by rotational movements of brain in relation to skull.

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Box 11.1 The Sims Case (USA)

On the night of 29 April 1989, Robert Sims, a worker in a newspaper factory returned home to find his wife (Paula Sims) (**Fig**) lying apparently unconscious on the kitchen floor. He revived her, and upon enquiry, his wife recounted the following story – when she had gone out into the backyard earlier that night to empty out the garbage, a masked man suddenly grabbed her and forced her back into the house. He then hit her on the back with his hand (*karate chop*), as a result of which she fell unconscious and remained so for 45 minutes until her husband returned home and revived her.

To their consternation, when they went through the house they found their daughter Heather missing from her crib. The police were informed. After they arrived, they made a search of the house and discovered that nothing was stolen, and there was no disturbance at the scene. They waited for a ransom call which never came.

A few days later, a fisherman found a body wrapped in a garbage bag in a trash can several miles away. It was identified as that of Heather, on the basis of sole prints (footprints) which were compared with those in the records at the hospital where Heather had been delivered. The body was autopsied by the local Medical Examiner who happened to be a lady who had specialized in neuropathology. She found evidence of smothering – bruising of inner aspects of lips and asphyxial signs.

The police began investigating the background of Robert Sims and his wife, and discovered that a few years earlier they had made a similar complaint relating to the disappearance of their younger daughter Laurie, while they were residing in another town. The skeletal remains of the baby in that case had been found, but the cause of death could not be ascertained, and the case remained unsolved.

Their suspicion aroused, the police analyzed the story furnished by Paula Sims more carefully. The lady medical examiner who had performed the autopsy on Heather made it clear (on the basis of her specialization in neuropathology), that the story appeared implausible. When someone is knocked unconscious because of a blunt force injury on the base of the head (as in this case), and recovers 45 minutes later, there is very little chance of remembering the events just before the blow because of "retrograde amnesia."

The police then turned their attention to the garbage bag in which the baby was found. They compared it with other bags in the Sims house and could prove scientifically and conclusively with help from the manufacturer of the bags, that the "crime" bag originated from that very house.

Based on these pieces of evidence, Mrs Sims was arrested on charges of murder, tried, and convicted to life imprisonment.

Motive: Robert Sims did not like to have daughters. He ignored the first daughter totally and made life miserable for his wife by secluding her and the baby. The same thing was repeated with the second daughter's birth. Frustration drove Mrs Sims to committing the crimes, hoping her marital life would improve.

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- Absorbed shock waves of trauma and penetrating injuries can also produce contusions.
- Subsequent infection can convert a contusion to a brain abscess.
- Older contusions appear yellow due to extravasated blood pigments. Occasionally there may be cortical atrophy.

Cerebral Laceration

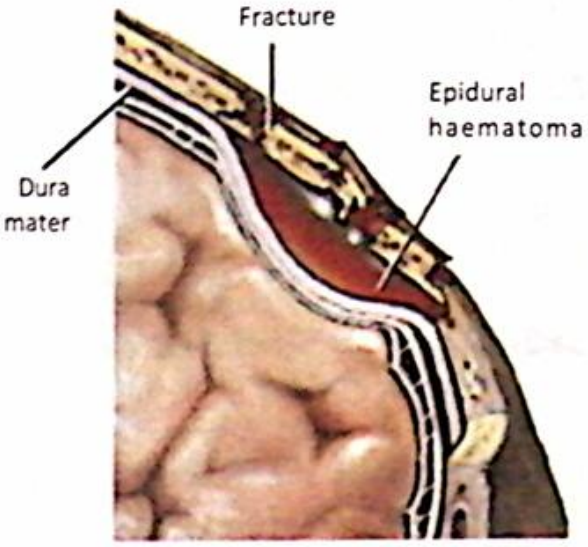
- Cerebral lacerations may occur with or without fractures of skull, and can be produced by the same mechanism as contusions.
- Lacerations are most commonly seen in regions of brain which are in close contact with projecting buttresses.
- Surface lacerations are accompanied by rupture of pia mater. Severed pial vessels can bleed and can increase the intracranial tension with fatal results.
- Healing occurs with gliosis, and cavities filled with yellow fluid may be formed in cases of extensive cell death.

Blood Vessels

Injury to intracranial blood vessels may manifest as any one of the following types of intracranial haemorrhages: **epidural (extradural), subdural, subarachnoid, intracerebral,** or **intraventricular haemorrhage**.

Epidural (Extradural) Haemorrhage (Fig. 11.12a & b)

- This type of haemorrhage occurs between the skull and the dura mater due to the rupture of diploic veins, venous sinuses or meningeal arteries. In the case of ruptured artery, the vessel most commonly involved is the middle meningeal artery, which usually gets cut at the sylvian point.
- A large haemorrhage (2 cm or more in thickness) in the extradural space leads to rapid compression of the brain, leading to fatal involvement of the vital centres in the medulla. The initial injury to the brain may cause unconsciousness due to cerebral concussion. Recovery may follow, but later the patient becomes unconscious due to compression of brain from accumulated blood. The intermediary period of consciousness between the two periods of unconsciousness is termed as **lucid interval**.
- Extradural haemorrhage is almost always traumatic, and is more common in adults than in children.



| **Fig. 11.12a** Extradural Haematoma |

| **Fig. 11.12b** Frontal and Temporal Extradural Haematoma *(Pic : Dr Jagadish Rao PP)* |

Subdural Haemorrhage (Fig. 11.13)

- This type of haemorrhage occurs between the arachnoid and dura mater. This could arise from tears in the dural venous sinuses or cortical veins, but the commonest cause is rupture of bridging or communicating veins.

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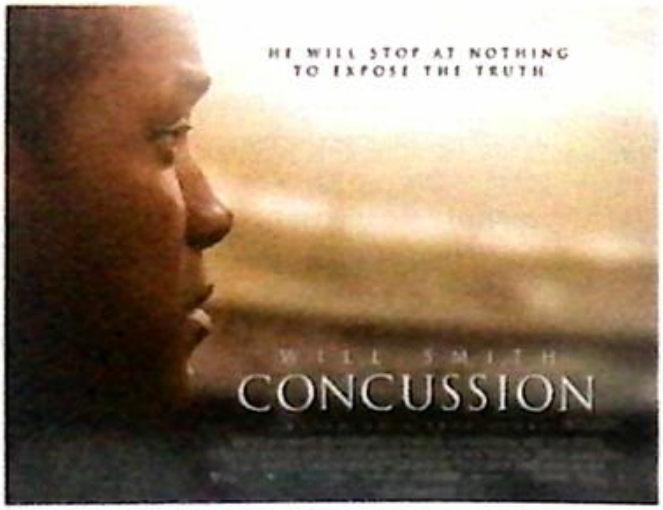
a gripping drama film on Dr Omalu's groundbreaking discovery.

| Fig. 11.16a Dr Bennet Omalu |



| Fig. 11.16b Film poster of Concussion |

- **Intraventricular Haemorrhage** (Fig. 11.17)
  - It is a collection of blood within the ventricular system, and may be associated with intracerebral or subarachnoid haemorrhage.
  - However, it can occur as an isolated event, e.g., severe trauma, vascular malformations of choroid plexus, etc.
  - When massive, intraventricular haemorrhage can be fatal due to impairment of circulation of cerebrospinal fluid and resultant hydrocephalus.

| Fig. 11.17 Intraventricular Haemorrhage |

Face

Injuries of face which cause permanent disfiguration represent *grievous hurt*. Such permanent disfiguration may be due to scar or keloid formation, or due to derangement or loss of tissues. Le Fort fractures are types of facial fractures involving the maxillary bone and surrounding structures in a usually bilateral and either horizontal, pyramidal or transverse way. LeFort fractures are classic in facial trauma. Pulping of face can result from vehicular run-over injury (Fig 11.18), or blunt impact by a heavy stone.

| Fig. 11.18 Crushed Head and Face – Run-over Injury *(Pic : Dr Prateek Rastogi)* |

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Mouth and Nose

- Abrasions and contusions in or around the mouth and nose could suggest forceful opening of the mouth to administer something, or forcible closure of mouth and nose as in smothering. Superficial lacerations of inner aspects of lips can occur due to forceful apposition of lips against the teeth, especially against the free edges of the latter.
- Injuries to lips can also result from blunt impact such as fisting.
- Occasionally, the lips or nose may be cut off or bitten off as a revengeful act.
- Blunt trauma as in the case of a fall or blow, can cause injuries to nasal bones and teeth. Injuries which lead to fracture of jaw bones or nasal bones, or fracture/dislocation of teeth constitute grievous hurt, and are often accompanied by contusions or lacerations of lips and gums. If the cribriform plate of ethmoid bone is fractured, anosmia may result.
- Partial detachment of nasal mucous membrane leading to nasal bleeding occasionally occurs after blunt trauma to head, even without direct involvement of nose.

Eyes and Ears

- The term **black eye** refers to accumulation of blood around the eyeball and eyelids which manifests as a darkish discolouration around the eye. This can occur directly from blunt trauma over the eye, or indirectly as an *ectopic contusion* especially from the scalp.
- Trauma can also cause injuries to cornea, iris, lens, and retina, or haemorrhage into anterior chamber. Retinal detachment and traumatic cataract are not uncommon sequelae of trauma.
- Penetrating injuries occasionally involve the eyes, sometimes leading to evisceration.
- Infections of eyeballs can spread to the brain and can lead to death by cavernous sinus thrombosis or meningitis. The uninvolved eye may suffer from sympathetic ophthalmia, leading to blindness of both eyes.
- Injury leading to permanent loss of vision of either eye or loss of hearing of either ear constitutes grievous hurt.
- Ears may be cut or chopped off, or bitten away as an act of revenge, or to forcibly remove ear rings.
- Abrasions, contusions and lacerations can occur to one or both ears, from accidents of different kinds.
- A hard blow to the ear can rupture the tympanic membrane and cause deafness.

Cheek

- Abrasions, contusions, and lacerations of cheek can occur from blunt trauma.
- Bite marks can result from an assault, or may be the offshoot (ironically) of an act of love (*love bite*)!
- Cheek bones (malar bones) can fracture from direct or indirect violence. The fracture line in such cases is usually horizontal, and involves the posterior third of the malar skeleton.

Jaws

- Fractures of mandible are commonly vertical, and invariably result from direct trauma, e.g., fisting.
- A blow to the point of the chin can indirectly cause a **ring fracture** of the base of the skull.
- Comminuted fracture of the maxilla is not an uncommon occurrence in blunt force injuries to the face.
- Occasionally there may be transmission of force to the cranial cavity leading to intracranial haemorrhages.
- Blood and dislocated teeth resulting from fracture of jaw bones may be ingested or even inhaled causing choking and death.

NECK

- Superficial wounds of the neck may or may not cause serious bleeding, but penetrating wounds (Fig 11.19), incised wounds, and deep lacerations produce copious bleeding due to severance of carotid and jugular vessels.
- Direct impact to hypopharynx can fracture the thyroid cartilage.

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Table 11.1 Differences Between Suicidal and Homicidal Cut-throat Wounds

Feature	Suicidal	Homicidal
Number	Usually multiple, of varying severity and depth	Single or multiple deep wounds
Hesitation cuts	Present	Absent
Tailing	Usually to the right	Either side
Slope	Towards the floor of the mouth	Away from the floor of the mouth
Position	Upper part of neck	Lower part of neck
Depth	Less	More
Direction	Usually oblique	Horizontal or oblique
Carotid arteries	Usually intact	Frequently cut
Bleeding	Usually venous	Mainly arterial

- Hyoid bone can fracture from blunt impacting force, or from blunt constricting force, as in hanging or strangulation. Scratch abrasions in the form of nail marks are good indicators of throttling (manual strangulation), while a pressure abrasion in the form of a ligature mark is pathognomonic for hanging or strangulation.

| Fig. 11.19 Stab Wound in the Neck
(Pic : Dr Hareesh S Gouda) |

- A blow on the front of neck can precipitate vagal inhibition which can result in sudden unconsciousness or death.
- Choking due to blood can result from injuries to trachea and larynx.
- Laryngeal oedema is another serious complication of trauma to these areas.
- Incised wounds of the throat are not uncommon. Such **cut-throat wounds** (Fig 11.20), can be suicidal, homicidal, or rarely accidental.
  - In a suicidal case, the person usually holds the weapon in his right hand and starts the incision from the left side of neck drawing it to the right. Tailing of the wound is therefore seen on the right side.
  - Thyroid membrane and muscles are usually cut and the wound slopes towards the floor of the mouth.
  - Carotid arteries are not frequently injured as they slip backwards when the head is extended.
  - Bleeding is usually venous, and loss of consciousness is gradual.

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- However, death may take place quickly from air embolism, due to air being sucked in by negative pressure in the veins.

| Fig. 11.20 Cut-throat Injury
(Pic : Dr EJ Rodrigues) |

- A person attempting suicide generally makes repeated horizontal, parallel, shallow, half-hearted cuts on the neck initially, before he picks up enough courage to make the final lethal cut sweeping across the neck. These preliminary shallow cuts which merge with the main wound represent hesitation or nervousness, and are therefore called **hesitation cuts, exploratory cuts, feeler strokes** or **tentative cuts**.
- A homicidal cut throat wound is invariably very deep, and obviously lacks hesitation cuts. The direction is usually horizontal. The wound is often situated at the lower part of the neck and slopes away from the floor of the mouth. Carotid arteries are often severed.
- Sometimes, air from wounded respiratory passages enters into the subcutaneous space resulting in *subcutaneous emphysema*, which may dissect down into the mediastinum leading to *mediastinal emphysema* and subsequent respiratory obstruction.
- The dome of the pleura if penetrated through the neck can cause pneumothorax.
- Aphonia and hoarseness of voice can occur if recurrent laryngeal nerve is involved, resulting in the cadaveric position of vocal cords. Speech is impossible in cases of open wounds of larynx and trachea below the level of the vocal cords.

- Injuries to postero-lateral aspect of neck can involve the brachial plexus leading to loss of function of the arm or hand.
- Infections from neck can spread to the mediastinum, which may cause a mediastinal abscess.

Table 11.1 summarises the salient differences between suicidal and homicidal cut-throat injury.

11

CHEST

Chest, although very elastic, becomes more fixed as age advances, and what would have been merely a temporary alteration in shape which would return to normal, will fracture under compression. External and internal injuries of chest often coexist, though this need not be the case always. Thus serious internal injuries can occur without any external evidence of the same. Impact of a considerable nature can give rise to alternate compression and decompression. This leads to congestion followed by laceration and haemorrhage due to rupture of lung alveoli. Such sudden and swiftly acting trauma may not leave behind any external manifestation, but can prove fatal after a lapse of time. Injuries of the chest may be penetrating ('open') or non-penetrating ('closed').

Chest Wall

- Breasts are common sites for wounds originating from a sexual act, e.g., nail marks, love bites.
- As far as fractures of ribs are concerned, they usually occur in regions of maximum stretch.
  - Thus anteroposterior compression of chest which causes maximum stretch at mid-axillary level produces fractures in the mid-axillary line, while side-to-side compression causes maximum stretch at the necks and costochondral junctions resulting in fractures at these sites.

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- The 4th to 8th ribs are the commonest ribs to fracture. However, localised blunt trauma with reasonable force can involve any rib at any site.
- Fractured ends of ribs sometimes project outwards or inwards causing injuries to the overlying or underlying membranes, tissues, muscles, or organs.
- Multiple rib fractures may give rise to **flail chest** or **stove-in chest** with consequent paradoxical respiration.
- Osteoporosis, osteomalacia and secondary malignancy are associated with fragility and easy fracture of ribs.
- 3rd to 5th ribs of left side are often involved in external cardiac massage. Such fractures usually occur at costochondral junctions and are associated with negligible amount of blood infiltration.
- Sternum is a bone which is not easily fractured. But it can fracture from direct local force as in the case of an impact with the steering wheel of a vehicle in a collision accident. Such fractures usually occur at or near the manubrio-sternal junction. Fractures of sternum are usually transverse in nature. Forces which result in hyperflexion or hyperextension of sternum are likely to result in fracture.

- Lacerated wounds involving chest wall and parietal pleura can lead to "open" pneumothorax.
- Severe blows on the chest wall may produce concussion of the chest, shock, and death, even in the absence of structural damage to the viscera.

Chest Cavity

- The lungs or the heart may get injured by blunt force applied on the chest, or from penetrating forces. They are especially susceptible to contusions or lacerations.
- Lung injury can be gross or microscopic, focal or diffuse, and located centrally or peripherally, or both. Trauma of substantial degree can produce multiple lacerations of lung (Fig. 11.21), or a single large irregular cavity, the latter being termed "traumatic cavitation." The pleura may or may not remain intact. Injury to lungs can result in pneumothorax, haemothorax, haemopneumothorax, interstitial and subcutaneous emphysema, mediastinal emphysema, or obstruction of air passages. An injured lung may collapse.

| Fig. 11.21 Lacerated Injury - Lung
(Pic : Dr Shashidhar C Mestri) |

- Injury to heart, especially stab injury, can result in serious consequences. As far as bleeding is concerned, injuries of atria are more dangerous than of ventricles, and those of right ventricle more dangerous than of left ventricle. The right ventricle is more prone for injuries, since it forms the major part of anterior surface of heart. If the injury to the heart is obliquely placed, there could be flap formation as a result of which bleeding is minimised, since the flap acts as a valve of occlusion during contraction of heart.
  - Penetrating injuries of heart inevitably penetrate the pericardium leading to accumulation of blood in the pericardial sac (**haemopericardium**) (Fig. 11.22), and subsequent escape from pericardial sac to pleural cavity (**haemothorax**).
  - In blunt injuries, the pericardium usually remains intact, while the heart itself may rupture leading to development of haemopericardium. Rapid accumulation of as little as 250–350 cc of blood can cause **cardiac**

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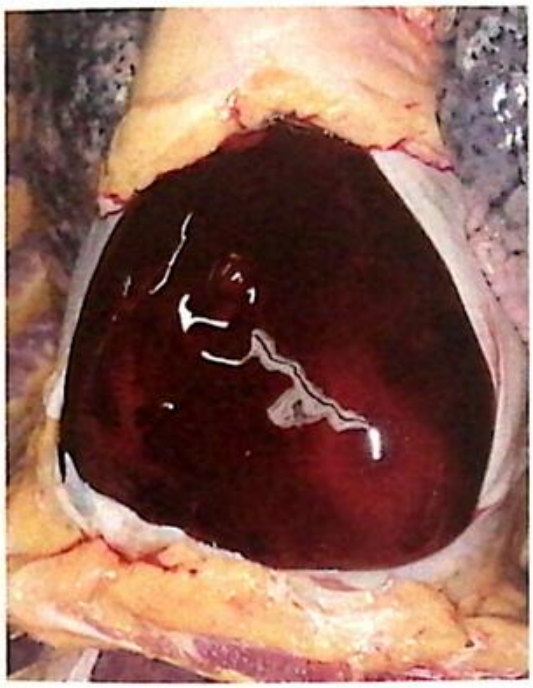
tamponade, i.e., progressive limitation of the pumping action of heart and eventual cardiac arrest.



| **Fig. 11.22** Haemopericardium
(Pic : Dr Zachariah Thomas) |

- Rupture of heart is more common in young individuals. Right atrium is most commonly involved in traumatic rupture, followed by right ventricle. A diseased heart may rupture even with trivial trauma (Fig 11.23).
- In the old, blunt injuries can precipitate myocardial infarction.
- Blunt injuries can also cause contusion of heart walls, septae, and papillary muscles. They can give rise to ventricular fibrillation or progressive circulatory failure.
- In the case of a pericardial tear, the heart can herniate through it and get compressed – *strangulation of heart*.

- Oesophagus, trachea, bronchi, bronchioles, aorta, vena cavae, and pulmonary arteries can be injured by blunt or penetrating trauma.
  - Rupture of aorta is usually transverse, and may be complete or partial (involving only the intima). It frequently occurs at the junction of the arch with the descending part.
  - Ruptures of oesophagus usually occur in the form of longitudinal splits.
  - The most common site of rupture of diaphragm due to blunt trauma is at or around the central tendon of the left side. Immediate or delayed herniation of abdominal viscera into the chest can occur in such a case.
  - Injury to thoracic duct can lead to **chylothorax**.

| **Fig. 11.23** Ruptured Heart
(Pic : Dr Shashidhar C Mestri) |

ABDOMEN AND PELVIS

Abdominal Wall

- The anterior abdominal wall easily yields to pressure, and hence usually escapes unscathed from blunt trauma. Contusion of anterior abdominal wall is therefore very rare, except in severe crushing injury as in the case of run-over injury by a vehicle. However, abrasions occur quite commonly.
- The following are some important points worth remembering:
  - Blunt trauma can result in extensive injuries of abdominal viscera even in the absence of any external injury.
  - The actual total depth of a penetrating wound of the abdomen can be exaggerated due to the yielding nature of anterior abdominal wall.
  - A blow to abdomen can cause death due to vagal inhibition.

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Viscera

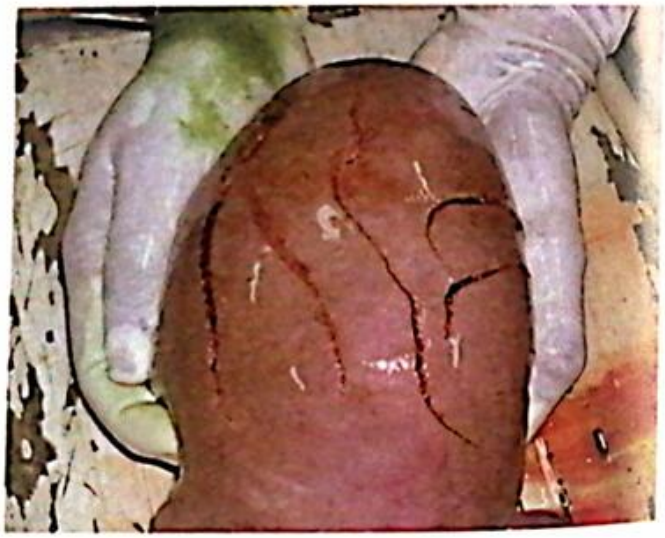
Any of the abdominal or pelvic viscera can get injured due to blunt or penetrating trauma. In severe crushing force, there can be sudden shock, haemoperitoneum, or peritonitis.

Oesophagus, Stomach and Intestines

- Rupture of stomach usually occurs in the pyloric region along the lesser curvature. This is due to deficient muscular layer in this region, as well as due to lesser elasticity. Since stomach wall can be contused from blunt trauma, delayed rupture can occur in such contused areas. Spontaneous rupture of stomach is extremely rare.
- Dissolution of distal end of oesophagus (oesophagomalacia), gastric fundus (gastric malacia) or both, may take place in some persons hours or days after sustaining cerebral trauma. This is believed to be brought about by neurogenic stimuli arising from the parasympatholytic centre of diencephalon.
- Intestines can rupture from blunt force either at the point of impact, or some distance away. The former shows clean edges, while the latter has a ragged appearance. Transverse ruptures of mesentery can lead to gangrene of a segment of intestine by transecting the supplying artery.

Liver and Spleen

- Liver is an organ which is very vulnerable to injury.
  - Laceration or rupture (Fig 11.24) mainly occurs over anterior and inferior surfaces of the right lobe. The direction of rupture depends upon the direction of pressure. For example, if the force compresses the lower part of the liver, a transverse rupture results. If the right lobe alone is compressed, a vertical rupture occurs between right and left lobes.
  - Hepatic ruptures can be transcapsular, subcapsular (Fig 11.25) or central (Fig 11.26).
  - Ribs can also cause injury to liver.
  - Diseased liver (e.g., due to fatty change, malaria, etc), ruptures easily by trauma.
  - Ruptured liver usually causes substanti haemoperitoneum.
- Spleen is easily injured from trauma due to eith blunt force or penetrating injury.
  - The degree of damage varies from laceratio of capsule to pulverisation. Bleeding is cha acteristically profuse.



| **Fig. 11.24** Lacerated Liver
(Pic : Dr Hareesh S Gouda) |

| **Fig. 11.25** Liver - Subcapsular Laceration
(Pic : Dr Jagadish Rao PP) |

- Malarial or leukaemic spleen is extremely susceptible to traumatic rupture. Such a diseased spleen can sometimes rupture in situations of strong muscular contractions as in coughing or defaecation.

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- The concave surface is more prone for rupture.
- Splenic ruptures result in haemoperitoneum.
- Ribs can cause laceration of spleen.

| **Fig. 11.26** Cut Section of Liver – Central Laceration *(Pic : Dr Shashidhar C Mestri)* |

Urinary Tract

- Rupture of urinary bladder often accompanies pelvic fractures, especially if the bladder happened to be full at the time of the incident. Even violent muscular contractions can lead to rupture of a full bladder.
- Ruptured bladder is usually accompanied by extraperitoneal extravasation of urine or blood.
- Shock, bleeding, peritonitis and urinary tract infection are common complications.
- Urethra usually ruptures in the region of the membraneous part, and may accompany pelvic fracture, or result from the application of blunt force in the perineum. Female urethra may be ruptured during a violent act of rape. Falling astride a projecting object is a frequent reason for rupture of male urethra.
- Lacerations of the kidneys can be transcapsular, subcapsular or transrenal.

Genitalia

- External genitalia can suffer different types of injuries, especially related to violent sexual act or sexual jealousy.
- Squeezing the testicles can be fatal due to reflex cardiac inhibition.
- Criminal amputation of male genitalia can cause death from bleeding.
- Self-inflicted injuries to genitalia are sometimes encountered in insane persons.
- Attempted criminal abortion or self-introduction of foreign objects can lead to injuries of female genitalia.

LIMBS

Any type of wound can occur to the limbs, from blunt injuries to sharp incisions. Direct and indirect trauma can produce different types of injuries to muscles. Tetanus, gas gangrene and renal failure may follow.

- Muscles may sustain severe crush injuries even though the skin may be intact (due to elasticity of the latter). Thighs with intact skin can accommodate even up to one litre of blood resulting from rupture of vessels due to a crushing force This can be fatal. Even multiple superficial soft tissue injuries due to blows or kicks can cause death, though the bones may be intact. Ligaments can undergo avulsion.
- Blunt injury to the limbs is extremely common, especially in traffic accidents. Fracture of femur or the bones of the lower leg resulting from the impact of a vehicle against a pedestrian is often referred to as a **bumper fracture**.
- Wounds sustained by a victim while trying to defend himself from an attack by raising his hands, or attempting to wrest the weapon away from the assailant, are called **defence wounds** (Fig 11.27). They are usually seen on the palms (Fig 11.28), and inner aspects of forearms.

VERTEBRAL COLUMN

- A useful categorization of vertebral column injuries is to divide them into fractures, dislocations, and fracture-dislocations. Such injuries can occur to the vertebral column due to direct or indirect mechanical force, which may or may not involve the spinal cord.

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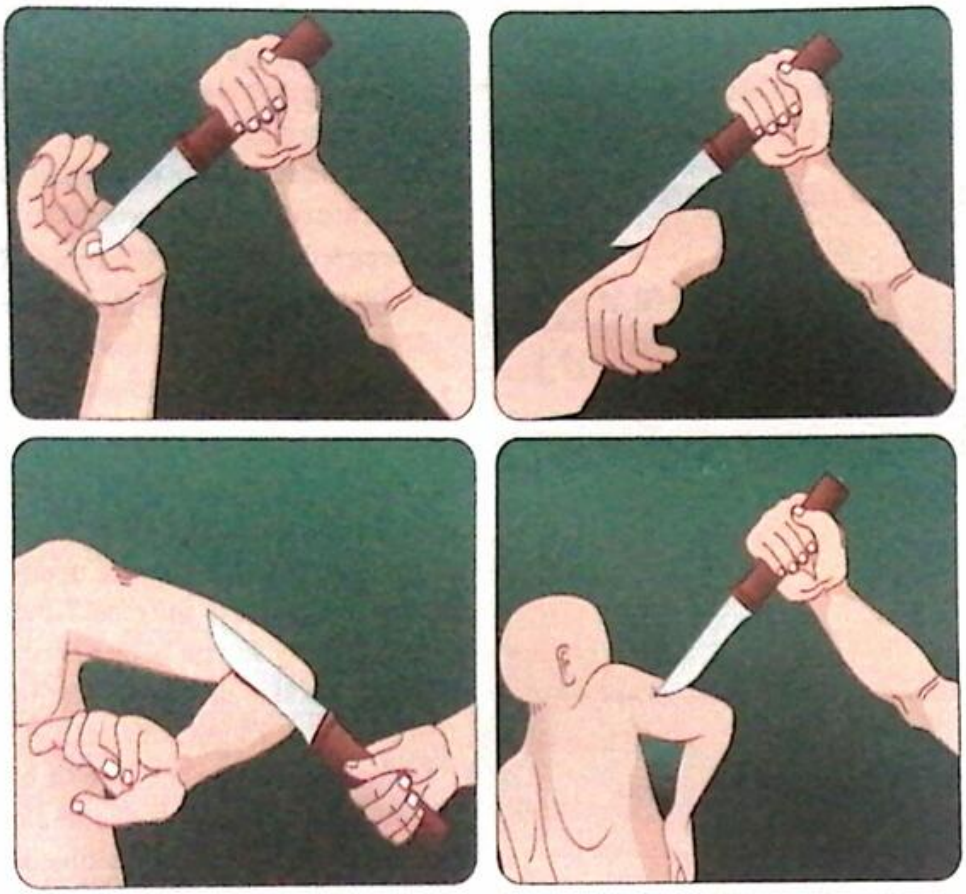

| **Fig. 11.27** Mode of Sustaining Defence Wounds During an Attack Involving a Knife.
(Fig : Dr Rohan Monis) |

| **Fig. 11.28** Defence Wound on Hand
(Pic : Dr Prateek Rastogi) |

- Commonest site of traumatic damage to the vertebral column is the lumbar region.
- Spinal cord is rarely injured without associated fractures of vertebral column.
- A sudden drop from a height of more than 5–7 feet in a case of hanging can cause dislocation between 2nd and 3rd, or 3rd and 4th cervical vertebrae, resulting in sudden death. Dislocation of atlas, with or without fracture of odontoid process, is a potentially lethal injury.
- Fractures of vertebrae can be one of the following three types:
  - *Wedge compression fracture* (vertebral bodies are compressed from above and below)
  - *Comminuted fracture*
  - *Fracture-dislocation* (sliding of one vertebra over another).
- A direct impact usually causes comminuted fracture, while an indirect impact, as in a fall on the feet or buttocks causes wedge compression fracture.
- Hyperflexion or hyperextension of neck can result in cervical vertebral column injury and is called **whiplash injury** (Fig. 11.29):
  - It is due to sudden strain affecting nerves, bones, muscles, discs, and tendons of the neck

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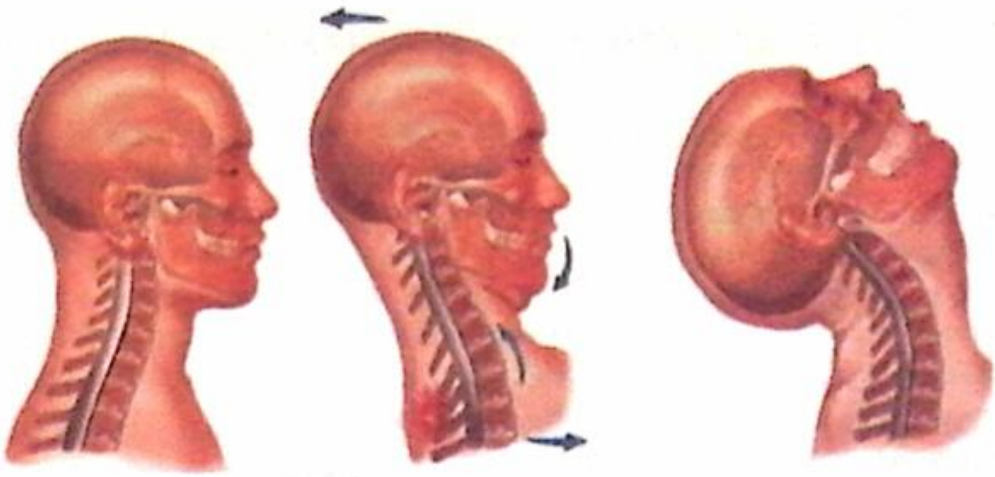

| Fig. 11.29 Mechanism of Whiplash |

due to a sudden and violent jerk of the neck forwards and backwards. As a result, the muscles and nerves may be torn or stretched, and bones slightly displaced, thus irritating nerves, interfering with blood flow, and nerve impulse transmissions.

- Whiplash injury can be extremely uncomfortable and may last for some time. The symptoms may appear immediately or after several weeks.
- Common symptoms include dizziness, headaches; stiffness of neck, jaw, shoulder or arm; pain in the neck, shoulder, upper limb, or lower back; numbness including pins and needles in upper arm, diminished ability to bend, nausea, vomiting, blurred vision, ringing in ears, lack of concentration, memory loss, tiredness, sleeplessness and irritability.
- Fatal contusion or laceration of the spinal cord can occur in whiplash injuries in the absence of any fracture of the vertebral column. Involvement of the cord above the level of the 5th cervical vertebra can be fatal due to damage to phrenic nerve. Lower level involvement can cause quadriplegia.

- Paraplegia, quadriplegia, and respiratory and urinary infections invariably follow vertebral column and spinal cord injuries. Box 11.2 recounts the tragic case of Christopher Reeve, the epitome of super-heroic powers, having enacted the role of 'Superman' in several Hollywood films on that theme before falling off a horse, breaking his neck, and becoming quadriplegic for the rest of his life.
- Sacral segment involvement can lead to impotence in a male victim.
- Blunt force over vertebral column can lead to concussion of spinal cord without visible injury to vertebrae. This is called **railway (railroad) spine** due to its frequent occurrence in railway accidents. Commonest region affected is the lumbo-sacral spine resulting in paraplegia, bladder disturbances, and impotence. Since concussion is spontaneously reversible, these abnormalities are usually only temporary.

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Box 11.2 Christopher Reeve: The Superman Who Could Walk No More

Christopher Reeve (Sept 25, 1952 - Oct 10, 2004) was an American actor, film director, producer, screenwriter, author, and activist. He achieved stardom for his acting achievements, in particular his motion picture portrayal of the comic book superhero Superman. Reeve had always been a talented all-around athlete. Portraying the role of Superman was easy as he was tall enough for the role and had the necessary blue eyes and handsome features. However, his physique was slim. He refused to wear fake muscles under the suit, and instead went through an intense two-month training regimen, running in the morning, followed by two hours of weightlifting and ninety minutes on the trampoline. In addition, Reeve doubled his food intake and adopted a high protein diet. He added thirty pounds (14 kg) of muscle to his thin frame. He later made even higher gains for 'Superman III' (1983), though for 'Superman IV: The Quest for Peace' (1987) he decided it would be healthier to focus more on cardiovascular workouts.

Christopher Reeve in the Film Poster of 'Superman'

Reeve married Dana Morosini in April 1992. Christopher and Dana's son, William Elliot Reeve, was born on June 7, 1992. Reeve also had two children from his relationship with Gae Exton.

Reeve began his involvement in horse riding in 1985 after learning to ride for the film 'Anna Karenina'. He bought a 12-yr-old American thoroughbred horse and planned to do Training Level events in 1995 and move up to Preliminary in 1996. Though Reeve had originally signed up to compete at an event in Vermont, his coach invited him to go to the Commonwealth Dressage and Combined Training Association finals at the Commonwealth Park equestrian center in Culpeper, Virginia. Reeve finished at fourth place out of 27 in the dressage, before walking his cross-country course. He was concerned about jumps 16 and 17, but paid little attention to the third jump, which was a routine three-foot-three fence shaped like the letter 'W'. On May 27, 1995, Reeve's horse made a refusal. Witnesses said that the horse began into the third fence jump and suddenly stopped. Reeve fell forward off the horse, holding on to the reins. His hands somehow became tangled in the reins, and the bridle and bit were pulled off the horse. He landed headfirst on the far side of the fence, shattering his first and second vertebrae. The fall resulted in a cervical spinal injury that paralyzed him from the neck down. Reeve stopped breathing, but was aided by paramedics who arrived three minutes later. He was taken first to the local hospital, before being flown on by helicopter to the University of Virginia Medical Center. Afterwards he had no recollection of the accident.

For the first few days after the accident, Reeve suffered from delirium, woke up sporadically and would mouth incoherent words to Dana. After five days, he regained full consciousness, and his doctor explained to him that he had destroyed his first and second cervical vertebrae, which meant that his skull and spine were not connected. His lungs were filling with fluid and were suctioned by entry through the throat; this was said to be the most painful part of Reeve's recovery. After considering his situation, believing that not only would he never walk again, but that he might never move a body part again, Reeve considered suicide. He mouthed to Dana, 'Maybe we should let me go.' She tearfully replied, 'I am only

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going to say this once: I will support whatever you want to do, because this is your life, and your decision. But I want you to know that I'll be with you for the long haul, no matter what. You're still you. And I love you.' Reeve never considered suicide as an option again.

Dr John A Jane performed surgery to repair Reeve's neck vertebrae. He put wires underneath both laminae and used bone from Reeve's hip to fit between the C1 and C2 vertebrae. He inserted a titanium pin and fused the wires with the vertebrae, then drilled holes in Reeve's skull and fitted the wires through to secure the skull to the spinal column.

Reeve was elected Chairman of the American Paralysis Association and Vice Chairman of the National Organization on Disability. He co-founded the Reeve-Irvine Research Center, which is now one of the leading spinal cord research centers in the world. He created the Christopher Reeve Foundation (currently known as the Christopher and Dana Reeve Foundation) to speed up research through funding, and to use grants to improve the quality of the lives of people with disabilities.

In 1997, Reeve made his directorial debut with the HBO film 'In the Gloaming' which won four Cable Ace Awards and was nominated for five Emmy Awards including 'Outstanding Director for a Miniseries or Special.' Dana Reeve said, 'There's such a difference in his outlook, his health, his overall sense of well-being when he's working at what he loves, which is creative work'.

Throughout this time, Reeve kept his body as physically strong as possible by using specialized exercise machines. He did this both because he believed that the nervous system could be regenerated through intense physical therapy, and because he wanted his body to be strong enough to support itself if a cure was found. In 2000, he began to regain some motor function, and was able to sense hot and cold temperatures on his body.

In 2001, Reeve was elected to serve on the board of directors for the company TechHealth, headquartered in Florida, which provided products and services for severely injured patients. While serving on the TechHealth board, Reeve participated in board meetings and advised the company on strategic direction. He refused compensation. He made phone calls to the company's catastrophically injured patients to cheer them up. Reeve served on TechHealth's board until his death in 2004.

In 2002 and 2004, Reeve fought off several serious infections believed to have originated from the bone marrow. He recovered from three that could have been fatal. In early October 2004, he was being treated for an infected pressure ulcer that was causing sepsis, a complication that he had experienced many times before. On October 5 he spoke at the Rehabilitation Institute of Chicago on behalf of the Institute's work. This was to be his last reported public appearance. On October 9, Reeve attended his son Will's hockey game. That night, he went into cardiac arrest after receiving an antibiotic for the infection. He fell into a coma and was taken to Northern Westchester Hospital in Mount Kisco, New York. Eighteen hours later, on October 10, 2004, Reeve died of cardiac arrest at the age of 52. His doctor, John McDonald, believed that it was an adverse reaction to the antibiotic that caused his death.

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CHAPTER 12

Injuries Due to Heat, Lightning, Electrocution & Radiation

Technology is a double edged sword. Fire can cook our food, but it can also burn us.
—**Jason Silva** *(Born: 1982; American film director)*

EFFECTS OF HEAT ON THE BODY

- Heat is a form of energy which when transferred to the body produces thermal injury in the form of **scalds** or **burns**, the former resulting from moist heat, and the latter from dry heat.
- Thermal injuries can result from the application of:
  - Flame
  - Hot liquids
  - Hot gases
  - Solid heated substances like metal or glass
  - Lightning
  - Electricity
  - Ultraviolet or infrared rays
  - X-ray
  - Corrosive chemical substances

Scald

- Scalds are produced due to application of moist heat to the body in the form of boiling liquid or steam. Boiling liquids that can scald include water, milk, oil, etc. Corrosive liquids (acids and alkalis) do not cause scalds; they cause burns.
- Depending on the severity, scalds are classified into first, second and third degrees:
  - *First degree*: Reddening of the skin.
  - *Second degree*: Blister formation (Fig. 12.1).
  - *Third degree*: Drying and desiccation of deeper tissues.
- When external heat is applied to the human body, the extent of damage depends on the applied temperature, the time for which it is applied, and the ability of the body to conduct excess heat. Temperatures as low as 44°C can cause damage if there is prolonged period of contact.
- Scalds do not show evidence of blackening or charring, unlike burns (Fig. 12.2). However, there may be evidence of splashing of the boiling liquid on the body, as well as trickle marks.
- Scalds usually heal without significant scarring or contracture formation. Death is rare, unless the body is extensively scalded by boiling liquid.

| Fig. 12.1 Scald Blister |

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| Fig. 12.2 Scalding with Molten Iron - No Blackening/Charring *(Pic : Dr Hareesh S Gouda)* |

Burn Injury

Classification

Based on Depth

A. **Dupuytren's Classification**

Dupuytren classified burns into *six degrees* depending on the severity of the burns.

First Degree: Erythema (reddening of the skin), followed by desquammation of superficial layer of epidermis.

Second Degree: Blister formation.

Third Degree: Destruction of the epidermis.

Fourth Degree: Destruction of the whole thickness of skin.

Fifth Degree: Destruction of muscles.

Sixth Degree: Destruction of bone, nerve trunks, etc.

B. **Hebra's Classification**

Hebra classified burns into *three degrees*, merging every two degrees of Dupuytren into one.

C. **Wilson's Classification** (Fig. 12.3)

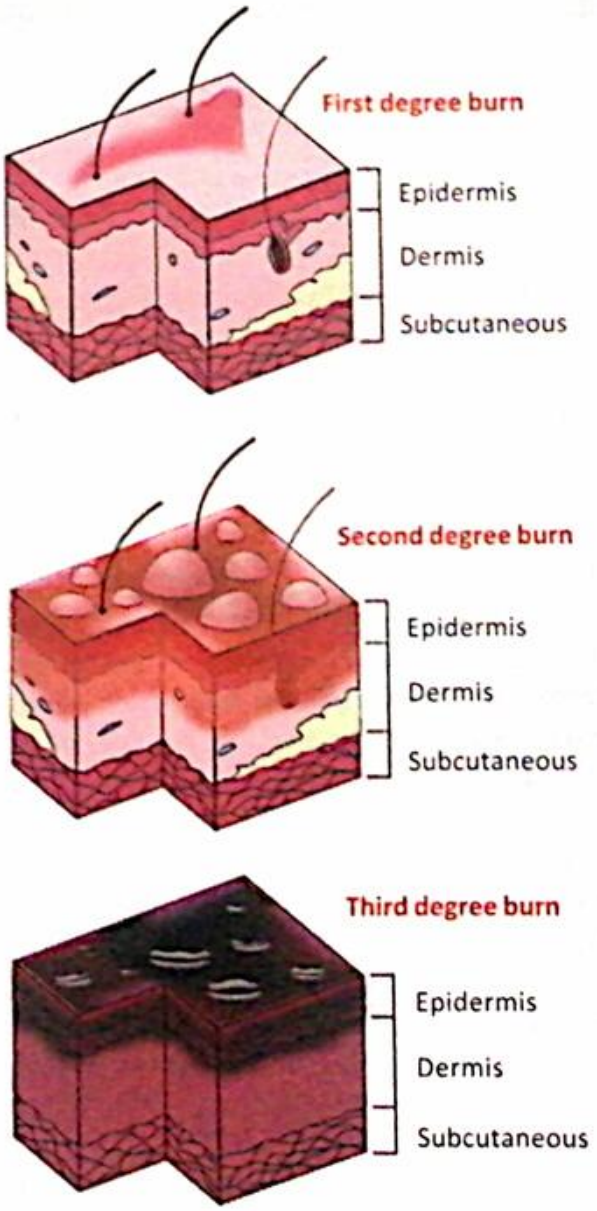
Wilson put forth a simpler and clearer classification (*vide infra*). On naked eye examination, the depth of the burn is difficult to make out, and hence he considered Dupuytren's classification to be of limited value in the practical situation.

First Degree: *Epidermal burns* (Fig. 12.4)

- In this type of burn injury, the lesion is confined to the epidermis. There may be blistering without loss of epidermis. If the blister bursts, a reddened base is seen.
- There is capillary dilatation and transudation of fluid into the tissues, causing swelling.
- First-degree burns heal without scarring.

Second Degree: *Dermoepidermal burns* (Fig. 12.4)

- There is destruction of full thickness of skin.
- The epidermis is coagulated or charred.
- There is a central zone of necrotic tissue surrounded by first-degree burns or hyperaemia. The central necrosis sloughs off and the epidermis grows in from the margins.
- Scarring is inevitable, and due to formation of contractures, there is disfiguration.



| Fig. 12.3 Burns - Three Degrees |

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| Fig. 12.4 First & Second Degree Burns over Face (Pic : Dr Shashidhar C Mestri) |

Third Degree: *Deep burns*

- There is destruction of deeper tissues below the skin surface.
- The skin is totally destroyed, though in some deep burns, islands of intact dermis may be found.
- Damage to subcutaneous fat, and loss of muscle, bone, etc., is seen.

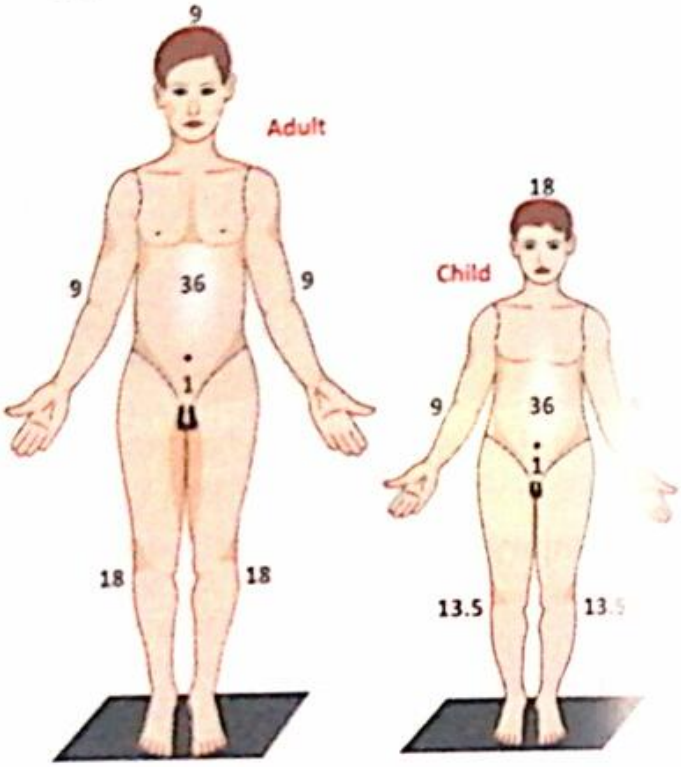
Based on Surface Area

The Rule of Nines

This is employed for the assessment of percentage of burns (used when burns are superficial in nature). Table 12.1 summarises the calculation of surface area involved, on the basis of the **rule of nines**, while Fig. 12.5 is a diagrammatic representation.

It is important to remember that the calculation is slightly different in children less than 5 years old. Since the head is proportionately larger in a child relative to the rest of the body as compared to that of an adult, the percentage allotted for the head and neck is *18%* and not *9%*. Since the lower limbs are proportionately smaller, the percentage allotment is *13.5%* for each lower limb, i.e., *27%* for both put together, instead of *36%*.

Today, however, it is recommended to use the **Lund and Browder Chart** for accurate estimation of the surface area involved (Fig. 12.6). The rule of nines is only a rule of thumb, but it is adequate for autopsy purposes in deceased individuals.



| Fig. 12.5 The Rule of Nines |

General Features of Burns

- A burn injury will be more severe if the heat applied is of great intensity. However, if the body is exposed to heat for a long time, it will show severe burn even if the intensity is less.
- The severity of burn also depends on the area involved. Burns affecting the face, genitals, or lower part of the abdomen are more dangerous than burns in other parts of the body.
- Infants and elderly individuals are more susceptible to complications of burns.
- **Heat Haematoma**
  - A haematoma may form in the extradural space between the skull and the dura mater when the cranium is exposed to tremendous heat.
  - It resembles a traumatic extradural haematoma, and may originate from venous sinuses, or from emissary veins in the diploe of the skull.
  - It can be differentiated from traumatic extradural haemorrhage by the presence of charring of the skull.

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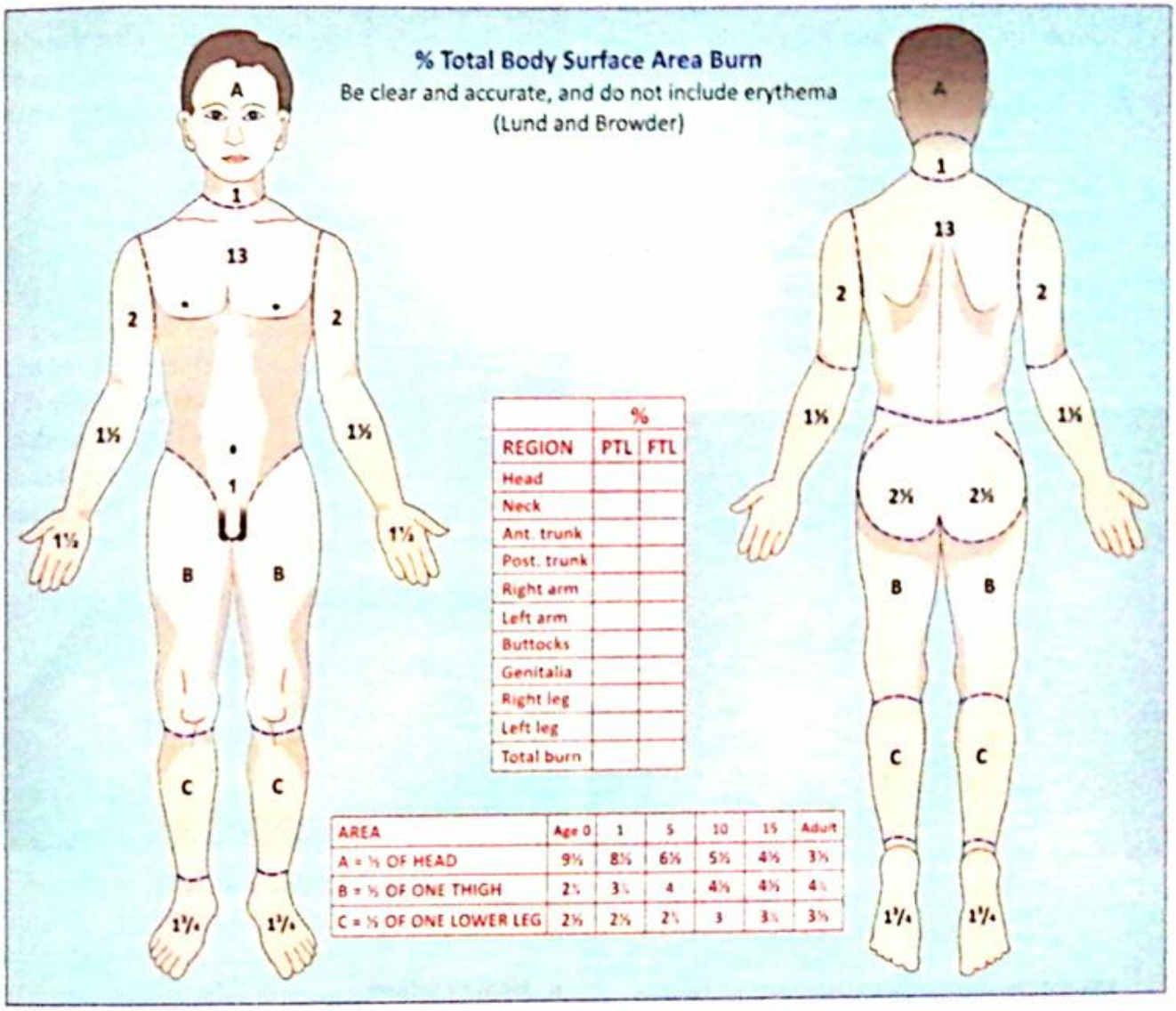

	%	
REGION	PTL	FTL
Head		
Neck		
Ant. trunk		
Post. trunk		
Right arm		
Left arm		
Buttocks		
Genitalia		
Right leg		
Left leg		
Total burn		

AREA	Age 0	1	5	10	15	Adult
A = ½ OF HEAD	9½	8½	6½	5½	4½	3½
B = ½ OF ONE THIGH	2¼	3¼	4	4½	4½	4¼
C = ½ OF ONE LOWER LEG	2½	2½	2¼	3	3¼	3½

| Fig. 12.6 Lund and Browder Chart |

Table 12.1 Rule of Nines

Body part affected	% of burns (adult)	% of burns (child <5 yrs)
Head & Neck	9	18
Right upper extremity	9	9
Left upper extremity	9	9
Right lower extremity	18	13.5
Left lower extremity	18	13.5
Front of trunk	18	18
Back of trunk	18	18
Genitals	1	1

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- The clot itself is soft and friable with honeycomb appearance, and follows the distribution of charring of the outer table of the skull.

- **Heat Ruptures** (Fig 12.7 and 12.8)
  - Heated skin contracts and splits. Such defects may appear to the inexperienced observer as antemortem wounds.
  - They are usually seen on the elbows, knees, and over the extensor surfaces of other joints, as well as on the head.

| Fig. 12.7 Heat Rupture - Lower Limb
(Pic : Dr Geetha O) |

| Fig. 12.8 Heat Ruptures - Head |

- **Heat Rigor**
  - Heat rigor is observed mainly in the muscles. This phenomenon is seen particularly in cases with extensive burn injury. It is due to coagulation and denaturation of proteins.
  - The posture of the body in such cases will demonstrate generalised flexion of the trunk, arms and legs. The upper limbs are held out with the fingers curled inwards, akin to the characteristic attitude of a pugilist (boxer) who is ready for a bout. Hence, this is sometimes referred to as the **pugilistic (boxer's or fencer's) attitude** (Fig 12.9). It is important to note that the pugilistic attitude does not necessarily indicate that the burns are antemortem in nature. This is seen even if a dead body is burnt.

| Fig. 12.9 Pugilistic Attitude
(Pic : Dr Rajesh Bardale) |

- **Heat Fractures**
  - Due to intense heat, bones may get fractured, especially the cranial vault and the limb bones. Such fractures are characteristically fissured in nature.
- In severe and extensive burns, the body may become charred (carbonized) and even fragmented (Fig 12.10)

Clinical Management of Scalds and Burns

Mild or Moderately Severe

First Aid

- Cool the area with running water for 20 minutes.
- Cold water compresses are useful for analgesia for localised burns.
- Do not apply ice.

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| Fig. 12.10 Extensive Burns with Charring (Pic : Dr Shashidhar C Mestri) |

- For chemical and eye burns, irrigate with copious volumes of water.
- Plastic (cling) wrap useful after cooling (limits evaporation and heat loss).

Pain Relief

- Paracetamol and codeine (PO) – 20–30 mg/kg paracetamol, 0.5–1 mg/kg codeine.
- Morphine (IV) – 0.1 mg/kg given in titrated boluses.
- Morphine (IM) – 0.2 mg/kg

Airway and Breathing

- Assess for presence of stridor, hoarseness, black sputum or respiratory distress, singed nasal hairs, or facial swelling.
- Oropharyngeal burns and significant neck burns usually require immediate intubation even if the airway is not yet compromised.

Circulation

- Early hypovolaemia is rarely related to the burn injury and other sources of bleeding should be sought.
- For circumferential burns, check for signs of circulatory obstruction and the need for an escharotomy, elevate the limb.
- For electrical burns, monitor ECG continuously. If high-voltage limb burn, early fasciotomy might be required.

Severe

Airway and Breathing

- For signs of airway burn or lung injury, arrange intubation as soon as possible and before airway swelling occurs.

Circulation

- If > 10% of body surface involved, commence burns fluid resuscitation, and calculate fluid requirements from the time of injury. Preferably insert IV line through uninvolved skin.
- Insert urinary catheter if burn > 15% SA, or if significant perineal burn.
- If > 10% deep partial thickness or full thickness burns, start feeding within 6–18 hr.

Investigations

- Hb, Hct, electrolytes, blood glucose, blood group, etc.
- COHb and cyanide levels (if fire in confined space).

Eye Care

- Burns to the eyes require early copious irrigation with normal saline or water and ophthalmologic opinion.

Document the Following

- Time of burn
- Extent – Consult charts
- Depth
- First aid
- Tetanus status

Other Measures

- Analgesia should be adequate; children may require morphine initially before assessment and initial dressings.
- Immobilisation with sling and splinting is suggested for upper limb burns.
- Closed dressings are recommended for partial thickness burns.
- Blisters have a protective function, and reduce pain if they are left intact for a few days.
  - If blisters are small, not near a joint, and not obstructing the dressing, leave alone.

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Table 12.2 Death due to Burns – Causes, Fatal Period, and Autopsy Features

Cause	Fatal period	Autopsy features
Shock		
Neurogenic	Instantaneous	No specific features
Hypovolaemic	Within 24-48 hours	Pallor, organs may be pale
Endotoxic	24 hours later	Focus of infection
Septicaemic	48 hours later	Acute tubular necrosis Adrenal haemorrhage possible
Suffocation Inhalation of smoke, noxious gases, e.g., CO	Immediate to first few hours	Look for soot particles in the trachea. May be absent if time gap prolonged
Injuries, Accidents Occur while attempting to escape from the fire, e.g., jumping off a highrise building	Depends on the nature and severity of the injury	Despite the obvious burns, look for signs of injury and record meticulously. The presence of injuries may complicate autopsy features of burns

Table 12.3 Differences Between Antemortem and Postmortem Burns

Feature	Antemortem burns	Postmortem burns
1. *Soot particles in the airways*	Present	Absent
2. *Colour of blood, tissues*	Cherry red	Dark red
3. *Line of redness*	Present around the burned part	Absent
4. *Blisters*	Contain serous fluid with proteins and chlorides. Base is red.	Contain fluid and air. No proteins and chlorides. Base is dry and hard.
5. *Vital reaction*	Present	Absent
6. *Enzymatic activity (by histochemistry)*	Present (time related): Tissue cathepsin – immediate Serotonin – 10 min Histamine – 20 min Esterase and ATPase – 1 hr Acid phosphatase – 3 hr Alkaline phosphatase – 4 hr	Absent

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- Large blisters and those overlying a joint should be de-roofed.
- Opaque blister fluid occurring after a few days suggests infection. The blister should then be de-roofed and dressed.

Causes of Death in Burns

- Death due to burns may be the result of **neurogenic shock** due to pain, **hypovolaemic shock** due to loss of fluid, **toxaemia** as a result of absorption of toxic material from the burnt site, or **septicaemic shock** due to infection.
- Death occurring within 24 hours is usually due to neurogenic shock, hypovolaemia, or toxaemia.
- Delayed deaths, which occur after 72 to 96 hours, are usually the result of infection, or renal damage, or haemorrhage from erosions (*Curling's ulcers*) of gastrointestinal tract (Table 12.2).
- Death can also occur from **smoke inhalation** (carbon monoxide poisoning), or **mechanical trauma** due to falling masonry, if a building is on fire with occupants trapped inside.

Autopsy Findings

External

- The body may demonstrate **"pugilistic attitude"** (which is however seen in both antemortem and postmortem burns). Table 12.3 outlines the salient differences between antemortem and postmortem burns.
- Antemortem burns appear reddened and blistered. Hair is singed or burnt. Even pubic hair, eyelashes, and eyebrows may be involved.
- Blisters may be seen (Fig. 12.11), but they occur also in postmortem burns, and even in a putrefying body (Fig. 12.12); the medical officer must therefore be careful while interpreting the cause of such dermal blisters.
- Often, there may be signs of gross infection of burns on a dead body with discolouration and pus formation (Fig. 12.13). This is of course clinching evidence of the antemortem nature of burns.
- In case of scalding, the body and clothes may be wet. If the scalding fluid has trickled down, the scald effect diminishes along its track, being maximum at the site of initial contact with skin.
- Burning of clothes, singeing of hair, charring of the body, etc., are not seen in scalds.
- Heat ruptures may be evident, which must not be confused with antemortem incised wounds.

| Fig. 12.11 Blisters in Antemortem Burn (Pic : Dr Prateek Rastogi) |

| Fig. 12.12 Blisters in Putrefying Body (Pic : Dr Prateek Rastogi) |

Box 12.1 outlines an infamous landmark case where correct interpretation of burns present on a dead body proved crucial in solving the crime. It is interesting to note that a similar case occurred in Kerala (India) in the 1980s, but has not been solved till date. **Sukumara Kurup** (Fig. 12.14) was accused in the murder of

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Box 12.1 The Case of Alfred Rouse

On the evening of Nov 6, 1930, two young men walking along a country road near Northampton, England, were surprised to see a neatly dressed man carrying a small case emerge from a ditch alongside the road. After the man had passed them and gone a distance ahead, he turned and shouted back to them, "It looks as though someone is having a bonfire up there." Just after he spoke, the men noticed flames on the horizon. When they reached the site of the fire, they discovered an automobile so consumed in flames that it was impossible to tell if there had been any occupants.

Alfred Rouse

The police arrived and extinguished the blaze, and the charred remains of a person were found in the front seat. The flames had all but destroyed the car, but the license plate was still legible. When police traced the number, they discovered that the car was owned by one Alfred Arthur Rouse, a travelling salesman who lived in Finchley, North London. Rouse's wife, when contacted, said she had no idea where her husband could be located.

Rouse returned to London on Nov 7, and was taken in for questioning by the police. He claimed that he had given a ride to a man and when he had left the car briefly to relieve himself, the man had accidentally set fire to a container of petrol in the car. Rouse claimed further that he had tried to pull the man from the car, but was prevented by the intensity of the fire. A police investigation revealed that Rouse was a notorious womaniser and bigamist. He himself admitted that between Nov 3 and Nov 7 he had been with Phyllis Jenkins, a young Welsh woman who was pregnant with his child.

Because of his philandering and the increasing financial strain created by orders for child support, police surmised that Rouse had torched the car himself with the unidentified man inside in an attempt to escape his problems, hoping the victim would be mistaken for himself. Police formally arrested Rouse and charged him with murder.

Rouse was tried in January 1931. The prosecution demonstrated that the car's carburetor had been tampered with, thus enhancing their case that Rouse had planned the murder. The Crown alleged that on the night of 5th November 1930 (Guy Fawkes night), the accused met a man (whose identity was never established), gave him a lift in his motor car, and stopped in a small country lane near Northampton.

It was alleged that he then struck his passenger on the head with a mallet and rendered him unconscious, placed him on the front seat of the car in a prone position and then poured petrol over him and set the car alight. The defence contended that the fire had arisen accidentally. The accused stated that he stopped the car on the roadside, and, as he noticed that his petrol was running low, he asked his passenger to fill the tank from a spare petrol can which he opened himself and placed on the driver's seat. He then walked down the road for a short distance, and when he turned round he saw that the car was in flames.

The bodywork of the car was completely burned out and only the chassis remained. The charred body of the deceased was found across the front seat of the car. The head was on the driver's seat, face downwards, and the body was on the passenger's seat. The left lower limb was bent up underneath the body with the leg flexed on the thigh and the thigh flexed on the abdomen. The right thigh was extended and the right leg was burned off below the knee.

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The defence maintained that this position of the body suggested that the deceased had been trapped in the blazing car and had made a violent attempt to get to the off-side door of the car. The medical witnesses called by the prosecution said that the position in which the body was found was consistent with the Crown's allegation. They explained that the muscles of the limbs had undergone heat rigor, and that although the left leg and thigh were free to bend as the limb projected beyond the edge of the seat, the right thigh could not become flexed because it was in contact with the seat.

The accused was found guilty and sentenced to death. He was hanged at Bedford on March 10, 1931.

| Fig. 12.13 Infected Burns *(Pic : Dr Geetha O)* |

Chacko, a film representative, in the year 1984. Chacko was strangled to death and his body burnt inside a car. Sukumara Kurup allegedly committed the crime to fake his own death and claim an insurance amount of Rs.800,000 by killing Chacko who bore a resemblance to him. Soon after, Sukumara Kurup is supposed to have fled abroad, while two of his co-accused were sentenced to life-term imprisonment. The Chacko murder case is one of the longest standing cases in the judicial history of Kerala. The case again caught media attention during the mid-2000s when there were reports of Sukumara Kurup look-alikes in various parts of India and Kerala, but all turned out to be false alarms.

Internal

- **Blood may be *cherry red* in colour, due to the presence of carboxyhaemoglobin**.
- Extradural heat haematoma may be seen.
- The brain is congested, and may demonstrate a "cooked" appearance.
- **Soot particles or carbonaceous material may be seen in the respiratory passages due to smoke inhalation**. However, carbon monoxide intoxication can occur without visible soot in the airways.
- Curling's ulcers may be seen in the stomach and duodenum.
- Serous pleural effusions are common. Lungs are congested and appear "cooked."
- Spleen and adrenals may be enlarged, congested, and softened.

| Fig. 12.14 Sukumara Kurup *(Pic : Dr Mithun Murali)* |

Medicolegal Aspects of Burns

1. First, determine whether the burns are antemortem or postmortem in nature:
   a. Features of **antemortem burns**
      i. Line of redness around the burn.
      ii. Blisters contain serous fluid rich in proteins and chlorides.
      iii. Soot in airways.

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iv. Cherry red colour of blood and tissues.
v. Evidence of infection.

2. Next, determine the manner of burning: accidental, suicidal, or homicidal:
   a. **Accidental**
      i. It is the commonest cause of burns.
      ii. Examples: dress catching fire while cooking, careless disposal of lighted matches cigarettes, firecracker mishaps, automobile or aircraft accident, etc.
   b. **Suicidal**
      i. Mostly in women. May be related to dowry harassment.
      ii. Self immolation.
      Some fire accelerant is often used in such cases.
   c. **Homicidal**
      i. Rare, but cases are reported from time to time.
      ii. Incendiary warfare: Box 12.2
   d. **Preternatural combustion**
      Can a body go up in flames on its own? Incredible as it may seem, cases are on record where this has apparently happened. However, closer examination usually reveals a more plausible explanation, e.g., drinking alcohol (which is flammable) and smoking at the same time in bed or on a couch while alone, and then falling asleep with a smouldering cigarette in hand that may come in contact with the alcohol.

      Can a person have the supernatural ability to start a fire by mental concentration ('firestarter')? While most people regard this as impossible, there have been incidents cited, books written, and even films made on this phenomenon (**pyrokinesis**). A well known example is Stephen King's startling novel by the name '**Firestarter**' which was subsequently made into a cult classic film by Mark L Lester (Fig 12.15).

| Fig. 12.15 Poster of the film Firestarter |

EFFECTS OF HIGH ENVIRONMENTAL TEMPERATURE

When the human body is exposed to high environmental temperature for a prolonged time, the following effects are seen:

1. Heat cramps
2. Heat exhaustion
3. Heat stroke

Heat Cramps

- These occur in persons who are working in a hot atmosphere, and perspire profusely, for instance, manual labourers, firemen, miners, and stokers (hence the synonyms **fireman's** or **miner's** or **stoker's cramps**).
- They are characterised by painful cramps of the voluntary muscles.
- Profuse perspiration results in substantial loss of water and sodium chloride from the system, which accounts for the cramps.
- Treatment consists of restoring fluid and salt intake.

Heat Exhaustion

- This occurs in persons who physically exert themselves for a long period in a hot and humid atmo-

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Box 12.2 Incendiary Warfare

Incendiary warfare involves the technique of '**firebombing**' which is designed to damage a target, generally an urban area, through the use of fire, caused by incendiary devices, rather than from the blast effect of large bombs.

Although simple incendiary bombs have been used to destroy buildings since the start of gunpowder warfare, World War I saw the first use of strategic bombing from the air to damage the morale and economy of the enemy, such as the German Zeppelin air raids conducted on London during the Great War. The Chinese wartime capital of Chongqing was firebombed by the Imperial Japanese starting in early 1939. London, Coventry, and many other British cities were firebombed during the Blitz by Nazi Germany. Most large German cities were extensively firebombed starting in 1942, and almost all large Japanese cities were firebombed during the last six months of World War II.

Incendiary weapons (incendiary devices or **incendiary bombs**) are weapons designed to start fires or destroy sensitive equipment using fire (and sometimes used as anti-personnel weaponry), that use materials such as napalm, thermite, chlorine trifluoride, or white phosphorus

Napalm is a flammable liquid that has been used extensively in incendiary warfare. It is a mixture of a gelling agent and either gasoline (petrol) or a similar fuel. It was initially used as an incendiary device against buildings and later primarily as an anti-personnel weapon, as it sticks to skin and causes severe burns when on fire. Napalm was developed in 1942 in a secret laboratory at Harvard University, by a team led by chemist Louis Fieser. Its first recorded use was in the European theatre of war during World War II. It was used extensively by the US in incendiary attacks on Japanese cities in World War II, as well as during the Korean War and Vietnam War "*Napalm*" is a portmanteau of the names of two of the constituents of the thickening/gelling agent: co-precipitated aluminium salts of *naph*thenic and *palm*itic acids. "Napalm B" is the more modern version of napalm and, although distinctly different in its chemical composition, is often referred to simply as "napalm". Napalm B became an intrinsic element of U.S. military action during the Vietnam War as forces increasingly employed its widespread tactical as well as psychological effects. Reportedly about 388,000 tons of US napalm bombs were dropped in the region between 1963 and 1973.

When used as a part of an incendiary weapon, napalm can cause severe burns (ranging from superficial to subdermal), asphyxiation, unconsciousness, and death. In this implementation, napalm fires can create an atmosphere of greater than 20% carbon monoxide, and firestorms with self-perpetuating winds of up to 70 miles per hour (110 km/h). One of the main anti-personnel features of napalm is that it sticks to human skin, with no practical method for removal of the burning substance

The Kim Phúc Story: Kim Phúc and her family were residents of the village of Trang Bang, South Vietnam. On June 8, 1972, South Vietnamese planes dropped a napalm bomb on Trang Bang, which had been attacked and occupied by North Vietnamese forces. The terrified little girl(Kim Phúc), joined a group of civilians and South Vietnamese soldiers who were fleeing from the Caodai Temple to the safety of South Vietnamese-held positions. A South Vietnamese Air Force pilot mistook the group for enemy soldiers and diverted to attack. The bombing killed two of Kim Phúc's cousins and two other villagers. Kim Phúc was badly burned and tore off her burning clothes. Associated Press photographer Nick Ut's photograph of Kim Phúc running naked amid other fleeing villagers, South Vietnamese soldiers and press photographers became one of the most haunting images

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of the Vietnam War **(Fig 1)**. In an interview many years later, she said, "Napalm is the most terrible pain you can imagine. Water boils at 100 degrees Celsius. Napalm generates temperatures of 800 to 1,200 degrees." New York Times editors were at first hesitant to consider the photo for publication because of the nudity, but eventually approved it. The photo was featured on the front page of the New York Times the next day. It later earned a Pulitzer Prize and was chosen as the World Press Photo of the Year for 1973.

After snapping the photograph, Ut took Kim Phúc and the other injured children to Barsky Hospital in Saigon, where it was determined that her burns were so severe that she probably would not survive. After a 14-month hospital stay and 17 surgical procedures including skin transplantations, however, she was able to return home.

Fig 1 Pulitzer Prize winning photograph of the badly burnt Kim Phuc fleeing from a napalm bombing

One of the most graphic films on the Vietnam War is **Apocalypse Now**, directed by Francis Ford Coppola, which is ranked Number 7 on Empire magazine's list of the 500 greatest movies of all time **(Fig 2)**.

Fig 2 Film poster of Apocalypse Now

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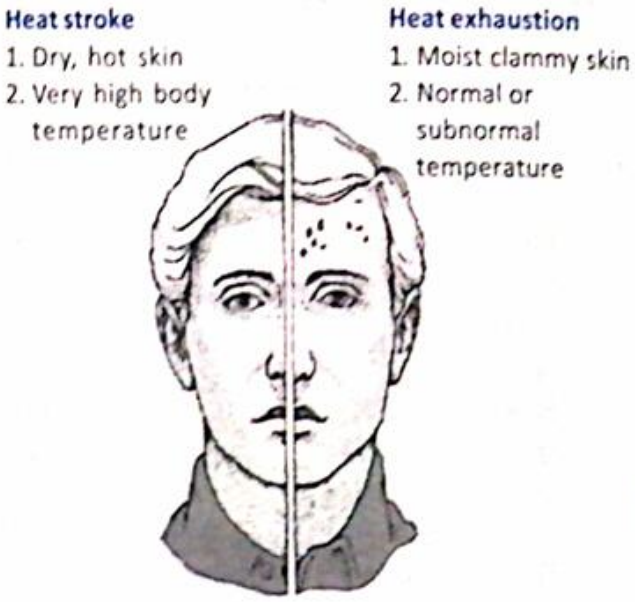
sphere. It results from dehydration and salt depletion.

- Heat exhaustion (also referred to as **heat collapse, heat prostration,** or **heat syncope**), is characterised by headache, pallor, profuse perspiration, vomiting, subnormal temperature, muscular weakness, and circulatory collapse. Urine becomes scanty.
- Treatment consists of administering fluids of glucose-saline with sodium bicarbonate.
- The condition is rarely fatal.

Heat Stroke

- This results from hyperpyrexia following exposure to excessive heat.
- There is a disturbance in the normal physiology of the heat-regulating centre in the hypothalamus.
- The victim first experiences headache, visual disturbances, nausea, vomiting and dizziness, and then suddenly becomes unconscious. The body is flushed and hot, with dry skin. The body temperature may go as high as 43°C. The pulse is feeble and rapid, and the respiration stertorous.
- Treatment involves removal of the patient's clothing, and immersion of the person (up to his neck) in a tap-water bath till the temperature comes down to 38°C.
- This condition (also referred to as **heat hyperpyrexia, sunstroke,** or **thermic fever**), is often fatal, if not treated in time.
- **Autopsy Findings**
  - Most of the victims die from disseminated intravascular coagulation.
  - The most striking autopsy findings are large areas of pulmonary haemorrhage.
  - The brain is congested and oedematous, with petechial haemorrhages in the white matter. Such haemorrhages are also found elsewhere in other organs of the body.
  - Microscopically, there are micro-thrombi in small blood vessels of many organs with small foci of necrosis of parenchymal cells.
  - Hepatic failure at times contributes to the death.
  - Skeletal muscles may demonstrate rhabdomyolysis.



| Fig. 12.16 Heat Stroke Vs Heat Exhaustion |

EFFECTS OF LOW ENVIRONMENTAL TEMPERATURE

Hypothermia

- This is usually defined as a condition in which the body's core temperature falls below 35°C.
- Exposure to cold, exhaustion, fatigue, lack of food, disease, injuries, drugs, or alcoholic intoxication are usually major causative or aggravating factors of such a condition.
- There is a progressive decrease in the metabolic processes in all the organs, a lowered oxygen dissociation from oxyhaemoglobin and oxymyoglobin, and a diminished blood flow through organs and tissues. The mechanism for temperature regulation becomes progressively inoperative.
- However, hypothermia protects the central nervous system from the effects of ischaemia, and is an important cause of "apparent death" (**suspended animation**). The heart rate slows down, and the cardiac output falls. Cardiac fibrillation occurs at temperatures below 28°C.
- Treatment involves administration of pre-warmed glucose by intragastric drip, and antibiotic prophylaxis.

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- If death is imminent, a peculiar feature sometimes occurs called **paradoxical undressing** wherein the person appears to actually feel warm instead of experiencing cold, and therefore removes all his clothes. Hence in some cases of death due to hypothermia, the victim may be found naked.
- Local effects of hypothermia produce **frostbite** and **immersion foot (trench foot)**.
  - **Frostbite** occurs at temperatures ranging from 5°C to 8°C. If this is continued for several hours, gangrene occurs. There is localized damage to skin and other tissues due to the extreme cold. Frostbite is most likely to happen in body parts farthest from the heart, and those with large exposed areas. Commonest site is the hand (especially the tips of the fingers) (Fig. 12.17). Frostbitten areas will turn discoloured, purplish at first, and soon turn black. After a while, nerve damage becomes so great that feeling is lost in the frostbitten areas. Blisters will also occur. If feeling is lost in the damaged area, checking it for cuts and breaks in the skin is vital. Infected open skin can lead to gangrene and amputation may be needed.

| Fig. 12.17 Frostbite of Fingers |

  - **Trench foot** is a condition caused by prolonged exposure of the feet to damp, unsanitary, and cold conditions. **Immersion foot** occurs when feet are cold and damp while wearing constricting footwear. Unlike frostbite, trench foot/immersion foot does not require freezing temperatures, and can occur in temperatures up to 60° Fahrenheit (about 16° Celsius). Affected feet become numb, and then turn red or blue. As the condition worsens, they may swell (Fig. 12.18). Blisters and open sores form, which lead to fungal infections; this is sometimes called **tropical ulcer (jungle rot)**. If left untreated, it usually results in gangrene, which requires amputation. If trench foot/immersion foot is treated properly, complete recovery is normal, though it is marked by severe, short-term pain when feeling returns.

| Fig. 12.18 Trench Foot |

- **Autopsy Findings (hypothermic death)**: A distinctive bright-pink colour of the blood and tissues is said to be characteristic of non-dissociation of oxygen from haemoglobin. There may also be prominent patches of purple discolouration of the limbs (Fig. 12.19).

| Fig. 12.19 Hypothermic Death |

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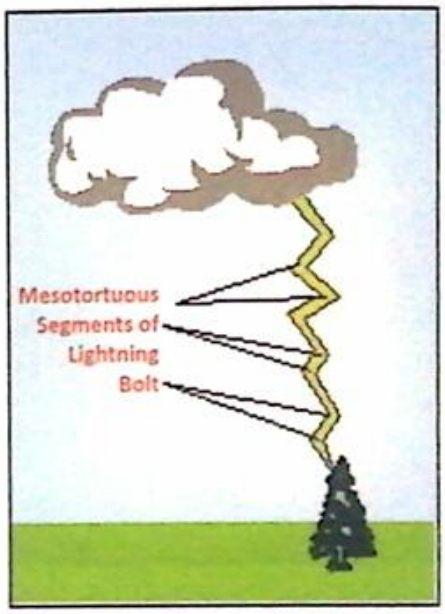
LIGHTNING

- When there is discharge of electricity between clouds, lightning occurs. When the charge jumps between cloud and earth, it is called **lightning strike** (Fig. 12.20). Lightning chooses the easiest path (not the shortest), and hence it sometimes takes a wandering, zigzag path (Fig. 12.21).
- When lightning strikes a person, a potential of 1000 million volts causes a 20,000 ampere current to pass through the body of the victim (direct effect). This induces lethal electrocution. The current may then disperse over an area close to where the victim is standing (indirect effect).
- When the lightning flash strikes a nearby metallic object it may give rise to induced voltage.

| Fig. 12.20 Lightning Strike (Thunder Bolt) |

- The atmospheric gases become heated to 20,000°C, and this heating of gases in the path of lightning causes an explosive expansion. Although the duration of explosion is for a fraction of a second, the blast effect can be devastating. Objects may be fragmented and flung away from the site of lightning.
- Lightning can incapacitate humans in four different ways:
  - **Direct strike**: The electrical charge strikes the victim first. If the victim's skin resistance is high enough, much of the current will *flash* around the skin or clothing to the ground, resulting in a surprisingly benign outcome. Metallic objects in contact with the skin may concentrate the lightning strike, preventing the flashover effect and resulting in more serious injuries.



| Fig. 12.21 Lightning – Zig-zag Path |

  - **'Splash'**: *Splash* hits occur when lightning prefers a victim (with lower resistance) over a nearby object that has more resistance, and strikes the victim on its way to the ground.
  - **Ground strike**: *Ground* strikes, in which the bolt lands near the victim and is conducted through the victim and his or her connection to the ground (such as through the feet, due to the voltage gradient in the earth), can cause great damage.
  - **EMP or electromagnetic pulse**: Results from close strikes, especially during positive lightning discharges.

Autopsy Findings

External lesions mostly take the form of burns –

- ***Linear burns***: They vary from 6–25 mm in width. They are linear in shape, and are found more commonly on moist surfaces of the skin, because moist skin offers less resistance than dry skin.
- ***Arborescent burns*** (Fig. 12.22): There is formation of superficial, thin, irregular, tortuous

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markings on the skin. They resemble the branching pattern of a tree, hence the name. Sometimes the pattern resembles a fern leaf (**filigree burns** or **Lichtenberg figures**).

| **Fig. 12.22** Lightning - Arborescent Marks (Filigree Burns) |

- ***Surface burns***: These burns occur due to heating up of metallic objects worn or carried by the person (Fig. 12.23). Sometimes the object becomes magnetised. This can be ascertained with the help of a pocket compass.

Other Effects

- Clothes may be torn
- Shoes may burst open.
- Rupture of tympanic membrane is often seen.
- Injuries from the skin may extend to involve subcutaneous tissue, muscle, and bone.
- Bony injuries may show periosteal elevation and destruction of superficial layers of the bone, or fractures.
- Petechial haemorrhages may be seen in the brain and the spinal cord. Chromatolysis and fragmentation of axons are common.
- Congestion of all organs, and pulmonary oedema are also common.

| **Fig. 12.23** Burn Caused by Heated Necklace *(Pic : Dr EJ Rodrigues)* |

ELECTROCUTION

Injuries caused by electrocution respect all the known laws of physics and thus are predictable in their manifestations, under different physical conditions.

- Electrical current is of two types: direct and alternating current (DC and AC). All modern homes and electrical appliances run on alternating current. AC is more dangerous to the human body than DC. AC can be fatal at 4 to 6 times lower strength than DC. This is because when alternating current comes in contact with muscles, it produces tetanic stimulation, which induces muscle spasm and does not allow the person to release contact with the source of current. An alternating current of 70–80 mA (milliamperes) can be fatal, whereas direct current (DC) of 200 to 250 mA can be tolerated without much damage.
- The resistance of the skin varies greatly, according to dryness. Wet skin may have a thousand fold reduction in resistance compared to dry skin.
- The point at which the electric current enters the body is called the point of entry. The point of exit denotes the point from where the electric

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current leaves the body. Burns may be seen both at the entry point as well as the exit point (Fig 12.24a & 12.24b). The electrical burn at the point of entry is called **Joule burn** or **endogenous burn**.

- It resembles the size and shape of the object causing it. Generally, it appears as a round or oval, shallow crater, surrounded by a ridge of skin, 2–4 mm high. The floor is composed of pale, flattened skin with a surrounding hyperaemic zone.

| Fig. 12.24a Joule Burn *(Pic : Dr EJ Rodrigues)* |

| Fig. 12.24b High Voltage Electrical Burn - Right Upper Limb |

- The effects of electrocution vary depending on the point of entry and exit.
  - If the point of entry is in one upper limb, and the earthing point is in the opposite foot, the current will pass across the chest in a diagonal direction and be most likely to produce myocardial fibrillation.
  - Electrical current passing through the lower parts of the body may not produce fibrillation at all.
  - Current passing through the head may not affect the heart, but can cause brainstem damage with central respiratory paralysis.
  - Sometimes the entry and exit points of the current are spread over such wide areas that no focal lesions are present on the body, more so when the skin is wet or the body is immersed in water.
- Death lurks in bathrooms where electrocution is common due to wet floors, wet skin, or metal plumbing that acts as a good conductor. Added to this, the presence of faulty earthing, current leakage and downright carelessness in handling electrical appliances make the bathroom a veritable graveyard for the unsuspecting, especially young children and frail, old people.
- **Other types of burns**
  - **Spark burn** is produced by intermittent contact with a live object, and is due to arcing of current from the conductor to the skin. A yellowish parchment-like skin surrounded by a pale area is seen. Sometimes thermal burns are seen over large surface areas of the body. While working with high-tension wire, etc, a person may be thrown off to a distance, yet may show different types of burns. This is also due to arcing. Occasionally there is actual charring of the skin with carbonisation.
  - At times, there is confluence of spark burns resulting in a **crocodile skin** effect (Fig 12.25).

Causes of Death in Electrocution

- Ventricular fibrillation.
- Respiratory failure due to spasm of respiratory muscles.
- Cerebral anoxia.
- Delayed death due to complications of burns.

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| Fig. 12.25 Crocodile Burns (High Voltage) *(Pic : Dr Puneet Arora)* |

Autopsy Findings & Medicolegal Significance

- Burns may be seen at the point of entry and exit. At the point of entry, the burn resembles the shape of the object causing electrocution. The skin may be ruptured at the point of exit.
- All the organs are congested. Petechial haemorrhages are seen on serous surfaces. There may be pulmonary oedema.
- Electrocution is by and large accidental. However, there are cases of electrocution due to suicidal and homicidal intentions. Judicial electrocution is practiced in some states of the USA. (Box 12.3)

RADIATION INJURY

- Radiation injury is caused by exposure to ionizing radiation, which can be particulate radiation caused by protons, neutrons, alpha rays and beta rays, or electromagnetic radiation due to X-rays. Gamma rays with short wavelength are also included in the latter.
- The radioactive elements, on entering the body, act on cells causing their death. This occurs in two ways: chromosomal breaks (double stranded DNA), and production of free radicals.
- Radiation injury has its most pronounced effect on cells in the mitotic phase of cell division. Epithelial cells of the GI tract and lymphoid tissue are especially susceptible.
- A single large dose of irradiation can lead to death (as observed in victims of the Hiroshima and Nagasaki bombings at the end of World War II).
- At doses greater than 100 Gy (10000 rad), death occurs within 24 to 48 hours. This is known as *acute radiation syndrome*. Most of those who suffer acute radiation injury die, not from the initial radioactive particles themselves, but from the devastation they cause in the immune system, the gastrointestinal tract, and other parts of the body. Main symptoms include nausea, vomiting, circulatory collapse and coma (Box 12.4 recounts the horrific tale of a political assassination carried out by inducing "acute radiation syndrome" in one high-profile victim).

| Fig. 12.26a & b Radiation Injuries |

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- At sublethal doses, delayed effects result in somatic changes such as sterility, premature abortions, and foetal abnormalities. Increased incidence of malignancies (both haematological and solid organ) have been observed.
- In the case of a nuclear explosion like the one that Japan suffered in World War II, generation of thermal radiation consisting of ultraviolet rays, infrared and light rays, creates a tremendous amount of heat, comparable to the interior of the sun in a volume of space a few inches in diameter. Because the reaction is completed in microseconds, a violent explosion results. Near the hypocentre, the temperature of 6,000°C incinerates the body, blisters tile surfaces, and instantly ignites flammable objects. At distances of about 3 kilometres, the skin is charred, but at distances closer to the hypocentre, internal tissues are injured as if they are roasted, and death is instantaneous. As thermal radiation and the penetrating nuclear radiation of gamma rays and neutrons act upon the body simultaneously, the combined effects would be lethal for those out in the open within 1,500 meters of the hypocentre, even for those who are not injured by the trauma.

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Box 12.3 Judicial Electrocution

The use of judicial electrocution as a means of executing a sentence of death against convicted criminals was first mooted in the mid 19th century in New York, USA, and arose out of concerns as to the unpredictability of hanging in causing a quick, certain death. Dr J Mount Bleyer designed the first electric chair.

The first execution by electric chair took place in New York in 1890. A 1400 volt, 150 Hz AC current was applied to a prisoner for 17 seconds. The attending medical officer was so certain that this was sufficient, that he declared the person dead immediately. Unfortunately, within the next few minutes, the prisoner began to groan and started to breathe once again. The current was hastily reapplied for an additional 2 minutes. This time around, the prisoner was indubitably dead. Eye witnesses even reported that the electric current was so intense that they saw smoke rising from the corpse which appeared to have been substantially burnt. Today the technique has been "refined," and proponents of judicial electrocution claim that the method is one hundred percent effective, very quick, and relatively painless.

Fig 1 Electric Chair in Florida State Prison

The actual protocol and voltage varies from state to state. The scalp and the left calf of the condemned person are shaved. One hour prior to the execution, sponges soaked in brine are applied to these areas, to enhance the conductivity of the skin. The condemned man is made to sit in a wooden chair and straps are applied to secure his hands, legs and chest. Metal electrodes are applied and an alternate current of 2400 volts (7.5 amps) is applied for 7 seconds, followed by 600 volts for 17 seconds, the whole being repeated twice. After 5 minutes a physician confirms death, or otherwise the procedure is repeated till life becomes extinct.

Judicial electrocution is presently practised in the following states of the USA: Alabama, Arkansas, Connecticut, Florida, Georgia, Indiana, Kentucky, Nebraska, Ohio, South Carolina, Tennessee, Vermont, and Virginia. But in most of these states, the condemned prisoner is first given the option of lethal injection as a substitute method of execution, if he prefers that. Some of these states have in fact abolished the electric chair totally.

An accurate, though gruesome, account of the procedure involved in judicial electrocution is mentioned in **Stephen King**'s novel *The Green Mile*, which was subsequently made into a movie starring Tom Hanks.

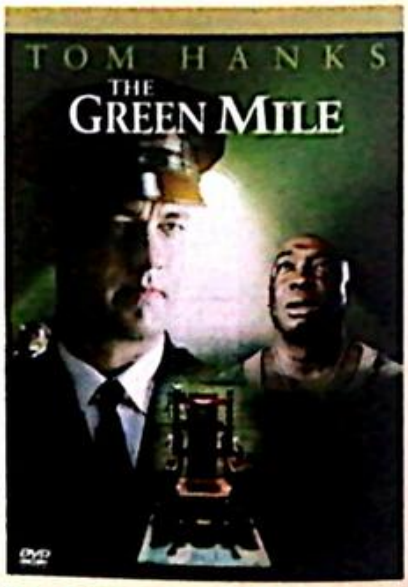

Fig 2 Flim Poster of The Green Mile

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Box 12.4 Assassination by Radiation–The Alexander Litvinenko Case (2006)

Alexander Litvinenko was a former officer of the Russian Federal Security Service, FSB, and KGB, who escaped prosecution in Russia and received political asylum in Great Britain. He authored two books, *"Blowing up Russia: Terror from Within"* and *"Lubyanka Criminal Group,"* in which he accused the Russian secret services of staging Russian apartment bombings and other terrorism acts to bring Vladimir Putin to power.

On 1 November 2006, Litvinenko suddenly fell ill and was hospitalized. Earlier that day he had met two former KGB officers, Andrei Lugovoi and Dmitri Kovtun. Lugovoi was a former bodyguard of Russian ex-Prime Minister Yegor Gaidar (also reportedly poisoned in November 2006), and former chief of security for the Russian TV channel ORT. Litvinenko had also had lunch at Itsu, a sushi restaurant on Piccadilly in London, with an Italian acquaintance, Mario Scaramella. The latter attached to the Mitrokhin Commission investigating KGB penetration of Italian politics, claimed to have information on the death of Anna Politkovskaya, 48, a journalist who was killed at her Moscow apartment in October 2006. He passed Litvinenko papers supposedly concerning her fate. On 20 November, it was reported that Scaramella had gone into hiding and feared for his life. Litvinenko died on 23 November.

Alexander Litvinenko – Before and After Exposure to Polonium-210

Shortly after his death, the UK's Health Protection Agency (HPA) stated tests had established Litvinenko had significant amounts of the radionuclide polonium-210 (Chemical symbol: ^{210}Po) in his body. British and US government sources both said the use of ^{210}Po as a poison had never been documented before, and this was probably the first time a person had been tested for the presence of ^{210}Po in his or her body. The poison was in Litvinenko's tea cup.

Polonium could be identified only after Litvinenko's death; it was not detected earlier because it does not emit gamma rays, which are encountered with most radioactive isotopes. Polonium-210 emits only alpha particles that do not penetrate even a sheet of paper, or the epidermis of human skin, thus being invisible to normal radiation detectors. Hospitals only have equipment to detect gamma rays. However, both gamma rays and alpha particles are classified as ionizing radiation which can cause radiation damage. An alpha-emitting substance can cause significant damage only if ingested or inhaled, acting on living cells like a short-range weapon. Litvinenko was tested for alpha-emitters using special equipment.

Litvinenko's autopsy took place on 1 December. According to doctors, his body had five times the level of polonium-210 that would be considered lethal.

Litvinenko's funeral reading took place on 7 December in Central London, after which his body was buried at Highgate Cemetery in North London.

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CHAPTER 13

Medicolegal Aspects of Injuries and Death

A doctor can only treat patients. A doctor can only help the people who are shot or who are injured. But a politician can stop people from injuries. A politician can take a step so that no person is scared tomorrow.

—**Malala Yousafzai** (Born: 12 July 1997; Pakistani activist for female education and the youngest-ever Nobel Prize laureate)

INJURIES AND THE DOCTOR

Since the nature of infliction of mechanical injuries is either **accidental, suicidal,** or **homicidal**, they are always associated with legal implications. Many such cases find their way to the criminal court. Therefore a doctor who has examined and treated such cases will inevitably be called to give evidence as an *expert witness*. His opinion is often crucial to the final outcome. It is imperative that every doctor be familiar with the procedure of examination and recording of data. The following constitute some important points in this regard:

- Every injury must be accurately documented as to the type, location, dimensions, presence or absence of foreign bodies, time of infliction, etc. Measurements must be exact, and terms such as 'about,' 'approximately,' etc., must not be used.
- As far as possible take photographs, or draw simple sketches of injuries.
- While the primary duty of a doctor is to treat a patient, he must never neglect medicolegal requirements.
- An **Accident cum Wound Certificate** is a medicolegal requirement to be recorded by the attending medical officer, especially by the first attending doctor, in full detail, in all cases irrespective of accident, suicide or homicide, when the doctor-patient relationship is established. It is to be prepared in duplicate, with the original furnished to the police as a confidential report when necessary, and the duplicate (carbon copy) to be retained in the institution under confidential safe custody. In India, the exact proforma differs from state to state, but is usually made available at both private and government hospitals. However, if a person is brought not as a patient but merely for certification of examination of wounds sustained, it is essential to insist on an official requisition from the police or court before commencing the examination to prepare the **wound certificate**. A sample of such a wound certificate is shown in Box 13.1. In such a case, a doctor-patient relationship is not necessarily established, and there is only doctor-subject relationship.
- An informed written consent is a must only for wound examination in the scenario of doctor-subject relationship, and not in that of doctor-patient relationship. But if the person is under arrest, or if there is an order from court, the doctor can proceed with the examination even in the absence of consent. In fact, he is empowered "to use such force as is reasonably necessary for that purpose" (*Section 53 CrPC*). However, whenever a female is to be examined by such force, "the examination shall be made only by, or under supervision of, a female registered medical practitioner."
- The doctor has to exercise maximum skill and care during management. Required investigations have to be undertaken. Dying declaration, if required, should be recorded in the usual manner.
- It is desirable for a government doctor to intimate to the police, all wounded cases, irrespective of the manner and nature of occurrence. But

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Box 13.1 Wound Certificate

From

Dr. .....
.....
.....
.....

To

The Sub-Inspector of Police
.....
.....
.....

Sir,

Sub: Issuance of wound certificate reg.
Ref: Requisition No. ....., dt. .....

Name of individual :
Sex :
Age :
Address :
Identification Marks : 1.....
2.....

Consent (*signature or thumb impression*)
Accompanying P.C.No., P.S. :
Brief History :
Date of Examination :

Time of Examination :
Beginning .....
Conclusion.....

Place :
Injuries :

Nature	Size	Site	Simple/ Grievous	Nature of weapon	Dangerous weapon or not	Additional remarks

Signature of Medical Officer
Date :
Name :
Designation:

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a private practitioner can abstain from such intimation in suicidal and accidental cases, if the patient does not give consent for such intimation.

- As per *Section 39 CrPC*, every citizen (including a doctor) has to give information about certain offences to police. Such offences include **murder** (*Sec. 300 IPC*), **culpable homicide** (*Sec. 299 IPC*), **theft after preparation was made for causing death or hurt** (*Sec. 382 IPC*).
- The duty of the doctor while examining a wounded subject is to record the wounds in detail and give necessary opinion. Recording and subsequent issue of the **wound certificate** is a must. The findings should be kept confidential. The wound certificate must be prepared in triplicate, under the seal and signature of the medical officer who prepared it. The original as well as one copy must be handed over to the police officer concerned in a sealed, addressed cover. The other copy is to be retained by the medical officer.

The recommended proforma of **wound certificate** is given in **Box 13.1**.

INJURIES AND THE LAW

Nature of Injury

The law is not concerned with explicit differences between the terms **hurt, trauma, injury,** and **wound**. However, in strict legal parlance the word **injury** denotes any harm, illegally caused to any person in body, mind, reputation or property (*Section 44 IPC*). **Hurt** is defined as any bodily pain, disease, or infirmity caused to a person (*Section 319 IPC*).

There is a special category of hurt referred to as **grievous hurt** (*Section 320 IPC*), of which the following constitute examples:

1. Emasculation.
2. Permanent privation of the sight of either eye.
3. Permanent privation of the hearing of either ear.
4. Privation of any member or joint.
5. Destruction or permanent impairment of the powers of any member or joint.
6. Permanent disfiguration of the head or face (**Fig 13.1**).
7. Fracture or dislocation of a bone or tooth.
8. Any hurt which endangers life, or which causes the sufferer to be in severe bodily pain, or unable to follow his ordinary pursuits, during the space of twenty days.

| **Fig. 13.1** Grievous Hurt - Permanent Disfiguration of Face
(Pic : Dr Shashidhar C Mestri) |

Note

- Self-inflicted injuries (**Fig. 13.2**) are not covered by this definition.
- Emasculation* means deprivation of masculine vigour (inflicting impotence by amputation of penis, or causing inability to take part in sexual intercourse by any means).
- A crack fracture of bone which does not involve the medullary cavity will not be considered as fracture, for the purpose of this section.
- A mere stay in hospital for 20 days or more will not constitute grievous hurt. It must be proved that during this period, he was in severe bodily pain or unable to follow his ordinary pursuits.

**Emasculation is different from castration which refers to removal of testicles. Castration is covered by item No. 4.*

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| Fig. 13.2 Self-Inflicted Incised Wounds (Pic : Dr Zachariah Thomas) |

- An injury may be construed as "simple" from the medical point of view, but legally, it may fit one of the clauses (examples) under *Section 320 IPC*. The opinion of the doctor as to the nature of injury must always be as per legal definition.
- The final opinion as to whether a particular injury is simple or grievous is left to the discretion of the court. The role of the doctor is only to guide and help the court in deciding the issue.

Other Relevant Sections of the Indian Penal Code Pertaining to Injury

1. **Voluntarily causing hurt** (*Section 321 IPC*) – Whoever does any act with the intention of causing hurt to any person, or with the knowledge that he is likely to cause hurt to any person, and does thereby cause hurt to any person, is said "voluntarily to cause hurt."
   - **Punishment for voluntarily causing hurt** (*Section 323 IPC*) – Imprisonment of either description for a term which may extend to one year, or with fine which may extend to one thousand rupees, or with both.
2. **Voluntarily causing grievous hurt** (*Section 322 IPC*) – Whoever voluntarily causes hurt, if the hurt which he intends to cause or knows himself to be likely to cause is grievous hurt, and if the hurt which he actually causes amounts to grievous hurt, is said to "voluntarily cause grievous hurt."
   - **Punishment for voluntarily causing grievous hurt** (*Section 325 IPC*) – Imprisonment of either description up to seven years, and shall also be liable to fine.
3. **Voluntarily causing hurt by dangerous weapons or means** (*Section 324 IPC*) – Whoever voluntarily causes hurt by means of any instrument for shooting, stabbing, or cutting, or any instrument which when used as a weapon of offence, is likely to cause death, shall be punished with imprisonment of either description for a term which may extend to three years, or with fine, or with both.
4. **Voluntarily causing grievous hurt by dangerous weapons or means** (*Section 326 IPC*) – Whoever voluntarily causes grievous hurt by means of any instrument for shooting, stabbing or cutting, or any instrument which when used as a weapon of offence, is likely to cause death, shall be punished with imprisonment for life, or with imprisonment of either description for a term which may extend to ten years, and shall also be liable to fine.

Amendments under the Criminal Law (Amendment) Act, 2013:

Section 326A IPC: Whoever causes permanent or partial damage or deformity to, or burns or maims or disfigures or disables, any part or parts of the body of a person or causes grievous hurt by throwing acid on or by administering acid to that person, or by using any other means with the intention of causing or with the knowledge that he is likely to cause such injury or hurt, shall be punished with imprisonment of either description for a term which shall not be less than ten years but which may extend to imprisonment for life and with fine which may extend to ten lakh rupees. Provided that any fine imposed under this section shall be given to the person on whom acid was thrown or to whom acid was administered.

Section 326B IPC: Whoever throws or attempts to throw acid on any person or attempts to administer acid to any person, or attempts to use any other means, with the intention of causing permanent or

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partial damage or deformity or burns or maiming or disfigurement or disability or grievous hurt to that person, shall be punished with imprisonment of either description for a term which shall not be less than five years but which may extend to seven years, and shall also be liable to fine.

Explanation 1: For the purposes of sections 326A and 326B, "acid" includes any substance which has acidic or corrosive character or burning nature, that is capable of causing bodily injury leading to scars or disfigurement or temporary or permanent disability.

Explanation 2: "Permanent or partial damage" includes deformity, or maiming, or burning, or disfiguring, or disabling any part or parts of the body of a person.

Explanation 3: For the purposes of sections 326A and 326B, permanent or partial damage or deformity shall not be required to be irreversible.

So, after these amendments, the following changes have come into effect:

- Earlier, only permanent disfiguration of face was considered as grievous hurt. But now even disfiguration of any other part of the body by throwing or administering acid is considered as grievous hurt.
- Even temporary disability due to throwing or administering of an acid is covered under the amendments.
- The damage or deformity shall not be required to be irreversible.
- The punishments have been enhanced and may extend to life imprisonment and a fine which may extend to ten lakh rupees.
- Even an attempt to throw or administer acid on any person is punishable.
- Offences under sections 326A and 326B are cognizable and non-bailable.

Occasionally, a doctor may be required to assess the extent and severity of physical disability from injuries. Details regarding permanent total or partial disablement are detailed in **The Workmen's Compensation Act, 1923** (for detailed information, refer Box 13.2).

- This act provides for compensation to be paid to employees by their employer in case of injury, disease, or disability resulting from occupational hazards, provided the injury, disease or disability was not the product of careless conduct of the sufferer while attending to his duties.
- The amount of compensation payable will depend upon the extent of injury, nature of the disease, or degree of disability. The latter is generally classified as permanent or temporary disability, and also as total or partial, depending upon the nature and extent of damage.
- In case of death, the legal heir of the employee will receive the compensation.

Manner of Injury

Injuries may be caused by human beings, animals or machines. Such infliction may be accidental or, if they have been caused by a human being, they could be suicidal or homicidal.

Homicide

The term "homicide" means causing the death of a person by another person.

The term "**dyadic death**" is used when homicide of a victim is followed by suicide of the perpetrator (formerly referred to as "homicide-suicide").

*Classification**

1. **Lawful**
   a. Justifiable
   b. Excusable
2. **Unlawful (Culpable)**
   a. Amounting to Murder
   b. Not Amounting to Murder

**Please note that 'lawful homicide' does not have a legal definition and is a term used informally only to clarify the meaning of 'unlawful homicide' (which does have a legal definition) more effectively.*

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Box 13.2 Workmen's Compensation Act, 1923

The Workmen's Compensation Act, 1923 provides for payment of compensation to workmen and their dependants in case of injury and accident (including certain occupational disease) arising out of and in the course of employment and resulting in disablement or death. The Act applies to railway servants and persons employed in any such capacity as is specified in Schedule II of the Act. The Schedule II includes persons employed in factories, mines, plantations, mechanically propelled vehicles, construction works and certain other hazardous occupations.

The amount of compensation to be paid depends on the nature of the injury and the average monthly wages and age of workmen. The minimum and maximum rates of compensation payable for death (in such cases it is paid to the dependents of workmen) and for disability have been fixed and is subject to revision from time to time.

A Social Security Division has been set up under the Ministry of Labour and Employment, which deals with framing of social security policy for the workers and implementation of the various social security schemes. It is also responsible for enforcing this Act. The Act is administered by the State Governments through Commissioners for Workmen's Compensation.

The main provisions of the Act are:-

- An employer is liable to pay compensation
  - If personal injury is caused to a workman by accident arising out of and in the course of his employment.
  - If a workman employed in any employment contracts any disease, specified in the Act as an occupational disease peculiar to that employment.
- However, the employer is not liable to pay compensation in the following cases -
  - If the injury does not result in the total or partial disablement of the workman for a period exceeding three days.
  - If the injury, not resulting in death or permanent total disablement, is caused by an accident which is directly attributable to
    - the workman having been at the time of the accident under the influence of drink or drugs
    - willful disobedience of the workman to an order expressly given, or to a rule expressly framed, for the purpose of securing the safety of workmen
    - willful removal or disregard by the workman of any safety guard or other device which has been provided for the purpose of securing safety of workmen.

The State Government may, by notification in the Official Gazette, appoint any person to be a Commissioner for Workmen's Compensation for such area as may be specified in the notification. Any Commissioner may, for the purpose of deciding any matter referred to him for decision under this Act, choose one or more persons possessing special knowledge of any matter relevant to the matter under inquiry to assist him in holding the inquiry.

Compensation shall be paid as soon as it falls due. In cases where the employer does not accept the liability for compensation to the extent claimed, he shall be bound to make provisional payment based on the extent of liability which he accepts, and, such payment shall be deposited with the Commissioner or made to the workman, as the case may be.

contd.

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If any question arises in any proceedings under this Act as to the liability of any person to pay compensation (including any question as to whether a person injured is or is not a workman) or as to the amount or duration of compensation (including any question as to the nature or extent of disablement), the question shall, in default of agreement, be settled by a Commissioner. No Civil Court shall have jurisdiction to settle, decide or deal with any question which is by or under this Act required to be settled, decided or dealt with by a Commissioner or to enforce any liability incurred under this Act.

The State Government may, by notification in the Official Gazette, direct that every person employing workmen, or that any specified class of such persons, shall send at such time and in such form and to such authority, as may be specified in the notification, a correct return specifying the number of injuries in respect of which compensation has been paid by the employer during the previous year and the amount of such compensation together with such other particulars as to the compensation as the State Government may direct.

Whoever, fails to maintain a notice-book which he is required to maintain; or fails to send to the Commissioner a statement which he is required to send; or fails to send a report which he is required to send; or fails to make a return which he is required to make, shall be punishable with fine.

Lawful Homicide

- It refers to the causing of death of a person which is permissible or excusable by law.
  - The former is called **justifiable homicide**, e.g., judicial hanging.
  - **Excusable homicide** is that type of lawful homicide which is caused unintentionally by an act done in good faith, or in self-defence.

Culpable Homicide (Section 299 IPC)

Whoever causes death by doing an act with the intention of causing death, or with intention of causing such bodily injury as is likely to cause death, or with the knowledge that he is likely by such act to cause death, commits the offence of culpable homicide.

Murder (Section 300 IPC)

Except in the cases hereinafter mentioned, culpable homicide is murder, if:

Firstly – The act by which the death is caused is done with the intention of causing death, or

Secondly – If it is done with the intention of causing such bodily injury as the offender knows to be likely to cause the death of the person to whom the harm is caused, or

Thirdly – If it is done with the intention of causing bodily injury to any person, and the bodily injury intended to be inflicted is sufficient in the ordinary course of nature to cause death, and

Fourthly – If the person committing the act knows that it is so imminently dangerous that it must in all probability cause death or such bodily injury as is likely to cause death.

Exceptions

Culpable homicide is **not** murder if:

- The offender, whilst deprived of the power of self-control by grave and sudden provocation, causes the death of the person who was responsible for the provocation, or causes the death of any other person by mistake or accident.
- The offender, in the exercise (in good faith) of the right of private defence of person or property, exceeds the power given to him by law and causes death of the person without premeditation, and without any intention of doing more harm than is necessary for the purpose of such defence.
- The offender, being a public servant or aiding a public servant acting for the advancement of public justice, exceeds the powers given to him by law, and causes death by doing an act which he, in good faith, believes to be lawful and necessary for the due discharge of his duty.

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- The offence is committed without premeditation in the heat of passion, in the course of a fight, without the offender's having taken undue advantage or acted in a cruel or unusual manner.
- The person whose death is caused, being above the age of eighteen years, suffers death or takes the risk of death with his own consent.
- The death of a person other than the intended victim was caused inadvertently (***Section 301 IPC***).

Punishment for Murder (Section 302 IPC)

Death (capital punishment), or imprisonment for life, and shall also be liable to fine.

Punishment for Murder by Life-Convict (Section 303 IPC)

Whoever, being under sentence of imprisonment for life, commits murder, shall be punished with death.

Punishment for Culpable Homicide not Amounting to Murder (Section 304 IPC)

Imprisonment for life, or imprisonment of either description for a term which may extend to ten years, and shall also be liable to fine.

Harassment for Dowry (Section 498-A IPC)

Whoever being the husband or the relatives of the husband of a woman subject such woman to cruelty for the purpose of extracting dowry shall be punished with imprisonment for a term which may extend to three years, and shall also be liable for fine.

Dowry Death (Section 304-B IPC)

- Where the death of a woman is caused by any burn or bodily injury or occurs otherwise than under normal circumstances within seven years of her marriage and it is shown that soon before her death she was subjected to cruelty or harrassment by her husband or any relative of her husband for, or in connection with any demand for dowry, such death shall be called "**dowry death**," and such husband or relative shall be deemed to have caused her death.
- In cases of dowry death, the inquest should be conducted by a magistrate or police officer not below the rank of deputy superintendent of police.
- The postmortem examination should be carried out by a panel of two doctors, one of whom should preferably be a lady medical officer.

Accident

Accidental death is one where there was no intention to cause death of oneself, or of another.

Road Traffic Accidents

- Numerically, **road traffic accidents** account for the great majority of accidental deaths world-wide.
- The purpose of forensic examination in traffic accidents is to determine the nature and manner of causation of injuries on a pedestrian, or the occupant or rider of a vehicle. At times, it may be necessary to reconstruct the details of an accident on the basis of the pattern of injuries, especially if there are no eyewitnesses.
- In traffic accidents, apart from examination of injuries sustained, a doctor has to observe whether the driver or pedestrian was suffering from any disease or disability, or if there is evidence of intoxication, and if so, whether the accident could have been a result of that.
- Identification of the vehicle involved in a **hit and run** case may be assisted by looking for trace evidence that is likely to have been exchanged between the victim and vehicle at the time of impact (**Locard's principle of exchange**, see *page 453*)

13

Pedestrian Injuries

The distribution and severity of pedestrian injuries depend on the speed and momentum of the impacting vehicle.

Classification

1. Primary impact injuries
2. Secondary impact injuries
3. Tertiary impact injuries

Primary Impact Injuries (Fig. 13.3)

- These are produced by the initial contact with the vehicle, and may be in the form of abrasions,

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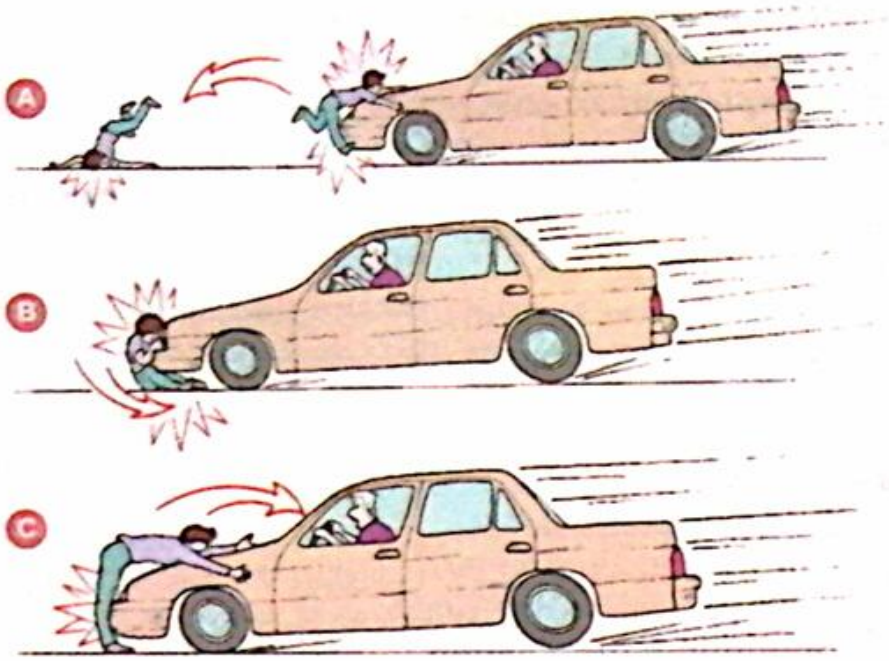

| Fig. 13.3 Road Traffic Accident: Pedestrian–Primary Impact Types |

lacerations or contusions. Occasionally, patterned injuries are seen (Fig. 13.4).

- Often, both legs may get fractured in the region of impact with the bumper of the vehicle (**bumper fracture**) (Fig. 13.5).
- Direct impact on the thorax not only results in fracture, but also may rupture the aorta.
- Direct impact on the hips may cause fracture of the vertebral column and pelvis.

| Fig. 13.4 Patterned Abrasions *(Pic : Dr Hareesh S Gouda)* |

| Fig. 13.5 X-ray Bumper Fracture - Knee |

Secondary Impact Injuries

- They are caused by subsequent contact of body with vehicle after the primary impact.
- They usually result from the victim being flung into the air after the primary impact and subsequently landing against the hood, windscreen, or roof of the vehicle.
- Head injuries are common.

Tertiary Injuries

- These injuries are caused by striking against objects or surfaces other than the vehicle, such as the kerb, road surface, or street poles.

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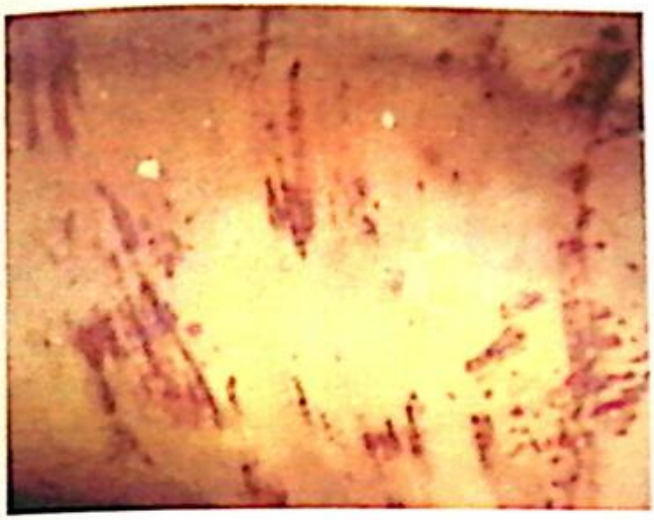
- Grazed abrasions, flaying injuries, etc., due to being dragged on the road are common (Fig. 13.6).



| Fig. 13.6 Multiple Grazed Abrasions (Pic : Dr Shashidhar C Mestri) |

Vehicular Occupant Injuries

- Injuries to driver and other occupants are mostly related to sudden deceleration due to collision, the commonest type of vehicular accident.
- The driver and front seat passenger often sustain lacerations over the face due to impact against the windscreen, and fracture or dislocation of hip due to hitting against the dashboard. Fractures and dislocations of upper and lower limbs are also common.
- A special type of injury seen in the driver is the **steering wheel impact injury**, which causes fractures of sternum and ribs, as well as contusion or even rupture of the heart or aorta. Hitting against the rim of the steering wheel may rupture liver, spleen, kidneys, or duodenum.
- Sudden hyperextension or flexion of the neck may result in fracture-dislocation of cervical spine and injuries of the spinal cord (**whiplash injury**, see *page 252*) (Fig. 13.7).

| Fig. 13.7 Whiplash |

Railway Accidents

- Railway accidents may involve a person who is not an occupant of the train (e.g., someone who is attempting to cross railway tracks), as well as one who is an occupant (passenger, driver, etc).
- The former invariably may be hit or run over. Primary impact injuries may be sustained over the front, back, or one or the other side of the body. After being hit, if he is thrown clear, he can sustain secondary injuries due to impact against the rail tracks, the ground, rocks or boulders, posts, or trees. If he is run over by the train, the injuries are usually in the form of decapitation (Fig 13.8), amputations (Fig 13.9) at various levels, transection of trunk, etc., which can be either instantly fatal, or extensively mutilating. Decapitation alone without the presence of other injuries usually indicates suicide, wherein the victim has lain on the tracks with the neck on one of the tracks, and the rest of the body lying outside the tracks. In such a case, there is usually generalized pallor of organs.
- Passengers of a railway train can sustain injuries when the train collides with another, or if it derails at high speed. Generally, they take the form of blunt injuries due to falling out of berths, or being

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| **Fig. 13.8** Decapitation - Railway Suicide *(Pic : Dr Jagadish Rao PP)* |

| **Fig. 13.9** Amputation of Leg - Railway Injury *(Pic : Dr Prateek Rastogi)* |

knocked about violently, or heavy luggage falling on them, etc. Occasionally, a passenger who is hanging out of a compartment door, or peeping out injudiciously may hit against posts or trees. Electrocution, or death by burns, or drowning in a lake or river (if the train falls off a bridge), etc., can also occur in train accidents.

Air Traffic Accidents

Aviation injuries characteristically involve large numbers of occupants, and are almost always highly mutilating, with a high degree of possibility for dismemberment or even fragmentation.

- The actual nature of injuries will depend on the circumstances.
  - If decompression of a large aircraft cabin occurs at high altitude, victims may be sucked out and fall to their death; others may suffer from barotrauma or physical trauma from being thrown about within the cabin.
  - When an aircraft hits the ground, the effects will depend upon the speed and angle of impact. Injuries result mainly from extreme-deceleration, and are usually of severe nature.
  - An aircraft which crashes or sustains a mid-air collision almost inevitably will burst into flames, and the occupants could get extensively burnt, or even reduced to ashes.
- Identification of each and every passenger and crewmember is the main aim of the autopsy in aircraft accidents, and is often a daunting task.
- Other important objectives include the evaluation of flight crew for evidence of disease, disability, or drug abuse that could have contributed to the mishap, and the overall reconstruction of events leading to the accident.
- A significant number of aircraft accidents occur at the time of take-off or landing. The various causes of aircraft accidents include:
  - Mechanical defects of aircraft
  - Signaling defects of airport
  - Errors on the part of pilot or other flight crew
  - Collision
  - Climatic disturbances such as storm, or lightning
  - Of late, terrorist activity has become a common cause of aircraft mishaps.
- A new and bizarre twist to aircraft crashes is the possibility of deliberate crashing of the aircraft by the pilot or co-pilot killing all crew and passengers on board. This may be an act of terrorism, or an act of suicide-mass homicide **(Box 13.3)**.

Waterway Accidents

- In waterway accidents, fatalities occur most commonly due to drowning rather than due to injuries.

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Box 13.3 Aircraft as a Weapon of Terrorism or Suicide-Mass Homicide

During World War II, the Russian aviator Nikolai Gastello was the first Soviet pilot credited with a "fire taran", a suicide attack by an aircraft on a ground target. In the following years there were more suicide attacks. The best known suicide attacks by military aviators are the attacks from the Empire of Japan, called 'kamikaze', against Allied naval vessels in the closing stages of the Pacific campaign of World War II. These attacks designed to destroy warships more effectively than by conventional means were mostly executed between October 1944 and 1945 in which 3,860 kamikaze pilots committed suicide.

The horrific September 11 attacks of 2001 (also referred to simply as 9/11 or 'nine eleven') marked a new era of suicide-mass homicide using a civilian aircraft as a weapon of mass destruction. A series of four coordinated terrorist attacks were launched by the Islamic terrorist group al-Qaeda on the United States in New York City and the Washington, DC metropolitan area on Tuesday, September 11, 2001. The attacks killed 2,996 people (including 19 hijackers) and caused at least $10 billion in property and infrastructure damage.

Four passenger airliners were hijacked by 19 al-Qaeda terrorists to be flown into buildings in suicide-mass homicide attacks. Two of the planes, American Airlines Flight 11 and United Airlines Flight 175, were crashed into the North and South towers, respectively, of the World Trade Center complex in New York City. Within two hours, both 110-storey towers collapsed with debris and the resulting fires causing partial or complete collapse of all other buildings in the WTC complex, including the 47-storey 7 World Trade Center tower, as well as significant damage to ten other large surrounding structures.

Nine Eleven Attack - 11 Sept 2001

A third plane, American Airlines Flight 77, was crashed into the Pentagon (the headquarters of the United States Department of Defense), leading to a partial collapse of its western side. The fourth plane, United Airlines Flight 93, was targeted at Washington, DC, but crashed into a field near Shanksville, Pennsylvania after its passengers tried to overcome the hijackers. In total, 2,996 people died in the attacks, including the 227 civilians and 19 hijackers aboard the four planes. It was the deadliest incident for firefighters and law enforcement officers in the history of the United States, with 343 and 72 killed respectively.

Suspicion quickly fell on al-Qaeda. Although the group's leader, Osama bin Laden, initially denied any involvement, in 2004, he claimed responsibility for the attacks. Al-Qaeda and bin Laden cited US support of

contd.

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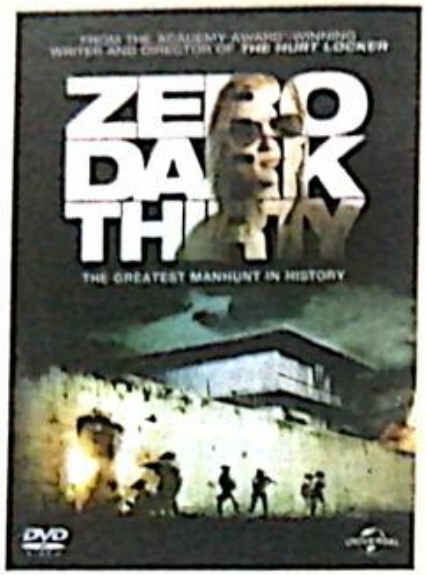
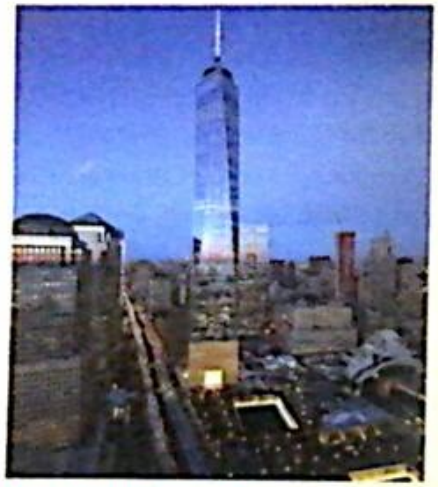
Israel, the presence of US troops in Saudi Arabia, and sanctions against Iraq as motives. The United States responded by launching the War on Terror and invading Afghanistan to depose the Taliban, which had harboured al-Qaeda. Many countries strengthened their anti-terrorism legislation and expanded law enforcement powers. Having evaded capture for almost a decade, bin Laden was located and killed by US forces in May 2011. The entire drama of locating bin Laden and his subsequent killing was starkly portrayed in the Hollywood film 'Zero Dark Thirty'.



Film Poster - Zero Dark Thirty

The destruction of the Twin Towers and other properties caused serious damage to the economy of Lower Manhattan and had a significant effect on global markets, closing Wall Street until September 17 and the civilian airspace in the U.S. and Canada until September 13. Cleanup of the World Trade Center site was completed in May 2002, and the Pentagon was repaired within a year. Numerous memorials have been constructed, including the National September 11 Memorial & Museum in New York, the Pentagon Memorial, and the Flight 93 National Memorial in Pennsylvania. On November 18, 2006, construction of One World Trade Center began at the World Trade Center site. The building was officially opened on November 3, 2014.


One World Trade Center

On 24 March 2015, an Airbus A320-200 (Germanwings Flight 9525), crashed 100 kilometres (62 miles) northwest of Nice, in the French Alps, after a constant descent that began one minute after the last routine contact with air traffic control and shortly after the aircraft had reached its assigned cruise altitude. All 144 passengers and six crew members were killed. This was a scheduled international passenger flight from Barcelona-El Prat Airport in Spain to Düsseldorf Airport in Germany, operated by Germanwings, a low-cost airline owned by Lufthansa. The crash was intentionally caused by the co-pilot, Andreas Lubitz.

Having previously been treated for suicidal tendencies and been declared "unfit to work" by a doctor, Lubitz kept this information from his employer and reported for duty. During the flight, he locked the captain out of the cockpit before initiating a descent that caused the plane to crash into a mountain. In response to the incident and the circumstances of Lubitz's involvement, aviation authorities in Canada, New Zealand, Germany, and Australia implemented new regulations that require two authorized personnel to be present in the cockpit at all times. Many other countries, including India, are expected to follow suit.

Andreas Lubitz

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- However, the violent rocking of vessels in storm or collision may cause blunt injuries to the occupants by being thrown about, or due to luggage falling on them, etc.

Suicide

- The deliberate act of taking one's own life is called "suicide."
- Common reasons for taking this extreme step include:
  - Endogenous depression
  - Depression arising out of sudden financial loss, bereavement, terminal illness, etc.
  - Escaping from huge debts which cannot be paid back, or from someone who is blackmailing the person for some illegal or immoral act
  - Harassment of a married woman by husband for dowry ("dowry death")
  - Harassment of a person by someone for other reasons
- Common methods of suicide in India include:
  - Hanging
  - Drowning
  - Poisoning
  - Immolation (burning)
  - Jumping from a tall structure (multi-storeyed building, bridge, mountain cliff, etc)
  - Getting run-over by railway train
  - Cut throat injury, cutting wrists, etc. In such cases, tentative or hesitation cuts may be seen **(Fig 13.10)**.

| **Fig. 13.10** Suicidal Incised (Tentative) Cuts *(Pic : Dr Geetha O)* |

- **Legal Aspects**
  - *Section 309*: **Attempt to commit suicide** – Whoever attempts to commit suicide and does any act towards the commission of such offence, shall be punished with simple imprisonment for a term which may extend to one year (or with fine, or with both).

    Section 309 of the Indian Penal Code is set to be limited in effect by the Mental Health Care Bill, 2013. The Mental Health Care Bill was introduced to the Rajya Sabha on August 19, 2013 and provides, in article 124, that "Notwithstanding anything contained in section 309 of the Indian Penal Code, any person who attempts to commit suicide shall be presumed, unless proved otherwise, to be suffering from mental illness at the time of attempting sucide and shall not be liable to punishment under the said section." It also provides that the Government shall have the duty to provide medical care to any such person attempting suicide.

    The bill was referred by the Rajya Sabha to a Standing Committee on September 18, 2013, which submitted a report on 20 November 2013. In its report, the Standing Committee had three concerns on this provision: firstly, that the presumption of mental illness would subject persons to 'mental health treatment'; secondly, concerns about the consequences on Section 306 of the Penal Code, which deals with abetment to suicide; and thirdly, concerns regarding the "institutionalization in silencing victims of domestic violence." In response, the Ministry proposed amendments which would change the language of this provision to one concerning the "presumption of severe stress in case of attempt to commit suicide". The Committee accepted this recommendation, noting that there was still ambiguity regarding the stage at which this presumption would operate.

    In response to a question in the Rajya Sabha on decriminalisation of suicide on 10 December 2014, the Minister of State for Home Affairs, Haribhai Chaudhary replied that "it has been decided to delete Section 309 of IPC

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from the Statute book." However, pending the passage of the Mental Health Care Bill 2013, Section 309 of the Indian Penal Code is yet to be limited or repealed.

On 24 February 2015, the Minister of State in the Ministry of Home Affairs said that a proposal to delete Section 309 from the Indian Penal Code had been sent to the Legislative Department of the Ministry of Law and Justice for drawing up a draft Amendment Bill. The Mental Healthcare Bill 2013 has been passed in the Rajya Sabha on August 8, 2016.

- *Section 306*: **Abetment of suicide** – If any person commits suicide, whoever abets the commission of such suicide, shall be punished with imprisonment of either description for a term which may extend to ten years, and shall also be liable to fine.
- *Section 305*: **Abetment of suicide of child or insane person** – If any person under eighteen years of age, or any insane or mentally challenged person, or any person in a state of intoxication, commits suicide, whoever abets the commission of such suicide, shall be punished with death or imprisonment for life, or imprisonment for a term not exceeding ten years, and shall also be liable to fine.
- *Section 304B*: **Dowry death** – Where the death of a woman is caused by any burns or bodily injury, or occurs otherwise than under normal circumstances within seven years of her marriage, and it is shown that soon before her death she was subjected to cruelty or harassment by her husband or any relative of her husband for, or in connection with, any demand for dowry, such death shall be called "dowry death" and such husband or relative shall be deemed to have caused her death. Whoever commits dowry death shall be punished with imprisonment for a term which shall not be less than 7 years, but which may extend to imprisonment for life.

Mass Disasters

- A mass disaster is a catastrophic event where there is almost always a substantial loss of life, as well as damage of property (and occasionally, loss of crops and livestock).
- Mass disasters are increasing in incidence due to bizarre climatic conditions, transportation accidents, and terrorism.
- Examples of a mass disaster
  - Multistoreyed building collapse (e.g., a block of residential flats, office building, etc).
  - Earthquake, including tsunami (earthquake under the sea leading to massive flooding)
  - Cyclone
  - Flood due to torrential rains
  - Explosion (especially terrorist bombing)
  - Aircraft accident
  - Industrial accident
  - Large scale rioting
  - Disease pandemic.
- Treatment of survivors, identification of the dead, reconstruction of mutilated remains to make them fit for presentation, and collection of evidence to determine and reconstruct the cause of disaster, all assume great importance.
  - This can be brought about only by teamwork of professionals of different fields, such as administration, police, medical and forensic experts, fire service, civil defense, water and power supply services, telecommunications, transportation services, etc.
  - A forensic pathologist as a member of the team has a pivotal role in such situations.
    - After emergency medical teams have satisfied themselves that all living survivors have been removed for treatment, the position of every corpse (or body fragment) must be marked, numbered and photographed.
    - They must then be removed to a temporary mortuary close to the site, which has adequate lighting and water connections, and communications facility. A part of this building can be used as an autopsy hall.
    - A team must be constituted comprising a forensic pathologist, forensic scientist, and dentist to undertake meticulous medicolegal investigation.

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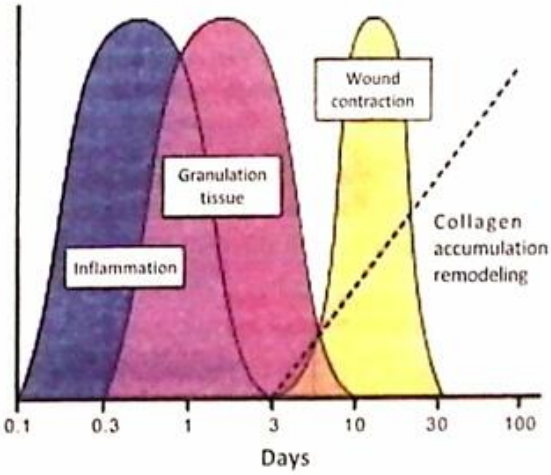
- While management of mass disasters is done systematically in most Western countries, the situation is unfortunately far from satisfactory in India.

AGE ESTIMATION OF INJURY

- Before an attempt is made to estimate the age of an injury at autopsy, it must be first determined clearly as to whether it is an **antemortem** or **postmortem** injury, i.e., whether it was inflicted during life or after death (Fig 13.11).
  - Evidence of ***vital reaction*** will be present in an antemortem injury, such as swelling, redness, leucocyte infiltration, pus formation, and process of repair. The longer the victim lives after sustaining an injury, the more evident will be the vital reaction.

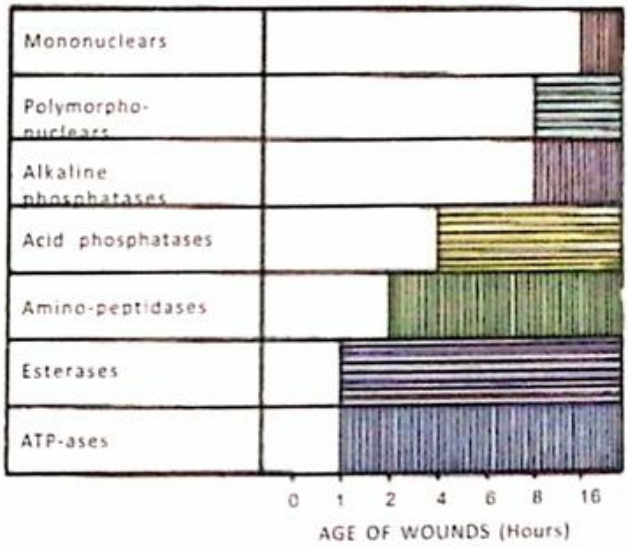


The orderly phases of wound healing

| **Fig. 13.11** Age Estimation of Injury Based on Different Phases of Healing *(Fig : Dr Dharmaraya Ingale)* |

  - The quantity of blood lost also may help in deciding whether the injury was antemortem or not. Thus, the presence of a large pool of blood probably suggests that the injury was antemortem.
  - Evidence of spurting of blood is an important indication of antemortem injury because it indicates the presence of arterial pressure at the time of sustaining the wound.
  - Wound gaping, adherent blood clots, etc., also indicate antemortem nature.

- Injuries occurring during the **perimortem** period may lead to difficulties. Perimortem period refers to the period very close to the death process, i.e., just before or after life gets extinguished. Injuries inflicted during this period do not demonstrate clear cut antemortem findings.
- The exact age of a wound may be difficult to deduce, but an approximate estimate can be done on the basis of reparative processes (see **Chapter 9**). Many types of injuries can be aged quite precisely on the basis of the stage of the healing process, e.g., abrasion, bruise, incision, etc.
- ***Enzyme histochemistry*** can help in more accurately estimating the age of wounds (**Fig. 13.12**).



| **Fig. 13.12** Schematic Diagram Showing the Histochemical Estimation of the Age of Antemortem Skin Wounds *(Fig : Dr Dharmaraya Ingale)* |

  - Enzyme activity is increased towards the periphery of the injury, and decreased in the region of the central zone. The activity of the following enzymes is increased in the peripheral zone: *adenosine triphosphatase* (1 hour), *aminopeptidase* (2 hours), *acid phosphatase* (4 hours), and *alkaline phosphatase* (8 hours).
  - The enzyme activity is detected histochemically by adding suitable chemicals and observing the resultant colour. The central zone (of negative vital reaction) shows diminishing colour, and

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the peripheral zone (of positive vital reaction) increasing colour. The latter is absent in postmortem injuries. Thus this technique can also be used to conclusively determine whether a particular injury is antemortem or postmortem in nature.

- Acid mucopolysaccharides and acid glycosamino-glycones are also reported to show increased and diminished activity in the respective zones, but are not helpful in determining the antemortem nature, since their activity is manifested only after a relatively long time following infliction of the injury.
- The concentration of RNA also increases in the peripheral zone and can be histochemically detected.

CONSEQUENCES OF INJURY (CAUSES OF DEATH FROM INJURY)

A wound may heal, or may get complicated by processes other than healing. Sometimes there are undesirable sequelae, as in the case of healed ureteric rupture causing cicatrization which can result in hydronephrosis. Keloid formation in scars can lead to permanent disfigurement. The most serious consequence of an injury is of course the possibility of death. Causes of death from wounds may be primary or secondary.

Primary (Immediate) Causes of Death

1. **Haemorrhage**

   Bleeding from an injury (*primary haemorrhage*) may be external or internal. A sudden loss of 1000 cc of blood can result in shock and death. If the loss is spread over longer duration, the symptoms are less severe. However, advanced age and pre-existing morbid conditions can predispose to death. Also, effusion of even small amount of blood in certain situations can cause immediate death. An example is cardiac tamponade. Bleeding occurring at a later stage due to infection, or due to dissolution of clot is called *secondary haemorrhage*.

2. **Injury to Vital Organs**

   Severe injury to vital organs such as brain, heart, or lungs can cause death irrespective of blood loss. It is important to note that if the organ is diseased, even trivial trauma can result in fatal consequences.

3. **Neurogenic Shock**

   The nervous control of cardiac and vascular functions is regulated by autonomic nervous system, and involves an optimum balance of two mutually antagonistic sympathetic and parasympathetic divisions. The former stimulates the cardiovascular system, while the latter exerts a tonic and inhibitory control over it, which is conservative-restorative in nature. The functioning of the cardiovascular system may be reflexly affected through the autonomic nervous system by factors such as emotion, variations in pressure in the carotid sinus, changes in the gaseous concentrations of blood, and excitation of peripheral afferent somatic or visceral nerves. These can cause either sympathetic stimulation or parasympathetic inhibition of cardiac function.

   a. *Emotion*: Psychic shock may lead to parasympathetic inhibitory effects, while fear and pain may lead to sympathetic stimulation.
   b. *Variations in pressure in the carotid sinus*: An increase in tension may lead to strong parasympathetic stimulation.
   c. *Gaseous concentrations in the blood*: Low oxygen and high carbon dioxide may cause sympathetic stimulation, acting directly on medullary centres through chemoreceptors of the aortic and carotid bodies.
   d. *Excitation of peripheral nerves*: Stimulation of pressor and depressor afferent fibres can lead to either generalised vasoconstriction with raised blood pressure, or generalised vasodilatation with lowering of blood pressure. Weak stimuli cause depressor effects, while strong stimuli cause pressor effects. Severe pain as in squeezing the testicles, is an example of a strong stimulus.
   e. *Reflex autonomic stimulation*: Can lead to either sympathetic acceleration of pulse, myocardial contractility, generalised vasoconstric-

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tion and increased blood pressure, or parasympathetic reduction of pulse rate, myocardial contractility and central venous pressure, generalised vasodilatation, and decreased blood pressure.

4. **Air Embolism**

Injury to the veins in the neck or chest can lead to air embolism. Air is sucked in due to negative venous pressure. An air lock in the right chamber of the heart results in acute circulatory block.

Secondary (Delayed) Causes of Death

1. **Infection**

Various microorganisms can infect wounds. Prominent among them are bacteria such as *Staphylococci, Streptococci, Pseudomonas, Clostridium tetani,* and *Clostridium welchii*. Cellulitis, abscess, gangrene, pyaemia, septicaemia, and toxaemia are the sequelae. Infection of the original injury with breakdown of sutures or blood clot can result in secondary haemorrhage.

2. **Thrombo-embolism**

Emboli and detached thrombi in injured veins can enter the right ventricle and (if large), can block the main pulmonary artery, or (if smaller), its branches. This can lead to cor pulmonale or pulmonary infarction. The time of occurrence is ordinarily 7–10 days after injury. Leg vein thrombosis is a complication of injuries to lower limb leading to confinement in bed.

3. **Fat Embolism**

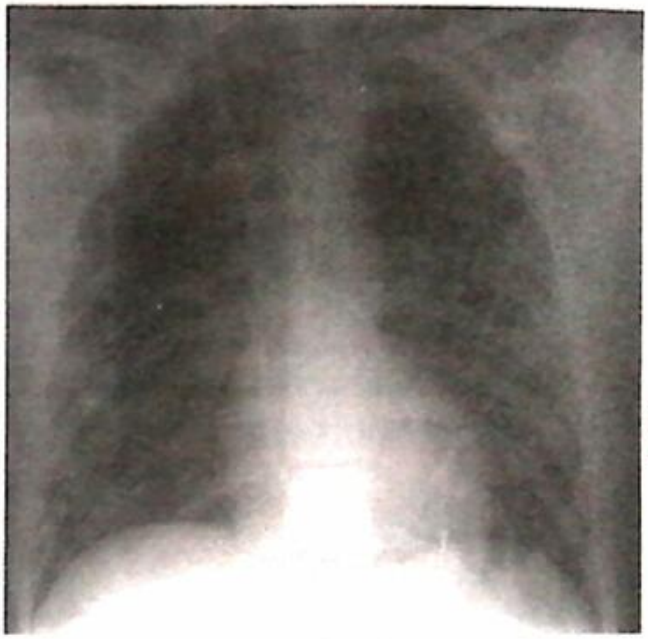
a. Fat can enter damaged veins at the site of injury from fractured long bones, or crushed fatty tissue. After passing through the heart it can enter the systemic circulation.

b. Fat embolism may manifest as punctate haemorrhages in the brain or skin.

c. Oedematous fluid from cut surfaces of lungs may contain fat globules.

d. Urine may also contain fat globules.

e. Respiratory pathology is thought to result from the metabolism of neutral fat particles by lipase within the lungs, releasing free fatty acids and glycerol, which in turn cause severe inflammation of lung parenchyma, endothelial injury, and increased capillary permeability (Fig. 13.13).



| Fig. 13.13 X-ray: Interstitial Oedema – Lungs – Fat Embolism |

f. Only when vital centres of brain are affected, death can be attributed to fat embolism.

g. *Fat embolism syndrome (FES)* is a serious manifestation of fat embolism, which appears as a combination of pulmonary, cerebral and cutaneous symptoms, including acute hypoxia, encephalopathy, thrombocytopenia and cutaneous petechial rashes.

4. **Crush Syndrome**

a. Crush syndrome occurs if a large bulk of muscle is crushed, as for example in vehicular run over injury, or injury due to falling masonry.

b. It is characterized by the development of profound shock.

c. The crushed limb becomes pulseless, and later red, swollen, and blistered. Nerve sensation and muscle power may be lost.

d. Crushing of muscles can liberate haeme and myoglobin, which enter the circulation and get excreted through the kidneys. This can lead to acute tubular necrosis. Death may occur in a week's time. At autopsy, the kidneys appear

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large and bulky, and haeme casts may be found in the distal convoluted tubules.

e. Amputation of the severely crushed limb above the site of compression is necessary to avoid development of crush syndrome. Cooling of the limb, and treatment for renal failure and shock are to be carried out in the event of the syndrome beginning to manifest.

5. **Other Causes**
   a. Trauma can exacerbate an existing disease, e.g., tuberculosis.
   b. Death can occur due to trauma to a diseased organ, e.g., malarial spleen.
   c. Death can also occur from complications arising out of an injury, e.g., hypostatic pneumonia in bedridden victims of spinal cord injury.

INJURIES AND WEAPONS

- The Indian Penal Code describes two types of weapons:
  1. **Deadly weapon** (*Section 148 IPC*): Whoever is guilty of rioting, being armed with deadly weapon, which when used as a weapon of offence is likely to cause death, shall be punished with imprisonment of either description for a term which may extend to three years, or with fine, or with both.
  2. **Dangerous weapon** (*Sections 324 & 326 IPC*): Described on *page 295*
- Weapons can also be classified as being blunt, sharp, or pointed. They are further sub-divided into light and heavy weapons. The lightness or heaviness of a weapon is based on subjective opinion, since no optimum weight is prescribed by law for such classification.

INJURIES AND VOLITIONAL ACTS

Volitional act refers to the ability of a fatally injured person to move and perform certain actions after sustaining an injury, before finally collapsing. Expert medical opinion is essential to clarify such cases. In most cases, it is a matter of conjecture, and often leads to controversy because of conflicting opinions of experts. The reaction to a potentially fatal injury varies from person to person. Dogmatic statements can never be given. The medical officer must be very guarded in his opinion.

SUDDEN DEATH

- **Sudden death is defined as the sudden or unexpected termination of life of an apparently healthy individual, usually from some natural disease.** It is usually taken to mean that death occurred unexpectedly, and from 1 to 24 hours after the onset of symptoms, with or without known preexisting conditions. The emphasis is on the unexpected character, rather than the suddenness of the death. In fact, sometimes the individual may linger on for a few hours or days after the abrupt onset of illness. The expression 'natural death' means that the death was caused entirely by natural disease, and that it was not caused by trauma or poisoning.
- The purpose of a medicolegal autopsy in sudden deaths is to determine whether violence or poisoning has been in any way responsible for the death. Absence of external evidence of injury does not preclude death from physical violence. The age of the deceased, authentic information as to past health status, and the presence or absence of witnesses at the time of death are all helpful in deciding the necessity for an autopsy. Sudden deaths are more frequent in older individuals, and they usually take place under circumstances which arouse no suspicion. It is the sudden death of younger individuals that invariably arouses suspicion. Medical officers must never issue death certificate in a case of sudden death, and instead must suggest that an autopsy be done.
- When there is no apparent cause of death as revealed by the police inquest, and on external examination of the body, death due to natural causes should be suspected. In that case, a detailed examination of all the systems should be conducted. Each organ has to be weighed and the naked eye observations have to be recorded. Bits of tissues should be taken from all the organs. If there is difficulty in interpreting the morbid

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anatomical changes in any of the organs, that organ as a whole can be preserved and despatched to the forensic pathologist for expert opinion.

- The tissues for histopathological examination have to be collected in wide-mouthed glass bottles. The preservative used is 10% formalin. If bits of tissues are sent for examination, gross findings should be provided to the expert with the history of the case.
- A peripheral blood smear should be taken for examination.
- In all such cases, relevant viscera and body fluids must be preserved in saturated saline and despatched for chemical analysis.
- Samples of blood must be collected for biochemical, haematological and microbiological examinations also. Sterile bottles have to be used for the collection of materials for microbiological examinations. If diseases like leukaemia are suspected, bone marrow should be taken.

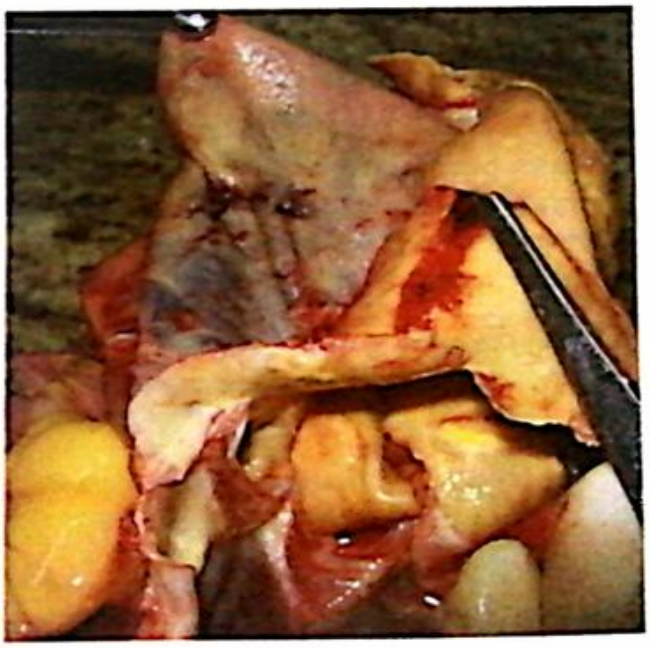
- If injuries are present on the body, they should be examined and details recorded. Effort must be made to find out the cause of injuries found on the body by examination of the scene, interrogation of witnesses, etc. If, on the other hand, the natural cause of death was a result of the injury, the relation has to be established. Injuries can either precipitate or hasten death of a person who is already suffering from a disease. For example, trivial injuries may precipitate death by myocardial infarction in a person having coronary arteriosclerosis.

Causes

Diseases of the cardiovascular system account for about 45 per cent of sudden deaths, diseases of the respiratory system 25 per cent, diseases of the nervous system about 20 per cent, and the rest occur due to diseases of other organs.

The most common causes appear to be:

- Coronary artery disease with myocardial infarction.
- Non-atherosclerotic coronary artery disease, cardiomyopathy, myocarditis.
- Cerebrovascular accident (cerebral stroke).
- Subarachnoid haemorrhage due to rupture of berry aneurysm.
- Sudden rupture of a diseased blood vessel with fatal bleeding, such as the rupture of an aortic aneurysm (Fig 13.14).
- Massive pulmonary embolism.
- Acquired respiratory distress syndrome (ARDS) due to any cause.
- Perforation of peptic ulcer.
- Fulminating infectious disease without any recognizable symptoms until death, e.g., lobar pneumonia, bacterial endocarditis, etc.
- A shift in the position of a viscus, causing sudden shock as in volvulus, strangulated hernia, twisted ovarian cyst, etc.
- Anaphylactic shock due to any cause.
- Sudden infant death syndrome (*discussed on page 400*)



| **Fig. 13.14** Ruptured Dissecting Aortic Aneurysm *(Fig : Dr Zachariah Thomas)* |

Since a significant proportion of sudden deaths occurs due to myocardial infarction secondary to coronary artery disease, forensic pathologists must be able to clearly recognize evidence of the same at autopsy.

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Postmortem Demonstration of Myocardial Infarction

- The commonest lesion of the coronary artery is atherosclerosis. The anterior descending branch is most commonly involved, especially its proximal part. Atheromatous plaques developed in intima form the basis of thrombi which will produce occlusion. The plaques can also rupture. If complete occlusion occurs, myocardial infarction results. Vegetations from bacterial endocarditis of the mitral or aortic valves may sometimes cause occlusion. The diagnosis of embolism can be made only if the source of embolus is established without doubt. When a thrombus is seen, histological examination should be done to confirm the diagnosis and also to find out whether it is a recent or old one.
- Myocardial infarction refers to necrosis of the heart muscle. Usually the apical portion of left ventricle, adjacent anterior wall, and interventricular septum are involved. After the occlusion of the artery, the changes in the myocardium occur gradually. In sudden deaths due to complete occlusion, there will not be any visible change in the heart muscle. Light microscopic changes will occur 6 to 8 hours after occlusion. Changes can be seen with the naked eye only after 24 hours.
- Thus, in some cases of sudden death following coronary occlusion or stenosis, no evidence of myocardial infarction can be made out even by the most sensitive methods, especially if the interval between onset and death was too short. Death in such cases is attributable to ventricular fibrillation or damage to the conduction system. In many cases however, the infarct can be demonstrated by standard techniques. The gross and microscopic changes characteristic of myocardial infarction are mentioned in Table 13.1.
- *Enzyme histochemistry in myocardial ischaemia:* A number of enzymes have been studied in this context, but only a few are found useful in the study of autopsy material: maleic dehydrogenase (MDH), lactic dehydrogenase (LDH) and succinic dehydrogenase (SDH). Of the various methods, the triphenyl tetrazolium chloride (TTC) reaction is considered the most reliable.
- *Best postmortem methods*: Of the various methods, the triphenyl tetrazolium chloride (TTC) reaction, and acridine orange fluorescence study are considered the most reliable postmortem methods of diagnosing myocardial infarction.

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Table 13.1 Autopsy Evidence of Myocardial Infarction

Time required for change to occur	Macroscopic features	Microscopic features
Up to 4 hours	Nil	Nil
4 to 6 hours	Pallor	Hyalinisation, loss of striations, and eosinophilia of muscle fibres
6–9 hours	Pale, brownish purple, or tigroid appearance of affected area	Slight leucocytic infiltration and necrosis
9–24 hours	Necrosed region has yellow border – dry, firm and with surrounding hyperaemia	Slight leucocytic infiltration, advanced necrosis
2–4 days	Yellowish border – area dry, firm	Advanced necrosis and marked infiltration of neutrophils
5–6 days	Yellowish area becomes broader	Neutrophils necrotic; removal of necrotic tissue begins; macrophages appear; oedema and focal haemorrhage
7th day	Entire area yellow	Capillaries and fibroblasts start invading the area; macrophages present; phagocytosis of muscle fibres commences
2nd week	Periphery appears red	Removal of dead tissues by pigmented macrophages; prominent ingrowth of capillaries and fibroblasts; moderate round cell and eosinophilic infiltration; collagen found in the periphery; removal of dead tissue complete in small infarcts
3rd week	Pale grey	Removal of dead tissue continues; numerous pigmented macrophages; cells still round, prominent; eosinophils decreased; more of vascular tissue; collagen prominent
4–8 weeks	Grey, grey-white (scar)	Increased collagen and decreased vascularity; pigmented macrophages; round cells still evident; eosinophils disappear

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CHAPTER 14

Mechanical Asphyxia

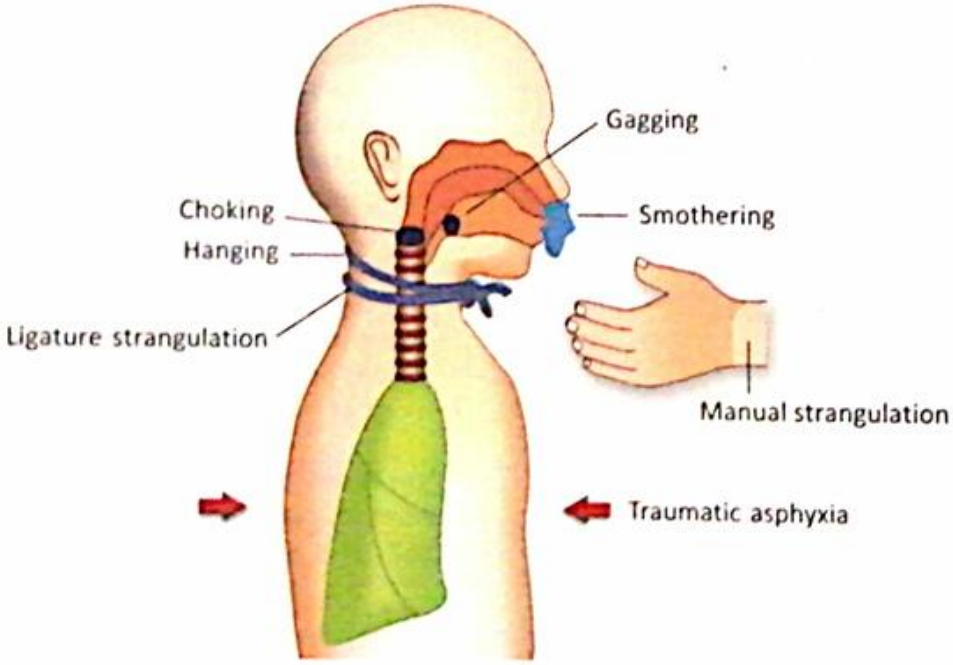
Big handfuls of pills, munch 'em up. That peculiar blue cast of the fingernails following asphyxiation: in its final grim struggle to survive, the brain takes all the oxygen that is left, even that in those living cells under the nails.

—**Stephen King** (born: 1947; American horror novelist) in 'Pet Sematary'

Literally, the term **asphyxia** denotes absence of pulsation (*pulselessness*), though its usage in Forensic Medicine has generally come to mean a lack of oxygen. Actually, **asphyxia is best described as an interference with respiration due to any cause – mechanical, environmental, or toxic**. The term **anoxia refers to a lack of oxygen**. In this chapter, we shall focus mainly on the mechanical causes of asphyxia, and not the toxic or environmental causes, which will be discussed under the section on Toxicology (*Chapter 37*).

CAUSES OF ASPHYXIA (Fig. 14.1)

- Closure of external respiratory orifices: **smothering**.
- Occlusion of air passage by pressure on the neck: **hanging, strangulation,** or **throttling**.
- Occlusion of air passage from within: **choking**.
- Lack of oxygen in the atmosphere, or inhalation of irrespirable gases: **suffocation**.
- Restriction of respiratory movements of the chest or abdomen: **traumatic asphyxia**.
- Prevention of gas exchange in the lung by fluids: **drowning**.
- Inability to utilize oxygen by peripheral tissues: **poisoning** (e.g., cyanide).



| **Fig. 14.1** Types of Asphyxia *(Fig : Dr Rohan Monis)* |

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Mechanical Asphyxia

The main types of mechanical asphyxia include the following (*mnemonic - **HSSD***)

1. **H**anging
2. **S**trangulation
3. **S**uffocation:
   a. **G**agging, **O**verlying, **S**mothering, **C**hoking, **T**raumatic **A**sphyxia, **B**urking (*mnemonic - **GOSCAB***)
4. **D**rowning

SIGNS OF ASPHYXIA (Fig. 14.2)

Classical Signs

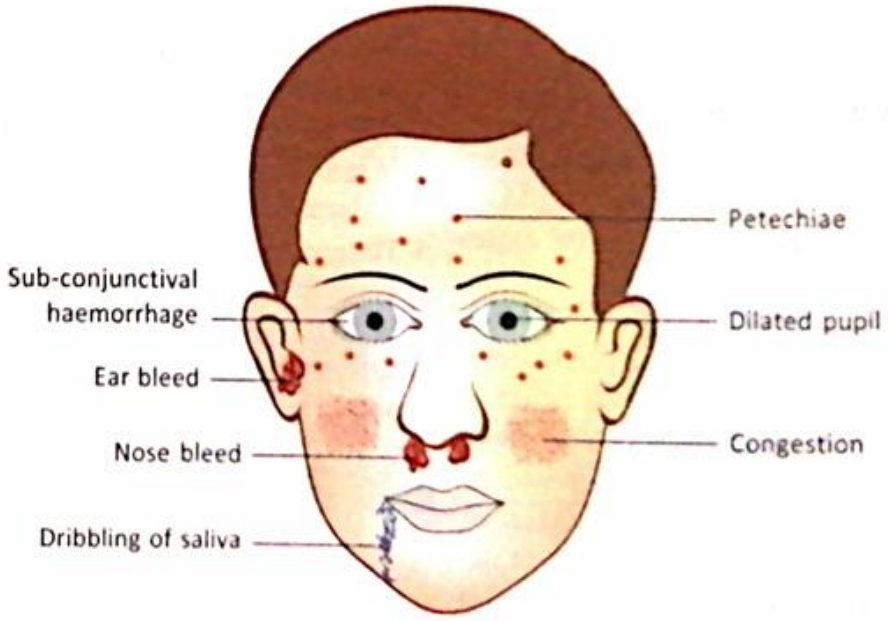
1. **Oedema and congestion of organs**: When the neck is compressed (as in hanging or strangulation), the venous return gets obstructed. This leads to congestion, i.e., the face, lips, and tongue become swollen and red. Sometimes there is darkening due to cyanosis (*vide infra*).

   Congestion is associated with tissue swelling if there is continued venous obstruction.

   When circulation stops completely with ensuing anoxia, the walls of capillaries become permeable resulting in exudation of fluid from the capillaries into neighbouring tissues, leading to oedema.
2. **Petechial haemorrhages**: Due to the impaired integrity of capillary walls, red blood cells escape through, producing small bleeding points, varying from pinpoint to pinhead size. These are known as petechial haemorrhages or petechiae or **Tardieu spots*** (Fig. 14.3). They are also attributed to rupture of venules, and are most commonly seen in the sclera, conjunctiva, or over serous membranes such as pleura and pericardium. If the bleeding spots are larger than 2 mm, they are called ecchymoses.
3. **Cyanosis**: The colour of oxygenated blood is normally scarlet red. When haemoglobin is not fully saturated with oxygen, i.e., it is reduced, the blood assumes a bluish colour. This is known as cyanosis. For this to happen, there should be at least 5 g of reduced haemoglobin per 100 mL of blood. Cyanosis is especially marked in traumatic asphyxia.

Non-Specific Signs

1. Abnormal fluidity of the blood.
2. Dilatation of right chambers of the heart, and great veins.



| **Fig. 14.2** Signs of Asphyxia *(Fig : Dr Rohan Monis)* |

*First described by Auguste Ambroise Tardieu (1818-1879), a French forensic pathologist.

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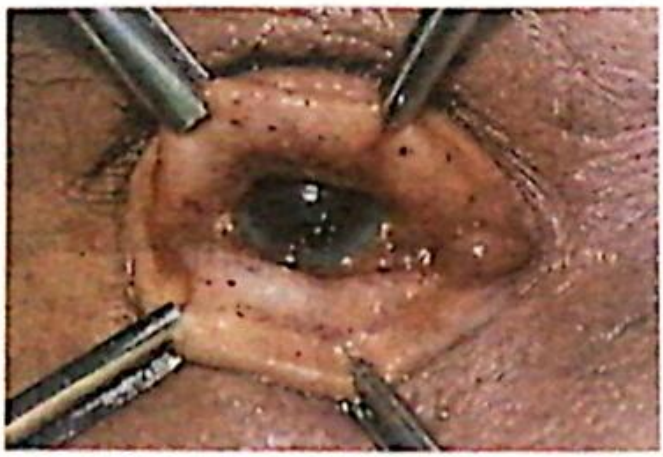
Specific Signs

Signs on the body which indicate the exact way in which the fatal chain of events was initiated, as well as changes which clearly indicate the type of asphyxial death, are referred to as specific signs. These include:

- Ligature mark on the neck in hanging.
- Fingernail abrasions on the neck in manual strangulation.
- Fluid medium in the air passages and stomach in drowning.
- Foreign body in the larynx in choking, gagging, etc.

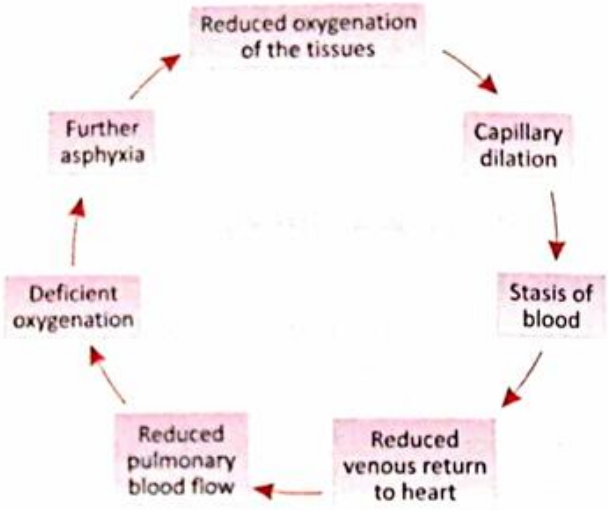


| Fig. 14.3 Tardieu Spots in the Eye
(Pic : Dr BM Balaraj & Dr MD Nithin) |

CAUSES OF ANOXIA

Asphyxia from any cause results in anoxia, which may also be the result of other causes (Fig. 14.4). The different types of anoxia (based on the cause) are as follows:

1. **Anoxic anoxia**
   This is due to defective oxygenation of blood in the lungs (hypoxic hypoxia) or a total failure in oxygenation (anoxic anoxia). In vitiated atmosphere such as the bottom of an unused well, or the interior of a granary, silo, or underground sewer, inhalation of inert or toxic gases results in decreased saturation of oxygen in the blood. This can also be due to mechanical interference of the passage of air into or down the respiratory tract caused by smothering, choking, throttling, strangulation, and hanging, or by external compression of the chest and abdominal walls as in traumatic asphyxia, or primary cessation of respiratory movements through paralysis of respiratory centre as in the case of electrical injury and certain kinds of poisoning.



| Fig. 14.4 Asphyxia - Vicious Cycle
(Fig : Dr BM Balaraj & Dr MD Nithin) |

2. **Anaemic anoxia**
   Death initiated by a reduced oxygen carrying capacity of the blood is called anaemic anoxia, which may be seen in massive haemorrhage or carbon monoxide poisoning.
3. **Stagnant anoxia**
   This occurs due to impaired circulation resulting in reduction of oxygen delivery, which can be seen in death from shock.
4. **Histotoxic anoxia**
   Death initiated by depression of oxidative process in the tissues is called histotoxic hypoxia or histotoxic anoxia, which can be seen in death due to acute cyanide poisoning.

MECHANICAL ASPHYXIA

SUFFOCATION

Suffocation is a type of mechanical asphyxia caused by obstruction of the passage of air into the lungs (*excluding constriction of the neck and drowning*). Suffocation may be produced by:

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- **External means**: By closure of mouth and nostrils, e.g., ***smothering***, ***overlying*** (also referred to as overlaying), or by pressure over the chest or abdomen, e.g., ***traumatic asphyxia***.
- **Internal means**: Closure of glottis or mouth by insertion of soft cloth, paper, etc., e.g., ***gagging***, or impaction of a bolus of food or foreign body deep into the airways, e.g., ***choking***.
- **Environmental causes**: This refers to death caused by reduction of oxygen in the atmosphere. This may occur in a wide variety of situations such as decompression, high altitude, vitiated atmosphere, etc.

To summarise, **suffocation** includes **smothering, overlying, choking, gagging, traumatic asphyxia (crush asphyxia)** and **inhalation of irrespirable gases**.

Smothering

- Here, death is due to mechanical occlusion of the mouth and nose, for instance by pressing a pillow or any other soft material over the mouth and nose, or by manually closing these orifices.
- Infants and elderly individuals are the usual victims of smothering.
- A circular pale area around the mouth and nose is often seen.
- Bluish discolouration, congestion, and petechiae may be seen.
- Internally, intra-thoracic petechiae are common.
- Scratches and nail marks on the face of the victim are also frequently present .

| Fig. 14.5 Homicidal Smothering - Bruising on inner aspects of lips |

- Lips, gums, and tongue may show bruising and lacerations (Fig. 14.5).
- **Plastic Bag Suffocation**: This is encountered in children who put their heads in plastic bags for fun. Such accidental deaths have also resulted in sexually deviant adults due to covering of the head with polythene sheet or other impermeable material, during auto-erotic sexual acts (*vide infra*).
- **Glue Sniffing/Volatile Substance Abuse**
  - This is a form of drug abuse indulged in mostly by street urchins of major cities in Western countries, and is being increasingly reported from India also *(see also page 737)*.
  - It involves the inhalation of volatile agents such as paint removers, adhesives, shoe polish, cigarette-lighter fluid, etc. Gasoline or petrol inhalation is also sometimes encountered.
  - In some cases, volatile substances are poured into a plastic bag and inhaled.
  - Volatile substances usually produce euphoria followed by disorientation and unconsciousness, especially when inhalation is through container. On becoming unconscious, the mouth and nose remain firmly fixed on the container. Hypoxia and hypercapnia exacerbate the toxic effects of the substance.
  - Death may result from cardiac arrhythmias.

Choking

- Choking refers to blockage of the trachea or larynx by a foreign body, e.g., coins, dentures, fish bones, food particles, seeds, aspiration of vomitus, etc (Fig. 14.6).
- Death may result from neurogenic cardiac arrest or hypoxia. If death is due to the latter, all the usual signs such as congestion, cyanosis, and petechiae may be present at autopsy.
- Another example of choking is the entry of blood into the airways in a case of cut-throat injury.
- It is important to remember that in order to effectively occlude an air passage, the object need not always be as large as the lumen of the air passage. Even an object smaller in size than the lumen can cause a complete block because of reflex spasm of the respiratory passage.

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| Fig. 14.6 Choking – Foreign Particles in the Airway *(Pic : Dr Zachariah Thomas)* |

- **Cafe Coronary**
  - Although by and large, choking is simple mechanical obstruction, entry of foreign material may in some cases cause death due to vagal inhibition.
  - A person under the influence of alcohol may sometimes choke over a large piece of meat or bone, due to depressed gag reflex.
  - The foreign body in the larynx or trachea causes parasympathetic stimulation from laryngeal nerve endings, which results in cardiac arrest and death.
  - This term is actually a misnomer, and was the result of such cases being earlier attributed (mistakenly) to myocardial infarction.
  - When a person chokes on food or any object, a bystander who is present at the scene must apply the **Heimlich manoeuvre** – This involves the rescuer standing behind the patient and using his hands with fingers interlinked to exert pressure in the region of the pit of the stomach (just below the xiphoid) (Fig. 14.7). This compresses the lungs and exerts pressure on any object lodged in the trachea, hopefully expelling it. It amounts to stimulating an artificial, explosive cough. Due to the forceful nature of the procedure, even when done correctly it can injure the person on whom it is performed. Bruising to the abdomen is highly likely, and if care is not taken, more serious injuries can occur, including fracture of the xiphoid process or ribs.
  - The Red Cross recommends a "**Five-and-Five**" approach to delivering first aid:
    - Give 5 back blows: First, deliver five back blows between the person's shoulder blades with the heel of the hand.
    - Give 5 abdominal thrusts: Perform five abdominal thrusts (Heimlich manoeuvre).
    - Alternate between 5 blows and 5 thrusts until the blockage is dislodged.

| Fig. 14.7 Heimlich Manoeuvre |

Gagging

- This is strictly speaking, a form of choking. The usual situation arises from a soft cloth being thrust into the mouth of a person to render him incapable of shouting.
- Even if the cloth happens to be small in size, it partially blocks the air passage, soaks up saliva, and swells. Due to constant foreign body irritation, there is pooling of saliva, and death subsequently occurs due to obstruction of air passages.
- As is evident from above, it may be accidental when done to render a person speechless in the

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course of the commission of a crime. It may however be homicidal in infants.

Traumatic Asphyxia

- **Synonyms**: *Crush asphyxia, Compression asphyxia.*
- In this case, death results from pressure and fixation of the chest and/or abdomen. Thus if a person is crushed under a vehicle or in a house collapse, or an earthquake, or in a stampede, the result is traumatic asphyxia. The steering wheel of a motor car violently impinging on the driver's chest in a car accident, is also an example of traumatic asphyxia. Because of the pressure, the victim is unable to breathe and dies of asphyxia.
- As would be evident from the foregoing, traumatic asphyxia is mostly an accidental phenomenon.
- **Autopsy findings**:
  - Gross congestion, cyanosis, and petechiae of the face, neck, and shoulders are the most remarkable findings.
  - Very dark discolouration of the body above the level of constriction (Fig. 14.8).

| Fig. 14.8 Traumatic Asphyxia: Intense Congestion of Face and Upper Chest |

  - Instead of petechiae, haemorrhages are frequently seen in the conjunctivae.
  - Copious bleeding may occur through the ears and nostrils.
  - There may be injuries resulting from the heavy object pinning the chest.
  - Internally, subpleural haemorrhages and Tardieu's spots are observed.
  - The right heart and all the veins above the atria are markedly distended. The blood is forced back into the great veins due to pressure on the chest. As the venous valves in the subclavian vessels prevent displacement into arms, the extra volume is forced up the valveless jugular system to cause congestion of the head and the neck. All the appearances of asphyxia (external and internal), are intensely pronounced.
  - Injuries to the chest, including fractures of the ribs and lacerations of the lungs and heart may be seen. If ribs are fractured, they are usually bilateral, multiple, and involve their angles.
  - In a steering wheel impact, there may be a transverse fracture of the sternum at the junction of the manubrium with the body (*buckled sternum*).

Overlying (Overlaying)

- This occurs when a parent or some other adult shares the same bed with an infant. During sleep, he/she may inadvertently roll over the infant asphyxiating it.
- Along with petechial haemorrhages, there may be evidence of flattening of the nose and face.
- A clear pattern of the object (fabric) involved in compression, is sometimes seen on the infant's cheek or body.
- There may be bloodstained froth at the mouth and nose.

Burking

- This term is derived from the notorious criminal **Burke**, who with his accomplice **Hare**, killed old people (mostly beggars and tramps) by a combination of **smothering** and **traumatic asphyxia**, and sold the bodies to the medical school in Edinburgh.
- The infamous duo would select victims who had no relations or friends (so that police complaints could be avoided), invite them to their derelict apartment and ply them with alcohol.

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- As soon as their guest was drunk enough, Hare would wrestle him to the floor and close his mouth and nostrils with his hands, while Burke would sit on the poor victim's chest. Thus an effective combination of intoxication and asphyxia (involving smothering and traumatic asphyxia), would result in a quick, non-messy death (Box 14.1).

HANGING

Definition

- Hanging results from constriction of the neck as a result of suspension of the body by a ligature, where the constricting force is the weight of the body or a part of the body.
- Hanging should always raise the presumption of suicide, while strangulation (*vide infra*) must always be considered homicidal, unless proved otherwise.
- In India, hanging is among the top 5 methods of choice for committing suicide, the other preferred methods being poisoning, drowning, burning, and jumping from a tall structure or in front of a train.

Causes of Death

Immediate Causes

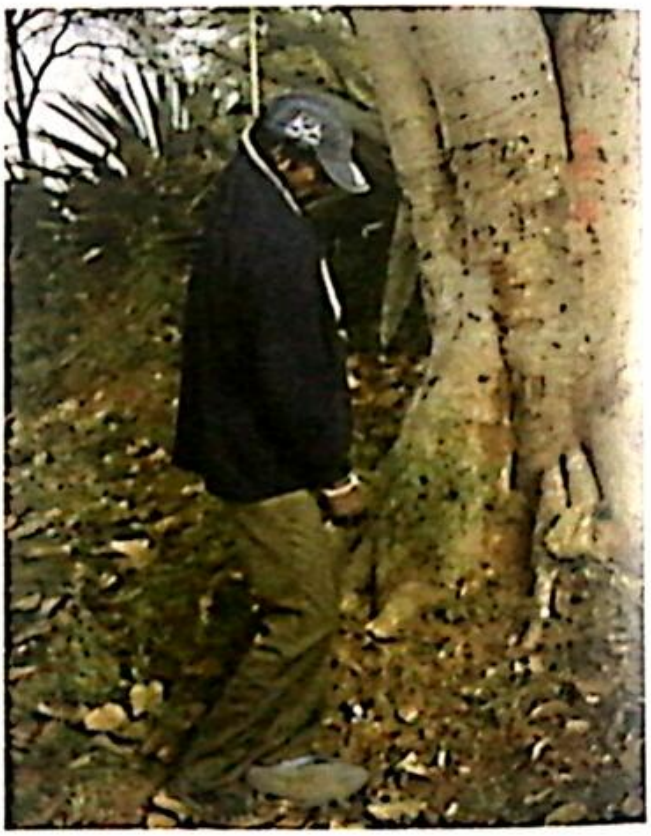
- Prevention of entry of oxygen into respiratory passages (airway occlusion).
- Vascular congestion from compression of large veins, subsequently interfering with blood supply to the brain leading to anoxia (*cerebral apoplexy*).
- Combination of the above.
- Compression of arteries of the neck with direct anoxic consequences on the brain (*cerebral anaemia*).
- Sudden cardiac arrest due to reflex vagal inhibition.

Delayed Causes

- Infection.
- Sequelae of hypoxia to the brain.
- Oedema of the organs, especially the lungs.

Mechanism

- A constricting pressure of just 2 kg is sufficient to compress the jugular venous system leading to intracranial venous congestion. The victim loses consciousness gradually and the inexorable build up of venous engorgement produces cerebral oedema, anoxia, and eventually death.
- A constricting pressure of 5 kg obliterates both carotid arteries. The victim loses consciousness rapidly, and the abrupt cessation of blood to the brain results in cerebral anoxia.
- These mechanisms explain why suicide victims may succumb even in cases of **partial hanging** (Fig 14.9), where the body does not hang free of the ground. In cases of **complete hanging** (Fig 14.10), where the entire body weight is suspended on the ligature and no part of the body touches the ground (Fig. 14.11), there is immediate occlusion of air passage along with obliteration of great vessels in the neck.



| **Fig. 14.9** Partial Hanging
(Pic : Dr BM Balaraj and Dr MD Nithin) |

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Box 14.1 The Case of Burke and Hare

In the early part of the 19th century in England, a criminal trade flourished relating to the sale of dead bodies to medical schools. There was an acute and perpetual shortage of cadavers. To plug this deficiency, a special breed of individuals emerged who came to be known as "Resurrectionists." They had a simple solution: dig out freshly buried bodies from cemeteries or graveyards and supply them to anatomists for a hefty price! This was done by clandestine nocturnal expeditions involving a trip to the grave, a quick exhumation, the stripping of clothing from the corpse, and the delivery of the naked body to the hospital. Some of the resurrectionists became experts at the trade, and could sometimes complete the whole process in 20 minutes, counting from the moment when they climbed over the cemetery wall down to the moment of delivery of the body. The evil fame of the resurrectionists spread all across England, and the inhabitants found it necessary to band themselves together in order to protect their cemeteries at night!

William Burke William Hare

The Edinburgh Medical School was particularly famous for procuring bodies regularly through resurrectionists. The Chief Anatomist, Dr Knox was never at a loss for cadavers and kept his hospital well stocked at all times. His chief suppliers were an ingenious duo named William Burke and William Hare. They had realised early on in their 'professional' career that if they depended only on cemeteries for procuring dead bodies, their trade would flounder. After all, people did not die every day. So they struck upon a gruesome plan of 'generating' dead bodies in order to maintain a regular supply.

Burke and Hare decided to kill people regularly, thereby doing away with the element of chance altogether. The ugly process of exhumation could also be avoided. Over a period of time, Burke perfected a method which they employed with great success. The modus operandi consisted of roaming the disreputable parts of the city at night and picking up tramps, beggars, or derelicts. They would invite the poor homeless victim to their living quarters with promises of drink, food, and merriment. There, they would drink together heavily, and as soon as their guest was drunk enough, Hare would wrestle him to the floor and close his mouth and nostrils with his hands, while Burke would sit on the poor victim's chest. Thus an effective combination of intoxication and asphyxia (involving smothering and traumatic asphyxia), would result in a quick, non-messy death, and the blemishless body would then be handed over to Dr. Knox who never asked awkward questions.

In this manner, Burke and Hare succeeded sixteen times without arousing suspicion, but on the seventeenth instance, a suspicious neighbour informed the police of "curious goings-on" next door. The police searched the lodgings of the macabre duo and discovered the body of an old woman in a box, ready for supply to Dr. Knox!

Both Burke and Hare were arrested. The latter turned approver and confessed everything. Burke was hanged publicly on 28 January 1829. William Hare, as well as Dr. Knox went scot-free. To this day, a small song sung by the people who had gathered to see Burke's public execution, remains popular - "Burke's the murderer
Hare's the thief,
And Knox the old boy
Who buys the beef!"

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- Airway occlusion can be the result of direct compression of the larynx or trachea, or alternatively, the ligature may force the base of the tongue upward and backward against the posterior pharyngeal wall, pushing the soft palate upward and depressing the epiglottis over the laryngeal opening. Pressure needed to occlude the trachea is 15 kg.

| Fig. 14.10 Complete Hanging
(Pic : Dr BM Balaraj and Dr MD Nithin) |

| Fig. 14.11 *(Fig : Dr Rohan Monis)* |

Points of Importance

- Pressure on the baroreceptors situated in the carotid sinus, the carotid sheaths, and the carotid body can result in slowing of the heart or cardiac arrest. The impulses travel to the 10th cranial nerve nucleus through the glossopharyngeal nerve, and return via the vagus nerve to inhibit the heart.
- In every case of hanging, the scene of the incident should be inspected with reference to the type of platform, evidence of stains, signs of struggle, presence of suicide note, or pornographic material (in auto-erotic sexual asphyxia).
- The body should be examined for injuries, type of clothing, and the nature of ligature mark.
- The ligature material used could be anything from a bed sheet to a leather belt, wire, rope, or even a handkerchief, as in most cases there is little premeditation (Fig. 14.12, 14.13 and 14.14). The length, width, and pattern of the material should be noted. The most important point is matching of ligature material with the ligature mark. The ligature material should always be cut away from the knot, and preserved for later laboratory examination (Fig. 14.15).
- Hanging can be accomplished even without the use of a noose (either fixed or running). For example, suspension could occur from a steering wheel in the case of a vehicular accident, or from the rungs of a ladder when the person who is using it slips while climbing.

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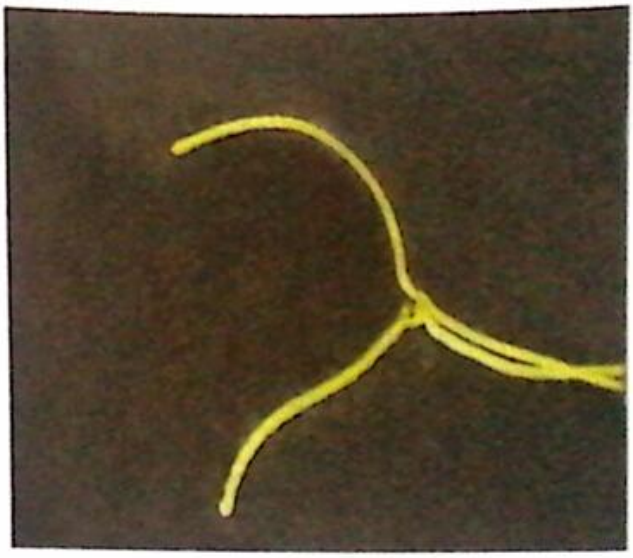
| **Fig. 14.12** Ligature Material - Synthetic Rope *(Pic : Dr EJ Rodrigues)* |



| **Fig. 14.15** Cutting Ligature Away from the Knot *(Pic : Dr Prateek Rastogi)* |

| **Fig. 14.13** Ligature Material - Coir Rope *(Pic : Dr EJ Rodrigues)* |

- An important point relating to the mode of application of ligature is that, a ligature knotted firmly following the first turn, and then knotted after the second turn is unlikely to be a suicide.
- The position of the knot in suicidal hanging is commonly over the occiput (**typical hanging**) (Fig 14.16), or either side of the neck (**atypical hanging**) (Fig 14.17). The most common position is on the right side of the neck (Fig 14.18).

| **Fig. 14.14** Ligature Material – Root of Banyan Tree *(Pic : Dr BM Balaraj and Dr MD Nithin)* |

| **Fig. 14.16** Typical Hanging *(Pic : Dr BM Balaraj and Dr MD Nithin)* |

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| Fig. 14.17 Atypical Hanging
(Pic : Dr Shashidhar C Mestri) |

| Fig. 14.18 Atypical Hanging: Most Common Position of Knot (Right Side)
(Pic : Dr BM Balaraj and Dr MD Nithin) |

- Grooving of the ligature mark is due to congestion and associated oedema. These are generally more marked near the upper border of the mark. The ligature groove will be deepest on the opposite side of the knot when the noose is tied with a fixed knot.
- The point of suspension chosen by a suicide normally will be one that is within reach, with or without the aid of some platform.

Symptoms

A victim of hanging experiences the following:

- Ringing in the ears (tinnitus)
- Blurring of vision
- Mental confusion
- Loss of power of thought
- Loss of consciousness
- Convulsions, leading to death.

Autopsy Findings

Ligature Mark

- The ligature leaves a distinct furrow of its own width and pattern on the skin surface. The bed of the furrow may be pale, and the edges reddish-brown due to abrasion caused by the constriction. Sometimes the entire mark appears reddish-brown. Ecchymosis and congestion of adjacent skin may be seen.
- In general, the thinner and tougher the material used, the more pronounced is the ligature mark (Fig 14.19). Similarly, the softer and broader the material, the less distinct is the ligature mark. The skin in the region of the ligature mark is generally dry and hard.

| Fig. 14.19 Deep and Prominent Ligature Mark
(Pic : Dr BM Balaraj and Dr MD Nithin) |

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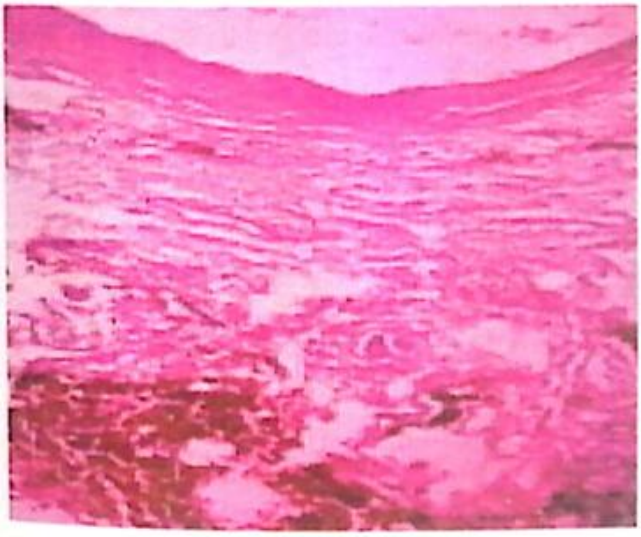
- The pattern of the ligature used often gets imprinted on the skin as a pressure abrasion.
- Ligature mark is usually situated above the level of the hyoid bone, and is oblique, passing backwards and upwards symmetrically on either side to the point of suspension. The mark is not seen at the point of suspension, and also in those regions where there is intervening hair or clothing.
- There may be more than one ligature mark when the material has been wound around the neck more than once. In such cases, the skin between the ligature marks will appear bruised due to pinching.
- Microscopically, the ligature mark displays the usual characteristics of an abrasion, showing desquamation and flattening of cells of the epidermis (Fig 14.20). If death has occurred quickly, vital reaction is quite difficult to demonstrate.



| Fig. 14.20 Microscopic Extravasation of Blood in the Subcutaneous Tissues of Neck in a Case of Hanging *(Pic : Dr Dharmaraya Ingale)* |

The Knot

- In most cases of suicide by right-handed victims, the knot is situated on the right side because tying of the knot is easier.
- It may be a slip knot as is usual in suicidal hanging, or a binding knot.
  - A **slip knot** (or **running knot**) is generally created by attaching a rope to itself, creating a loop which can be tightened (Fig. 14.21). In other words, the 'tail' of the rope is passed through a small loop on the end of that same rope. This gives rise to a progressively constricting, larger, second loop which is termed '**running noose**'*.

| Fig. 14.21 Slip Knot |

  - A **binding knot** is a knot that uses a rope which passes at least once around the neck, and is held in place by the two ends of the rope being knotted together (Fig. 14.22). This gives rise to a **fixed noose**.

| Fig. 14.22 Binding Knot |

- A third type of knot used in professional executions by hanging is the **hangman's knot**. This is actually a slip knot having multiple turns in the knot (Fig 14.23).

* *Not 'running nose'!*

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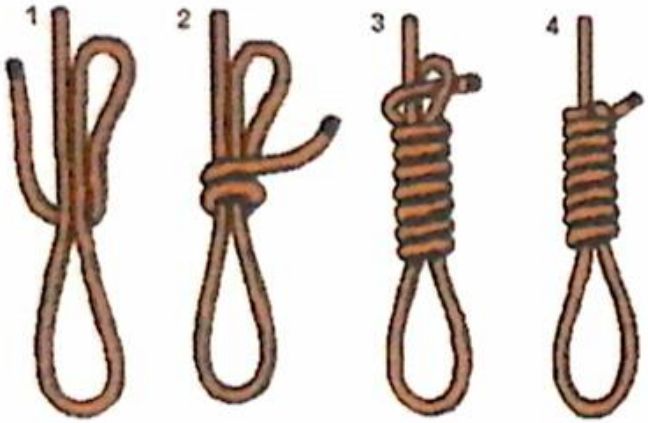

| Fig. 14.23 Hangmans Knot |

- The common sites for the knot include the right or left side of the neck, and the occiput. Cases of suspension where the knot is below the chin, are rare.
- The groove is deepest opposite the position of the knot.
- When hanging is from a low point of suspension, the mark may be horizontal and could resemble strangulation, although in hanging it is invariably above the level of the thyroid cartilage.

Other External Features

- The face may be congested, puffed up, & bluish.
- Bloody froth may be seen in the region of the mouth.
- Postmortem lividity is seen in the distal parts of upper and lower limbs, which gets fixed after 6–8 hours. This is because the hands and feet constitute the dependent parts of the body, in the suspended state. If the body remains suspended for a long time, petechial haemorrhages are seen on the lower limbs.
- The head is tilted away from the knot.
- The ligature may press on the salivary glands causing increased salivary secretion, which causes **dribbling of saliva** from the angle of the mouth (Fig. 14.24). If the body is viewed later, dried up salivary stains running down from the angle of the mouth on to the front of the chest may be seen. This conclusively suggests the antemortem nature of hanging.

| Fig. 14.24 Salivary Dribbling - Hanging
(Pic : Dr BM Balaraj & Dr MD Nithin) |

- The tongue is protruded and may have been bitten.
- If the knot presses on the cervical sympathetic ganglia, the eye on that side remains open, and the pupil is dilated.

| Fig. 14.25 Hanging - Le Facie Sympathique
(Pic : Dr Pratik Patel) |

This is also a vital antemortem feature, and is often referred to as ***le facie sympathique*** (Fig. 14.25).

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Neck Dissection

- Blood often extravasates into the subcutaneous tissues of the neck, beneath the ligature mark.
- Contusion of sternocleidomastoid and platysma may be present.
- The intima of the carotids may be ruptured transversely.
- Occasionally, the hyoid bone is fractured. If such is the case, it is more common in the case of a deceased above 40 years of age, in whom the greater cornua have fused with the body.
  - As the hyoid bone is pressed backwards against the vertebrae, it results in an ***anteroposterior compression fracture***. This is also called ***abduction fracture***. The greater cornua therefore diverge outwards. The broken fragments of the bone also have an outward angulation and can be freely moved only outwards, but cannot be manipulated inwards. The periosteum is torn on the inner aspect of the fracture.
  - Superior horn of thyroid cartilage may be found fractured in some cases.
- The lymph nodes of the neck above and below the ligature mark show evidence of congestion, stasis, and haemorrhage. This is never seen in postmortem hanging.
- In hanging associated with a long drop, destruction of larynx, and fracture-dislocation of cervical vertebrae are common. Punctate haemorrhages may be present in the laryngeal mucous membrane.

Internal Features

All the usual signs of asphyxia are generally seen (*page 315*).

Medicolegal Aspects

- Hanging is invariably suicidal. Accidental and homicidal hangings are rare.
- **Suicidal hanging**
  - Any material that is immediately available may be used as ligature material.
  - A foot stool may be found at the scene of death, wherein the person attempting suicide ties one end of the ligature material to the beam or ceiling fan, stands on the stool, adjusts the noose around his neck and steps off the stool.
  - When the feet do not touch the ground and the body is completely suspended by the ligature, it is called **complete hanging**. If the body is in a reclining or sitting position, or if the feet touch the ground, it is called **partial hanging** (Fig. 14.11).
  - When the body is suspended by a ligature which runs upwards from either side of the thyroid cartilage, and the point of suspension is above the occiput, it is called **typical hanging**. When the point of suspension is elsewhere such as the right or left side of the neck, it is called **atypical hanging** (Fig. 14.17).
- **Accidental hanging**
  - Tragic cases have been recorded of accidental hanging in children who play dangerous games that include simulation of hanging (e.g., cops and robbers). Some have luckily survived.
  - Although by definition hanging is defined as suspension of the body by a ligature, it may occur without the use of a ligature, e.g., being suspended from the rung of a ladder, if one slips while climbing.
- **Homicidal hanging**
  - This is difficult to accomplish unless the victim is a child, or a weak and feeble individual, or one who is weakened by alcohol or drugs.
  - ***Lynching***: It is a form of homicidal hanging where a person suspected to be involved in dacoity, murder, or rape, is overpowered by a mob, and hanged forcibly from a tree or lamp-post. The term "lynching" is derived from the name **Charles Lynch** (1736–96), a justice of the peace who administered rough justice in Virginia (USA). Lynching was originally a system of punishment used by Whites against African American (Negro) slaves (Fig. 14.26). Today, the meaning has been extended to include any act of violence (not just homicidal hanging) inflicted by a mob upon the body of another person which results in the death of the person. A recent horrific example is the **Dimapur mob lynching**, in which a mob in Dimapur, Nagaland, broke into a jail and lynched a rape-

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accused awaiting trail, on 5 March 2015. The mob numbering about 7000-8000 people broke into the prison, pulled out the rape accused, paraded him naked, dragged him behind a motorbike, and beat him to death in a shocking display of vigilante justice.

| Fig. 14.26 Lynching |

- **Judicial hanging**
  - In some countries (including India), hanging is the mode of legal execution of death sentence.
  - The condemned man is first led to the gallows, and his face is covered with a black mask. The noose is adjusted around his neck.
  - He is then made to stand on a platform, which by means of a lever is pulled back, so that he drops down to 5–9 feet.
  - When he comes to the end of the rope, there is a violent jerk which causes a fracture dislocation of upper cervical vertebrae. This disrupts the brainstem resulting in instantaneous death.

Box 14.2 gives a detailed account of the process of judicial execution by hanging. It is to be noted that the Indian armed forces (army, navy and air force) also allow judicial execution of somebody who is sentenced to death by means of firing squad (as an alternative to hanging). Section 166 of the Army Act 1950, Section 163 of Air Force Act 1950, and Section 147 of Navy Act 1957 all deal with the way an execution of death sentence is to be carried out and states, "In awarding a sentence of death, a court-martial shall, in its discretion, direct that the offender shall suffer death by being hanged by the neck until he be dead, or shall suffer death by being shot to death".

- **Postmortem hanging**

  Occasionally, after a victim has been murdered, the body may be suspended to simulate hanging, in order to mislead the police into believing it to be a case of suicide. Findings of asphyxia will not be prominent in such a case.

- **Auto-erotic hanging**
  - This is also known as **sexual asphyxia, asphyxiophilia, hypoxiphilia or Kotzwainism** (named after the Czech musician who indulged in this activity).
  - It is a rare type of hanging seen mostly in white males in Western countries. It is one form of sexual paraphilia. Of late, cases are being reported from India also (Fig. 14.27).

| Fig. 14.27 Auto-erotic Asphyxial Death *(Pic : Dr Pratik Patel)* |

  - The individual (often dressed in female attire) partially asphyxiates himself with a ligature. The resulting partial anoxia is believed to enhance sexual pleasure by masturbation.
  - The neck is usually protected by a soft cloth, so that the ligature mark is not seen.
  - Some element of bondage (tying) is also seen in such auto-erotic hanging cases.
  - Pornographic literature may be seen scattered around.

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Box 14.2 The Process of Judicial Hanging

Hanging is the oldest and most widely used method of execution in the world today. Countries which use this method of execution include Japan, Singapore, Malaysia, South Korea, India, Pakistan, Bangladesh, several African countries, including Botswana and Zimbabwe, and some Middle Eastern countries including Iran, Iraq, Egypt, Jordan, Kuwait, Lebanon and Syria and in most Caribbean states. It is also a lawful method as an option to lethal injection in two states of America, Washington and Delaware.

Hanging originated as a method of execution in Persia (now Iran) about 2500 years ago. In early times, it was considered ideal because it was the simplest method to carry out, did not give the condemned person a particularly cruel death, made a good public spectacle as the prisoner was above the level of the viewers, and the equipment was easy to come by - a tree, a piece of rope and a ladder or cart.

Hanging was also used by many other countries that have since abolished capital punishment, such as Australia, Austria, Canada, Czechoslovakia, Hungary, Ireland, New Zealand, Poland and South Africa. There are 4 main forms of hanging:

- **Short drop hanging** where the prisoner drops just a few inches, and his suspended body weight and physical struggling causes the noose to tighten, normally resulting in death by strangulation or carotid or vagal reflex.
- **Suspension hanging** where the executee is lifted into the air using a crane or other mechanism. Death is caused in the same way as with short drop hanging.
- **Standard drop hanging** where the prisoner drops a predetermined height, typically 4-6 feet, which may or may not break the neck.
- **Measured or long drop hanging** as practised currently in India, where the distance the person falls when the trapdoors open is calculated according to his weight, height, and physique, and is designed to break the neck. This method is supposed to be more humane.

Up to the early part of 20th century, the length of drop was calculated to provide a final "striking" force of approximately 1,260 lbs, which caused fracture and dislocation of the neck, usually at the 2nd and 3rd, or 4th and 5th cervical vertebrae. This is the classic "hangman's fracture". The length of the drop was worked out by the formula 1,260 foot pounds divided by the body weight of the prisoner in pounds = drop in feet. After 1913, other factors were also taken into account, and the drop was calculated to give a final "striking" force of around 1,000 lbs. Today, all drops are restricted to between 5 and 8 feet 6 inches, as this has been found to be an adequate range.

Research into how the brain functions has revealed that a total loss of any awareness will take place within 300 milliseconds after the spinal cord has been completely severed. When all the large spinal nerves are disconnected from the brain stem, as they are in measured drop hanging or beheading, an extremely rapid reaction takes place in both ends of the severed nerves, leading to all nerve impulses becoming stochastic (random) instead of structured. Consciousness is instantly lost when the process becomes stochastic, no matter how high the activity of the brain may have been prior to it. Furthermore, a self-destroying process will begin in the axons, spreading from the point of damage, and destroying the nerves all the way to the main synapses within the brain. This process will be completed within only 5 seconds. On this basis where the spinal cord is severed, a third of a second is the maximum possible time that any pain could be felt. This is borne out by observation of the total lack of any obvious struggling in properly carried out measured drop hangings.

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- These cases invariably occur in secluded or private spots.
- Death can occur sometimes, since the margin between constriction of neck to enhance sexual pleasure, and that which can lead to fatal asphyxia is very narrow.
- One of the most well known cases of autoerotic practice leading to death is that of **David Carradine** (Fig 14.28), the Hollywood actor known best for the titular role in the film 'Kill Bill'. On June 4, 2009, David Carradine was found dead in his room at a hotel in Bangkok, Thailand. He was in Bangkok to shoot for his latest film. A police official said that Carradine was found hanging by a rope, naked, in the room's closet, causing immediate speculation that his death was suicide. However, reported evidence suggested that his death was the result of autoerotic asphyxiation. Two autopsies were conducted, and the cause of death became widely accepted as 'accidental asphyxiation'. Immediately following his death, two of his former wives, Gail Jensen and Marina Anderson, stated publicly that his sexual interests included the practice of self-bondage. The latter said in an interview with Access Hollywood, "There was a dark side to David, there was a very intense side to David. People around him know that." Previously in her divorce filing she had claimed that "it was the continuation of abhorrent and deviant sexual behaviour which was potentially deadly".

| Fig. 14.28 David Carradine in 'Kill Bill' |

Table 14.1 mentions important differentiating poi[illegible] between antemortem and postmortem hanging.

STRANGULATION

Definition

- Strangulation refers to the application of exter[illegible] pressure on the neck either by bare hands, or [illegible]

Table 14.1 Differences Between Antemortem and Postmortem Hanging

	Antemortem hanging	Postmortem hanging
Ligature mark	Produces prominent furrow or groove in the tissues, which becomes yellow or brown, and parchment-like	No characteristic features
Salivary dribble	Present. Sometimes dried saliva stains present over the front of chest	Absent
Le facie sympathique	Present (rarely)	Absent
Drag marks on the body	Absent	May be present
Rope fibres	May be seen in the hand of the victim	Absent
General asphyxial signs	Often seen	Absent

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a ligature, or by any other material. It is a form of asphyxia caused by constriction of the neck **without** suspending the body.

- Strangulation that is effected by a ligature is called **ligature strangulation**, while that which is accomplished by bare hands is called **manual strangulation**, or **throttling**.

Manual Strangulation (Throttling)

- When the hands are used to squeeze or compress the neck, the resulting asphyxia is called manual strangulation or throttling.
- Occasionally, compression of carotid structures (e.g., carotid sinus), may result in cardiac arrest.
- It is always homicidal. At times however, a mild playful tweak on the neck has resulted in death from vagal inhibition.
- **Autopsy findings**
  - Signs of asphyxia are seen. In addition, the following specific findings may be present:
    - *Bruising of the neck:* Bruising occurs due to the assailant's fingers grasping the neck. The bruises are usually circular, dark red or purple in colour, and are 1–2 cm in size. If the fingers slide over the skin, elongated marks may be seen. *Abrasions on the neck:* Scratches may be caused by the fingernails of either the assailant or the victim. They may be curved or linear. During autopsy, scrapings from under the fingernails of the deceased may be taken for DNA fingerprinting and compared with that of the suspect, because the victim may have scratched the assailant in an attempt to ward off the attack.
  - **Internal appearances**: The tissues of the neck are often markedly contused. Bleeding may be seen in the strap muscles or platysma. If excessive force has been applied, bleeding from larynx may have occurred.

Ligature Strangulation

- Material used for ligature strangulation can be anything from flexible rubber tubing to cloth, or sticks, wooden planks, belt, wire, rope, etc.
- The ligature is usually wound transversely around the neck, sometimes with several turns, and is often below the level of the thyroid cartilage.
- Intense congestion of the face, bleeding from nose, mouth and even ears are characteristic features.
- Involuntary passage of urine, defaecation, etc., are more common than in hanging.
- In infants, homicidal strangulation may be brought about by winding the umbilical cord around the neck.
- Variations of ligature strangulation include **bansdola, mugging,** and **garroting**.
  - **Bansdola**: In this form of strangulation, a wooden pole or rod is placed over the front of, and another behind the neck. One end of these rods is fastened together by a rope. The other ends when forcefully brought together squeeze the neck to cause death.
  - **Mugging**: It is brought about by squeezing the neck of the victim in the crook of the elbow, or the bend of the knee.
  - **Garrotting**:
    - This was a method of judicial execution in some countries. The victim is made to wear a neck collar of metal. Death is brought about by tightening the collar (Fig. 14.29).

| Fig. 14.29 Garrotting - Method of Execution |

  - Garrotting may also be effected by an assailant who comes up behind a seated

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victim, throws a ligature around his neck, and pulls it tight. This was supposed to be popular among the Mafia gangs of the USA, who employed it to execute their enemies.
- Since there is an upward pull, the resulting ligature mark may resemble that of hanging.

Autopsy Findings of Ligature Strangulation

- Classical and non-specific signs of asphyxia are prominent.
- Tongue is often protruded.
- Bleeding from the ears or the nose may be seen.
- The **ligature mark** (Fig. 14.30a & b) is usually seen as a depression around the neck because of the oedema of the tissues above and below it.
  - The skin over the mark is invariably dry and hard. The base of the mark appears pale, while the edges may show small abrasions.
  - The width of the mark depends on the ligature used. When there is a pronounced pattern in the ligature material, the pattern may get imprinted on the skin as an imprint abrasion. The mark is usually situated around the middle of the neck at the level of the thyroid cartilage, in contrast to the higher location in hanging.
  - In most cases it runs horizontally, contrasting with the oblique direction in hanging. Sometimes, several turns may have been effected with the ligature, which is then secured with one or more knots.
  - The ligature mark completely encircles the neck in strangulation, while in hanging it is absent near the point of suspension.
  - The position of the knot is indicated by a wider impression on the skin. The type of knot is generally a binding knot.
  - The occurrence of a narrow zone of engorgement or bruising immediately above and below the groove, confirms that the victim was alive at the time when the ligature was applied. In addition, abrasions may be present. Fingernail marks, sometimes linear and vertical may also be present, suggesting efforts on the part of the victim to ease the pressure of the ligature.
  - Even if putrefaction has set in, the ligature mark usually remains distinct.

| **Fig. 14.30a** Strangulation - Ligature in-situ *(Pic : Dr BM Balaraj & Dr MD Nithin)* |

| **Fig. 14.30b** Strangulation - Ligature Removed *(Pic : Dr Shashidhar C Mestri)* |

- Asphyxial component is always more pronounced in strangulation, as compared to hanging (Fig 14.31).
- Carotid arteries show transverse intimal tears.
- Fracture of left or right superior horn of thyroid cartilage is a common feature. If more force is applied, there may also be fracture of cricoid cartilage and tracheal rings.

Medicolegal Aspects

- Strangulation is usually homicidal.
- Suicidal strangulation is rare, because once anoxia sets in, the pressure over the neck gets

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| Fig. 14.31 Homicidal Strangulation - Intense Asphyxial Signs *(Pic : Dr Manoj Gupta)* |

relaxed. In very rare cases, suicide may be effected successfully by strangulation when the victim manages to keep the ligature tight by knotting it, or twisting it, sometimes employing a stick as a lever.

- Accidental strangulation is rare, but it may occur when an article of clothing such as a dupatta, neck band, or cord gets tightly drawn around the neck, in an abrupt manner.
- **Pseudostrangulation**: In the neck of a dead (obese) person or infant, the skin folds may sometimes mimic ligature marks, which may be confused with strangulation marks. However, dissection will reveal absence of bruising or abrasions.

Box 14.3 details the infamous case of "**The Boston Strangler**," a serial rapist-murderer, who sexually assaulted and strangled 13 women in Boston, USA, in the 1960s.

It is **important to differentiate between hanging and strangulation** from the forensic point of view, if miscarriage of justice is to be avoided. Important differentiating points are mentioned in Table 14.2

Fractures of Hyoid & Thyroid (Fig. 14.32)

- The hyoid bone calcifies, i.e., it becomes a single bone, by the age of 40 to 45 years. In younger individuals, it is usually cartilaginous and hence fractures are uncommon.

Table 14.2 Differences Between Hanging and Strangulation

	Hanging	Strangulation
1. Ligature mark	Oblique, above the level of thyroid cartilage. Not encircling the neck completely	Transverse, at or below the level of thyroid cartilage, completely encircling the neck with crossing of the ligature mark
2 Injuries to neck structures	Under the ligature, on reflection of skin, tissues look pale. Bruising of neck muscles is less common	Bruising of neck muscles is more common
3. Hyoid bone	Fracture may occur	Fracture is uncommon
4. Thyroid cartilage	Fracture is less common	Fracture is more common
5. Larynx and trachea	Fracture rare	Fracture may occur
6. Signs of asphyxia	Less prominent	More prominent
7. Bleeding	From ears, nose, and mouth, is less common	From external orifices is more common
8. Saliva	Dribbling often present	Absent

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Box 14.3 The Boston Strangler

Between June 1962 and January 1964, thirteen women were sexually assaulted and then strangled to death in the Boston area of Massachusetts, USA, by an unknown assailant whom the press dubbed the "Boston Strangler." This man proved to be Albert Henry DeSalvo. Born in 1931, DeSalvo began stealing when he was in his teens, and was charged with breaking and entering numerous times before joining the army at age seventeen. While stationed in Frankfurt, he met and married a petite German girl.

Returning to the US with his new wife, DeSalvo was stationed at Fort Dix, New Jersey, where in January 1955, he was charged with molesting a 9-year-old girl, his first sex offense. He was discharged from the army a short time later and moved back to Boston with his wife. DeSalvo worked as a handyman, and he and his wife had two small children.

Albert DeSalvo

DeSalvo's sex drive was almost overwhelming. He thought about sex night and day, according to his later admissions, and he found little release. In 1958, he embarked on a sexual game whereby he became known to the police as "Measuring Man". DeSalvo approached young, attractive women in their apartments, telling them he represented a modelling agency. While taking measurements of their "vital statistics", he managed to seduce a number of these gullible females.

On Mar. 17, 1960, police responded to an alarm of a break-in and they chased and caught DeSalvo. On his person was found a pair of gloves and a tailor's measuring tape. He admitted that he was the "Measuring Man". DeSalvo received a two-year sentence for breaking and entering, and was released in ten months.

After his release, he returned to his family, but now became more aggressive, breaking into apartments and tying up and raping females. In the summer of 1962, DeSalvo began to add murder to his sexual attacks, raping and strangling his victims, the first of whom was 55-year-old Anna Slesers, found in her apartment in Boston, her body placed in a lascivious position. DeSalvo had used a cord to strangle his victim and had tied the ends in a bow beneath her chin, a technique he would continue to employ, as if it were his trademark. Within two weeks, DeSalvo attacked and killed an 85 year-old woman, Mary Mullen. On June 30, 1962, DeSalvo raped and strangled Helen Blake, a 65-year-old nurse. Next was Nina Nichols, a woman in her sixties.

On Aug. 19, DeSalvo raped and strangled 75-year-old Ida Irga. Jane Sullivan, sixty-seven, died at DeSalvo's hands the next day. Boston police were inundated with demands to solve the rash of horrible rape-murders. DeSalvo refrained from making more attacks until Dec.5, 1962, his wedding anniversary. He went to the apartment of 25-year-old Sophie Clark, a tall, attractive black woman, and persuaded her to open the door, saying that he was from a modelling company. He then raped and strangled her.

His next victim (on Dec 8, 1962) was Patricia Bissette, a 21-year-old secretary. On Mar 9, 1963, 69-year-old Mary Brown allowed DeSalvo into her apartment, thinking him to be a workman sent by the landlord to fix her stove. This time DeSalvo's violence was unchecked. He had brought along a lead pipe, which he used to crush

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his victim's head. He raped Brown after killing her. He also strangled her, although by that time, she was dead. On May 6, 1963, DeSalvo drove to Cambridge, and there spotted pretty Beverly Samans, a 23-year-old undergraduate. He gained entrance to her apartment, tying her to bedposts. He then blindfolded and gagged her and repeatedly raped her. He used the girl's nylon stockings to strangle her. Before leaving his victim, DeSalvo got out his jackknife and stabbed the girl repeatedly.

DeSalvo's eleventh victim was 58-year-old Evelyn Corbin, whom he strangled and raped on Sept 8, 1963. He left his trademark, a nylon with a bow, tied around her ankle. Boston police seemed helpless to catch the killer. The city was in a near panic with thousands of husbands constantly calling their wives or staying home from work to protect them against a monster who seemed to come and go at will.

On Nov 23, 1963, DeSalvo struck again gaining entrance to the apartment of Joann Graff, a 23-year-old dress designer. He raped and strangled her with her own black leotards, tying these in a bow about her neck.

On Jan 4, 1964, DeSalvo struck for the last time, claiming his thirteenth victim, 19-year-old Mary Sullivan. Once inside her apartment, he flourished a knife, tied up the girl and raped her. He then strangled her with his hands.

In Fall 1964, a young woman reported being sexually assaulted in her apartment, describing a man police identified as DeSalvo, using the same technique as he had when labelled the Measuring Man. DeSalvo was arrested for breaking and entering, and sent to the mental institution at Bridgewater.

At Bridgewater, DeSalvo was diagnosed by psychiatrists as "schizophrenic". Another inmate after interacting with him, came to believe DeSalvo was the Boston Strangler. He informed his lawyer, who interviewed DeSalvo, recording his conversations. DeSalvo admitted being the Strangler and even added two killings to the known murder count of thirteen.

The police were however not sure, since they had no eyewitnesses who could positively identify DeSalvo. They were disinclined to officially prosecute him as a mental patient. Later, DeSalvo was transferred to the Walpole State Prison, where in his cell, on Nov 26, 1973, he was found dead, stabbed through his heart.

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| Fig. 14.32 Antero-Posterior (Left) and Inward Compression Fracture (Right) of Hyoid Bone |

- The thyroid horns are especially vulnerable to pressure on the neck.
- Antemortem fractures of the thyroid and hyoid are diagnosed by evidence of haemorrhage around the fracture site, with blood spots under the periosteum.
- The broken region may be slightly crepitant.
- Microscopically, there may be extravasation of RBCs.
- There are basically two types of hyoid bone fractures—**Antero-posterior type** and **inward compression type**.
  - The former is most often seen in cases of hanging where the hyoid bone is forced backwards due to which the divergence of the greater horns is increased, resulting in a fracture with outward displacement of the fractured fragment. The periosteum is disrupted on the inner side alone and the fragment can be easily moved outwards, but inward movement is restricted.
  - In the case of inward compression type of hyoid bone fracture which is seen in throttling, the greater horns are squeezed towards each other by the constricting hand as a result of which the bone gets fractured with inward displacement of fractured fragment. The periosteum is therefore disrupted on the outer side alone, and the fragment can be easily moved inwards, but outward movement is restricted.
- Rarely, a third type of hyoid bone fracture occurs called **avulsion, traction**, or **tug fracture**, which results from muscular overactivity. It is an indirect type of fracture without direct injury to the hyoid.

DROWNING*

Definition

- It is a form of asphyxial death which results from complete or partial submersion of a person in a fluid medium. Death occurs due to entry of fluid into the respiratory passages, or due to the effects of severe water and electrolyte imbalance.

Mechanism

- In order to understand the mechanism as well as the autopsy findings, it is necessary to appreciate what happens when a person (who cannot swim) falls into water.
  - Initially, he sinks to a depth directly proportional to the momentum of the fall. The inherent buoyancy however tends to make the person float rather than sink. Additionally, his struggling movements, and the air trapped in the clothes help him to rise to the surface.
  - In his desperate attempts at inhaling air, large gulps of water enter the throat, and may be partly inhaled and partly swallowed. The water which inadvertently enters the respiratory passages acts as a foreign irritant, and excites a strong reflex. Consequently, a large volume of air is driven out of the lungs.
  - There is therefore a greater need for air, and the vicious cycle of drowning continues till a large quantity of water enters the lungs.
  - Asphyxia consequently occurs, which leads to insensibility, and the victim finally succumbs.
  - The barotrauma to the middle ear results in haemorrhages which causes vestibular disturbance, and this makes the victim lose his sense of direction under water.
- During the struggle for life under water, the victim may grasp anything within his reach. This accounts for objects such as weeds or mud occasionally found grasped in the hand of the victim, as a manifestation of cadaveric spasm.

*According to some investigators, drowning should no longer be considered an 'asphyxial death' and must be placed in a separate section of its own.

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Types of Drowning

1. Wet Drowning

In this type of drowning, which is the commonest type, water is completely inhaled into the lungs.

A. **Freshwater drowning**

- Drowning in fresh water causes dilution of the blood up to 70%, within a couple of minutes.
- This causes haemodilution resulting in lysis of RBC's, which in turn leads to hyperkalaemia and hyponatraemia.
- The circulation becomes overloaded.
- Fresh water also denatures surfactant, which causes decreased lung compliance.
- There is a fall in systolic blood pressure.
- Myocardial anoxia occurs, and death results from ventricular fibrillation.

B. **Seawater drowning**

- Seawater constitutes a hypertonic medium. Due to haemoconcentration, as much as 40% of water from circulating blood is withdrawn into the lungs and massive pulmonary oedema is produced.
- There is increased serum sodium concentration (hypernatraemia).
- Pulmonary oedema and myocardial anoxia cause death.

Death in freshwater takes 2–3 minutes, whereas it is delayed up to 4–5 minutes in seawater (Table 14.3).

2. Dry Drowning

Water enters the larynx, but is prevented from entering the lungs due to severe laryngeal spasm.

3. Secondary Drowning (Post-immersion Syndrome)

Death occurs due to secondary effects of drowning, after a gap of half an hour to a few days following resuscitation. Death is due to cerebral anoxia and irreversible brain damage, associated with electrolyte disturbances and metabolic acidosis. Bronchopneumonia is also common.

4. Hydrocution (Immersion Syndrome)

Death results from cardiac arrest due to vagal inhibition, as a result of cold-water stimulation of the nerve endings on the surface of the body, the epigastrium, and the ear and nasal passages.

Causes of Death in Drowning

The causes of death in drowning could be:

- Asphyxia
- Ventricular fibrillation
- Myocardial anoxia
- Laryngeal spasm
- Vagal inhibition
- Exhaustion
- Head injuries (from striking against objects during a fall into river, well, etc).

Autopsy Findings

14

External Appearances

- The clothing is wet.
- The skin is wet, cold, and clammy. It appears pale due to contraction of superficial blood vessels.
- Body temperature falls to the temperature of the water in a few hours.
- Postmortem lividity is seen in the head, neck, and front of chest. It is usually bright pink in colour due to the imbibition of oxygen through water, but it may be dusky and cyanotic if the body had been floating face down, buttocks up, and hands and feet dangling down. This is in fact the usual position of a body floating in water after putrefactive gases begin to form. However, if the water is turbulent and constantly turns the body, postmortem staining may not be seen at all.
- **Cutis anserina** (*goose fleshing*), occurs due to contraction of erector pilorum muscles (Fig. 14.33). There is a puckered appearance of skin with hairs standing on end.
  - Rigor mortis sets in and passes off early, due to exhaustion resulting from the person's struggle under water.
  - Conjunctivae are often congested; subconjunctival ecchymoses may be present.
- Hands affected by cadaveric spasm may contain various objects grasped while struggling in the water, such as seaweed, sand, straw, etc.
- After 48 to 72 hours or more, the skin of the palms and the soles becomes bleached, wrinkled, and

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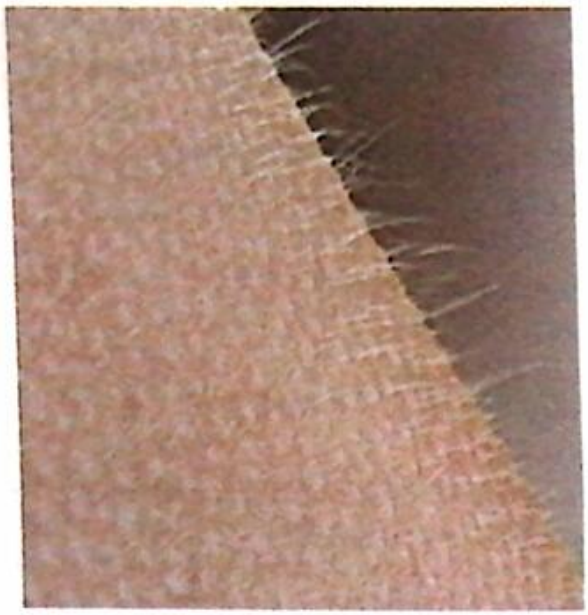

| Fig. 14.33 Cutis Anserina |

soddened (Fig 14.34). This is called **washer-woman's hands and feet***. The epidermis separates from the dermis in glove and stocking fashion, from the hands and feet.

| Fig. 14.34 Soddening of Hand
(Pic : Dr BM Balaraj and Dr MD Nithin) |

- Putrefaction leads to accumulation of gases, and the body rises to the surface of water to float (**floater**).

- **Froth** (Fig. 14.35)
  - A fine, white, tenacious, persistent, frothy foam in the shape of a balloon (Fig. 14.36), or mushroom, or horn, is invariably seen at the nose and mouth.

| Fig. 14.35 Drowning - Froth
(Pic : Dr Prateek Rastogi) |

| Fig. 14.36 Drowning - Balloon-Shaped Froth *(Pic : Dr EJ Rodrigues)* |

  - This is formed by the water inhaled into the lungs, which acts as an irritant prompting the secretion of mucus. Water, air, desquammated epithelium, and mucus, are all churned up to form froth by violent respiratory efforts.

*Why do we refer to this as 'washerwoman's hands and feet'? Do all those who wash clothes as a means of livelihood belong to the feminine gender? In fact, the famous 'Dhobi Ghat' of Mumbai (the world's largest outdoor laundry) has more washermen than washerwomen! It is time that we moved away from such sexist appellations and called this 'washerperson's hands and feet'!

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- Sometimes the froth is tinged pink due to blood from ruptured capillaries. This froth is pathognomonic of drowning.
- Copious froth exudes out when pressure is exerted on the chest. Froth may also be seen in cases of poisoning due to opium, organophosphates, and snakebite, but it is never as copious as in drowning.
- However, in dry drowning, froth may not be present at all.

Internal Appearances

- Airways contain stiff foam or frothy fluid, or grit, gravel, mud, etc.
- Water in the air passages and stomach, especially dirty marshy water which is not potable, is an important finding to confirm death due to drowning.
- **Lungs**
  - Large subpleural haemorrhages may be produced due to rupture of interalveolar partitions beneath the pleura. These are called **Paltauf's haemorrhages***. They are more prominent over the lower lobes, and the interlobar surfaces.
  - The lungs appear ballooned, oedematous, and have a heavy and boggy feel. They are doughy and spongy, water-logged, and pit on pressure. This is referred to as **emphysema aquosum**. The condition develops only when the conscious victim of drowning struggles for survival, whereas a related condition called **oedema aquosum** develops when a body is passively immersed in water, or when the victim is unconscious. It is a mere flooding of the lungs.
  - Because of water-logging, rib marks are often seen on the lung surfaces.
  - On cut section, watery, frothy fluid exudes out of the lungs.
  - In deaths due to laryngeal spasm (**dry drowning**), these changes in the lungs and in the respiratory tree are not seen.
  - In saltwater drowning, the lungs appear purple, and are much more oedematous than in freshwater drowning. Further, in the latter case, lungs appear pinkish, and crepitus is heard on applying pressure.
- The blood is likely to remain in a fluid state, free from clots, due to prevention of coagulation resulting from the release of plasminogen activator from damaged endothelium of pulmonary capillaries.
- Water may be detected in the middle ear, resulting from violent respiratory excursions, which force the water into the ear. This never happens in **postmortem submersion**, i.e., submersion of the body after death, which is sometimes resorted to deliberately, for the purpose of misleading criminal investigation.
- Haemorrhages may occur in the middle ear and mastoid air cells, due to barotrauma produced by the pressure exerted by the surrounding water (Fig. 14.37).

| **Fig. 14.37** Drowning-Middle Ear Haemorrhages *(Pic : Dr Jagadish Rao PP)* |

Main differences between **antemortem drowning** and **postmortem submersion** have been listed in Table 14.4.

Named after the Austrian medical examiner, **Arnold Paltauf (1860–1893) who first described these haemorrhages in 1888.)*

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Table 14.3 Differences Between Freshwater and Seawater Drowning

	Freshwater	Seawater
Time required for fatality	2 to 3 min	4 to 5 min
Changes in the blood	Haemodilution Hyponatraemia Hyperkalaemia	Haemoconcentration Hypernatraemia
Changes in the lungs	Ballooned out and lighter Pinkish Emphysematous Crepitant Less froth Retains shape after removal from body	Ballooned out and heavier Purplish/bluish Soft and jelly-like No crepitus Copious froth Flattens out on removal from body

Table 14.4 Differences Between Antemortem Drowning and Postmortem Submersion

	Antemortem drowning	Postmortem submersion
Froth	Fine, persistent froth at the mouth & nose, which increases by pressure on chest	No froth
Cadaveric spasm	May be seen rarely, with the victim clutching weeds, etc.	Absent
Water in stomach/ small intestine	May be present, which suggests active peristalsis	Absent
Sand particles	May be present till secondary bronchioles	Absent
Haemorrhage in mastoid air cells of middle ear	Present, though difficult to demonstrate	Absent

Note: The absence of any of the above features does **not** conclusively rule out antemortem drowning

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Diatom Test

- Most samples of water contain microscopic, unicellular algae or plankton called **diatoms**, which possess silicaceous cell membranes, and vary in size from 10–80 microns (Fig. 14.38). As a result of the hard cell wall, these microorganisms are resistant to heat and acids.
- In wet drowning, diatoms get aspirated into the lungs along with inhaled water, and then pass into the venous circulation through ruptured pulmonary capillaries or alveolar walls.
- They get distributed to various organs of the body and the bone marrow.

| Fig. 14.38 Diatoms – Various Types |

- These diatoms are demonstrable histologically, and their presence in the blood, viscera, or bone marrow along with their presence in control samples of water from where the body was fished out, is pathognomonic of drowning.
- A simple test can be performed on the sternal bone marrow to demonstrate these diatoms:
  - The marrow is subjected to acid digestion, centrifuged, and the sediment examined under the microscope. A sample of bone marrow (minimum 5 g) can be taken from the sternum or long bones, and digested with nitric acid for 1–2 hours. Then the fluid is centrifuged, and the deposit is examined microscopically. Through acid digestion, all organic matter will be dissolved except diatoms which resist it because of their silicaceous covering.
  - A sample of the drowning medium (water in which the body was submerged) should also be subjected to microscopic examination. A few drops of tincture iodine Lugol's iodine is added to the water sample and allowed to stand for 24 hours. Then it is centrifuged at 3000 rpm. The supernatant fluid is discarded. The deposit is examined microscopically. If both the medium and the marrow contain the same type of diatoms, it is evidence of death due to drowning in that medium. Tissues like lungs, kidney, brain etc. can also be subjected to this test.
  - A great advantage of this test is that diatoms resist putrefaction and are present even in highly decomposed bodies.
  - A negative diatom test however does not rule out the possibility of drowning, since it could be a case of dry drowning.
- Indian studies corroborate a number of Western studies, which indicate that the biggest drawback of the diatom test is that diatoms can be demonstrated even in non-drowning death. Hence, extreme caution should be exercised while opining on the cause of death in a medicolegal case, on the basis of a positive diatom test alone.
- Today, most experts agree that the diatom test, like the Gettler test (*vide infra*) has too many flaws and must NOT be undertaken to conclusively diagnose death by drowning. At best, it can be considered as a supplementary laboratory test.

Gettler Test

The **Gettler test** or **Chloride test** is done by withdrawing 10 mL of blood from each ventricle of the heart and subjecting it to estimation of chlorides. Normal value of chloride is 600 mg% in both chambers. In seawater drowning, there is said to be 30–40% increase of the chloride level in the blood in left ventricle, while in freshwater drowning, the

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chlorides get reduced by 50%. This change is of course not evident in dry drowning. **Actually, the Gettler test is only of historical interest, and has no practical relevance.**

Medicolegal Aspects of Drowning

- Before deciding as to the manner of death (accidental, suicidal, or homicidal), it must first be established with certainty that it is a case of antemortem drowning, and not postmortem submersion. The points in favour of antemortem drowning are as follows:
  - Copious fine, lathery, tenacious froth exuding from mouth and nose.
  - Material such as weeds, sand, etc., gripped in the hands.
  - Petechiae in the face; congestion of eyes.
  - Paltauff's haemorrhages on the surface of lungs (sub-pleural).
  - Ballooned out, crepitant lungs full of frothy fluid that oozes out on cut section.
  - Sand or mud particles within bronchi and bronchioles.
  - Water (especially muddy or otherwise non-drinkable) in the stomach and intestines.
  - Water in the middle ear: Water can be aspirated from the middle ear and mastoid air cells in antemortem drowning.
  - Positive diatom test (in wet drowning).
- Most cases of drowning are either accidental or suicidal in nature. The former are more common in young children, elderly individuals, and non-swimmers, while the latter are more common in women.
- Homicidal cases are very rare. But cases do get reported from time to time **(Box 14.4)**.
- Death occurring in shallow water should be considered as homicide unless otherwise proved. Tying of limbs or attaching a weight to the body is not always indicative of homicide. A person who is determined to drown himself may resort to this, especially if he is a swimmer.
- If injuries are found, they should be carefully evaluated with regard to the location, nature, etc. An examination of the scene is necessary to find out whether the injuries could have been sustained during the act of drowning.
- It is important to remember that bodies in water may be attacked by fish and various types of postmortem injuries can occur. These will however have irregular margins, and will be devoid of vital reaction.

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Box 14.4 Andrea Yates – Mass Murder by Drowning

Andrea Yates is an American woman who killed her five children on June 20, 2001 by drowning them in the bathtub in her house. She had been suffering for some time with severe postpartum depression and postpartum psychosis. Andrea Yates was born in Houston, Texas, the youngest of five children of a religious Catholic couple. She graduated in 1982 and completed a two-year pre-nursing program at the University of Houston before obtaining a degree from the University of Texas School of Nursing. From 1986 until 1994, she worked as a registered nurse at the University of Texas M.D. Anderson Cancer Center.

Andrea Yates During her Trial - 2006

In the summer of 1989, she met Russell "Rusty" Yates, and married him on April 17, 1993. In February 1994, the couple's first child, a son named Noah, was born. Shortly thereafter, Rusty accepted a job offer in Florida, so the family relocated to a small trailer in Seminole. By the birth of their third son, Paul, they settled back to Houston and purchased a 'motor home'. Following the birth of their fourth son, Luke, Andrea became depressed. The media alleged that her condition was influenced by the extremist sermons of Michael Peter Woroniecki, the preacher who sold them their 'motor home'. Her family was concerned by the way that she was so captivated by the minister's words.

On June 16, 1999, Rusty found Andrea shaking and chewing her fingers. The next day, she attempted to commit suicide by overdosing on pills. She was admitted to the hospital, and prescribed antidepressants. Soon after her release, she begged her husband to let her die as she held a knife up to her neck. Once again hospitalized, she was given a mixture of medications including haloperidol, an anti-psychotic drug. Her condition improved immediately, and she was prescribed it on her release. After that, Rusty moved the family into a small house for the sake of her health. Andrea appeared temporarily to stabilise.

In July 1999, she succumbed to a nervous breakdown, which culminated in two suicide attempts and two psychiatric hospitalizations that summer. She was diagnosed with postpartum psychosis. Her psychiatrist testified that she urged the couple not to have more children, as it would "guarantee future psychotic depression". But they conceived their fifth and final child approximately 7 weeks after her discharge. She stopped taking haloperidol in March 2000 and gave birth to daughter Mary on November 30 of that year. She seemed to be coping well until the death of her father on March 12, 2001. She then stopped taking medication, mutilated herself, and read the Bible feverishly. She also stopped feeding her youngest child, Mary. Yates became so incapacitated that she required immediate hospitalization.

On April 1, 2001 she came under the care of another psychiatrist, Dr. Mohammed Saeed. She was treated and released. On May 3, 2001, she degenerated back into a "near catatonic" state and drew a bath in the middle of the day; she would later confess to police that she had planned to drown the children that day, but had decided against doing it then. Yates continued under Dr. Saeed's care until June 20, 2001, when Rusty left

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for work, leaving her alone to watch the children against Dr. Saeed's instructions to supervise her around the clock. Rusty's mother had been scheduled by him to arrive an hour later to take over for her. In the space of that hour, she drowned all five children. She started with the youngest boys, and after drowning them in her bathtub, laid them in her bed. She then drowned Mary, whom she left floating in the tub. Her oldest son, Noah, came in and asked what was wrong with Mary. He then ran, but she soon caught up with him and drowned him. She then left him floating in the tub and laid Mary in her brothers' arms. Afterwards, she called the police. Then she called Rusty, saying only "It's time" repeatedly.

During the subsequent court trial, Yates confessed to drowning her children. She told investigators that she waited for Rusty to leave for work that morning before filling the bathtub because she knew he would have prevented her from harming the children. Although the defense's expert testimony agreed that Yates was psychotic, Texas law requires that, in order to successfully assert the insanity defense, the defendant must prove that he or she could not discern right from wrong at the time of the crime. In March 2002, a jury rejected the insanity defense and found her guilty. Although the prosecution had sought the death penalty, the jury refused that option. The trial court sentenced her to life imprisonment in the Texas Department of Criminal Justice with eligibility for parole in 40 years.

On January 6, 2005, a Texas Court of Appeals reversed the convictions, because a psychiatrist who was one of the prosecution witnesses admitted he had given false testimony during the trial. He stated that shortly before the killings, an episode of Law & Order (a popular TV show) had aired featuring a woman who drowned her children and was acquitted of murder by reason of insanity (such an episode was never released). The appellate court held that the jury may have been influenced by his false testimony and that thus a new trial would be necessary.

On January 9, 2006, Yates again entered pleas of not guilty by reason of insanity. On February 1, 2006, she was granted release on bail on the condition that she be admitted to a mental health treatment facility. On July 26, 2006, after three days of deliberations, Yates was found not guilty by reason of insanity, as defined by the state of Texas. She was thereafter committed to the North Texas State Hospital - Vernon Campus. In January 2007, Yates was moved to a low security state mental hospital in Kerrville, Texas.

While in prison, Andrea stated she had considered killing the children for two years, adding that they thought she was not a good mother and claimed her sons were developing improperly. She told her jail psychiatrist: "It was the seventh deadly sin. My children weren't righteous. They stumbled because I was evil. The way I was raising them, they could never be saved. They were doomed to perish in the fires of hell." She also told her jail psychiatrist that Satan influenced her children and made them more disobedient.

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CHAPTER 15

Surgical and Anaesthetic Deaths

Before undergoing a serious surgical operation, put your affairs in order - you may survive.

—Victor Hugo (1802-1885; French writer)

INTRODUCTION

Anaesthesia, the panacea for pain, has improved the quality of all surgical procedures, since management of pain had been the prime concern in such procedures. However, it is also true that the agents which relieve pain are themselves often the source of morbidity and mortality, for any intervention (surgical or anaesthetic), does carry with it an element of risk to the life of the patient.

CAUSES OF SURGICAL AND ANAESTHETIC DEATHS

| Fig. 15.1 |

Fatalities associated with surgical intervention or invasive diagnostic procedures can be separated into the following categories:

1. Those Directly Caused by the Disease or injury for which the Operation or Anaesthetic was Necessitated

- In the advanced stage of some diseases, a heroic effort may have to be taken to save the life of the patient, and if such intervention leads to the death of the patient, the disease from which he was suffering is cited as the cause of death, and the intervening procedure is not taken into account.
- But in cases where the patient had been relatively well when he was wheeled into the operation theatre and is subsequently brought out dead, the suspicion of the relatives may be aroused, and such death might lead to an investigation.
- The American Society of Anesthesiologists (ASA) has classified deaths during surgical procedures as follows:
  - ASA Risk I: Normal healthy patient.
  - ASA Risk II: Mild systemic disease.
  - ASA Risk III: Severe systemic disease limiting activity but not incapacitating.
  - ASA Risk IV: Incapacitating systemic disease that is a constant threat to life.
  - ASA Risk V: Moribund patient not expected to survive 24 h without an operation.
  - E: Emergency operation.

  Categories I, II and III require full medicolegal investigation, as death is unexpected in these cases. It is important to note that in those cases where surgical operation was done in a victim of trauma, it may be impossible to separate the relative contribution of each to death.

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2. Those Caused by a Disease or Abnormality Other than that for which the Procedure was being Carried out

- In case death was caused by a disease other than that for which the procedure was carried out, and its existence was known beforehand, the pathologist must evaluate the need for the operation.
- However, if the disease had not been suspected by the clinicians, or if specialised diagnostic procedures were not available, the death can be excused.
- But the presence of common conditions such as hypertension, ischaemic heart disease, lung disease, etc., can lead to medicolegal problems, if proper care had not been taken in their diagnosis or treatment.

3. Surgical or Diagnostic Procedure Mishap

- Failure of a surgical technique might be inadvertent as happens in some unusually difficult operative circumstances, or anatomical abnormalities, or it may be accidental due to failure of the equipment, or it might be a result of error or incompetence on the part of the surgeon, in which case he can be sued for negligence.

4. Mishap or Complication of Anaesthetic Administration

a. Overdosage of Anaesthetic Agent

- True anaesthetic deaths arising out of overdosage of the anaesthetic agent are very rare, and if at all they do occur, it is due to ill-advised polypharmacy.
- Though data regarding the blood levels of various anaesthetic agents at different grades of anaesthesia are available in the literature, they are of limited use in practice.

  The current trend is to achieve a light plane of unconsciousness with a barbiturate or some other hypnotic, accompanied by the inhalation of nitrous oxide and oxygen, along with small quantities of a liquid agent like halothane. Muscular relaxation is achieved by the use of relaxants.
- Anaesthetic gases are known to cause dependence (physical or psychological), among anaesthesiologists, dentists, and paramedical personnel to whom they are readily available.
  - **Etheromania** is the dependence caused by ether, and is characterized by rapid onset and sudden abatement. Etheromania is of two types – acute and subacute.
    - In the acute variety, the person becomes delirious, and suffers from hypomania and convulsions leading to death.
    - In the subacute type, the person becomes aggressive and psychotic. It is usually difficult to determine whether the death was due to accidental overdosage or due to suicidal ingestion in such cases.
- Muscular relaxation is achieved by the use of relaxants such as gallamine, pancuronium bromide, tubocurarine, etc., which compete with acetylcholine at the motor end plate, or with agents such as succinylcholine, decamethonium iodide, etc., which depolarize the motor end plate rendering it inexcitable to acetylcholine.
- Whatever be the mode of action, the end result is the same – paralysis – the only difference being the former are long acting agents, while the latter are short acting.
- Overdose with tubocurarine and pancuronium bromide can be treated with neostigmine, while prolonged mechanical ventilation is the only solution to overdosage with succinylcholine and similar agents.

b. Anaesthetic Misadventure

An anaesthetic misadventure or a *critical incident* as it is called, is a human error or equipment failure that could have led (if not discovered or corrected in time), or did lead to an undesirable outcome, ranging from increased length of hospital stay to death.

- Most cases of anaesthetic morbidity and mortality occur from one of the following causes:
  1. *Complications of anaesthetic procedure:* Some of the complications arising out of anaesthetic procedures (due to either inherent risks of the procedure, human error, or equipment failure), are listed in **Table 15.1**.

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Table 15.1 Complications of Anaesthetic Procedures

Complication of/Due to	Aetiology	Outcome	Management
1. **Upper airway obstruction**	Anaesthetic agents cause an alteration in the pattern of activation of muscles which maintain the upper airway.	Hypoxia leads to a) impairment of gas exchange b) regurgitation & aspiration of gastric contents c) pulmonary oedema d) cardiovascular disturbance	Premedication with anticholinergics to reduce secretions, jaw thrust, extend neck, mandibular support by lifting at both angles
2. **Laryngo-spasm**	Performing laryngoscopy & surgery under light anaesthesia, presence of foreign matter such as blood, saliva, sputum or vomitus on or near the vocal cords. Inhalation of irritant vapours		
3. **Difficult laryngoscopy**	Conditions which cause difficulty in opening the mouth, or extending the head at occipito-atlanto-axial complex. Conditions causing airway obstruction, variants of normal small mouth (large tongue, receding jaw); acromegaly, thyroid enlargement, bulky tonsils, etc.	Upper airway obstruction and laryngospasm, leading to hypoxia	Pre-operative assessment prior to anaesthesia regarding head extension, mouth size, dentition etc. X-ray to detect upper airway obstruction. Use of antisialogogues IM preoperatively
4. **Laryngoscopy and tracheal intubation**		a) Gingival damage b) Lingual nerve damage c) Cardiovascular responses d) Increased intraocular pressure	Proper assessment and treatment of cardiovascular diseases, and proper technique of anaesthesia based on intravenous opioid analgesics. Suxamethonium is given to facilitate atraumatic intubation
5. **Endotracheal intubation**	Use of excessive force Nasal intubation	Perforation of pyriform fossa/posterior pharyngeal mucosa/cervical oesophagus. Trauma to nasal passages. Oesophageal intubation	Gentle insertion, well-lubricated tube, and use of a) Oesophageal detector device b) Capnography c) Direct visualisation of tracheal rings with fibre optic laryngoscope

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6. Dental damage	Insertion and removal of laryngoscope, fragile dentition		Use of a tooth shield. Use of gumelastic, or neoprene oesophageal bougie
7. Ocular damage	Surgical drapes, instruments, hands, anaesthetic hardware, facemasks	Corneal abrasions, retinal detachments and retinal artery thrombosis	Closure of eyes with a tape Appropriate size of face mask with little or no pressure
8. Pharyngeal airway	Long airways irritate the larynx	Laryngospasm	Use of correct length and diameter
9. Laryngeal mask airway		Laryngospasm, as the effect of muscle relaxant wanes at the end	Remove when patient is still in deep plane, or full recovery
10. Throat pack	Failure to remove it prior to extubation	Complex airway obstruction	
11. Harnesses	Tight straps	Facial nerve palsy, and blindness due to retinal artery thrombosis	
12. Fire in the airway	Endotracheal tube ignition in laser surgery with CO_2 laser beams, especially with high concentrations of oxygen		Non-combustible tube. Wrapping the endotracheal tube with reflective tape. Moist ribbon gauze placed around the tube above the cuff. Cuff filled with physiological saline
13. Regional, epidural, and spinal anaesthesia	Puncture of and injection into the spinal cord and nerve roots	a) Haematoma b) Paraesthesia c) Anaesthesia of adjacent structures leading to cardiac arrest d) Systemic toxicity of local anaesthesia e) Myelopathy f) Arachnoiditis	Ascending gentle procedure Correct dose Aseptic technique
14. General anaesthesia		Hepatic and renal complications. Halothane hepatitis.	
15. Malignant hyperthermia	Autosomal dominant inherited trait, plus succinylcholine and halogenated anaesthetic agents	Sudden rise in temperature, stiffening of skeletal muscles, rapid heart rate, and respiratory distress	Diagnosis by elevated creatine phosphokinase etc. Inj. dantrolene IV Hypothermia
16. Supplementary oxygen	Inlet port of the oxygen mask loosely applied over the open end of tracheal tube, with/without the cuff inflated		

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2. *Human error:*

A variety of factors associated with human error have been reported: emergency case, lack of experience with technique or equipment, failure to perform a normal check, lack of skilled assistance, restricted access to patient, & inadequate supervision of the patient due to distraction, fatigue, inattention, boredom, or anxiety.

There are three categories of human error:

i. Technical - in which the action taken is not the action intended, arising from deficiencies of technical skill, or from poor design of the equipment or apparatus.

ii. Judgemental - in which the action represents a bad decision, arising from lapses in training or poorly developed decision making skills.

iii. Monitoring & vigilance failures - in which the essence is a failure to recognise or act upon visible data requiring a response.

3. *Equipment failure:*

Equipment failure is a relatively minor cause of anaesthetic mishaps.

PREVENTION STRATEGIES

The following preventive strategies have been suggested:

1. **Training and Supervision**
   - Observation by investigators has indicated that some critical incidents were associated with inexperience or inadequate training.*
   - Inadequate supervision by seniors also has been cited as a cause.
   - Inadequate knowledge about a new device/technique also leads to error.

   All these can be rectified by regular in-house training of the anaesthetists.

2. **Specific Protocol Development, More Complete Preoperative Assessment, and Equipment and Apparatus Inspection**
   - Pre-operative assessment of patients, and pre-operative inspection of equipment and apparatus will prevent a number of critical incidents.
   - A standard checklist procedure similar to the one used by pilots in aviation is suggested to inspect the equipment, which can vary from one institution to the other according to the nature and availability of the instruments.

3. **Additional Monitoring of Instrumentation and Equipment, and Human Factors Improvements**
   - Improved standardization or arrangements of drugs in the anaesthesia workspace, and improvements in design of gas-flow control knobs and breathing circuit scavenging connections are now mandated by the national standards for new apparatus.
   - The standards recommended by the American Society of Anesthesiologists for basic patient monitoring include arterial blood pressure recorder, electrocardiography, an oxygen analyzer, and a ventilator disconnection alarm. Monitors that are encouraged but not mandatory, include pulse oximetry, capnography, and spirometry. Monitors must be fitted with alarm systems, preferably with preset and modifiable thresholds, which produce an auditory signal when a high or low limit is passed.

4. **Organizational Improvements**
   - The deployment of properly trained personnel will alleviate most of the critical incidents. Human errors are associated frequently with lack of sleep and fatigue. Regulation of working hours of anaesthetists/medical staff will minimise the problem.

MEDICOLEGAL ISSUES

While most surgical procedures carry with them an element of risk, there is an increased risk of serious morbidity, and even mortality in the case of

*A dull operator named Sue
Rang my beeper at quarter past two
It seems Mrs Fabor
Had gone into labor
And she hadn't a clue what to do!

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complicated procedures, infants, aged patients, and persons with pre-existing diseases, especially diabetes, hypertension, endocrine diseases, immunological disorders, etc. Also, emergency surgical procedures generally are associated with greater risk than elective procedures for obvious reasons.

Lack of empathy and failure of proper communication with the patient and his relatives are the main precipitating factors of negligence suits. Anaesthetists and surgeons should ensure the following in order to minimise the possibility of malpractice actions:

1. Always establish a proper physician-patient relationship.
2. Establishment of identity is important in surgery, which also includes the type of surgery to be performed, the side (in bilateral structures), self-identification, i.e., the patient must feel the presence of the doctor during surgery, and lastly re-identification, so that the patient sees the familiar face of doctor on awakening.
3. Informed consent of the patient (or that of a relative) with particular regard to the physical status of the patient, and associated disabilities must be obtained. Legally, separate consent for anaesthesia apart from surgery has to be taken.
4. Documentation regarding pre-anaesthetic evaluation and assessment of the patient, and pre-operative record of events is of vital importance. *Automated anaesthesia records systems* similar to the 'black-box' in aviation are available, which are clearer and more complete than handwritten records, reduce the workload of the anaesthetist, and can prove to be a valuable tool for retrospective analysis of anaesthetic mishaps.
5. Detailed, written records of the actual anaesthetic administered, the dose, route, etc., must also be ensured. The anaesthetic chart should contain details of premedication given, methods of induction, and the periodic recording of the vital parameters at regular intervals as the surgery proceeds. Details of the recovery phase are also to be recorded.
6. A written record must not be modified, once it has been made. If any alteration is done because of a genuine error, it must be done without delay and initialed by the surgeon or anaesthetist in charge, with date and time, stating reasons for such alteration.
7. Regarding any new instrumentation/technology, it is imperative to ascertain whether the anaesthetist had acquired the necessary skill to operate it, by formal training or by the demonstration of a salesperson, as also the rate of success of the procedure in his hands.
8. During the postoperative period (which is usually taken as up to 30 days following a surgical procedure), intensive care is very important, and the patient must be managed in a specialized intensive care unit with necessary facilities, equipment, and trained staff. Prophylaxis against cardiac deaths and deep vein thrombosis (DVT) may be required. For instance, administration of anticoagulants, use of calf pumps, and thromboembolic deterrent (TED) stockings are helpful in preventing DVT and pulmonary thromboembolism, two of the commonest postoperative complications.
9. All unexpected deaths occurring during the course of anaesthesia, surgery, or childbirth, or within a short time thereafter should be reported to the police, as they come under the definition of unnatural death. It is always desirable to request for an autopsy to ascertain the cause of the unexpected death. An open approach such as this will enable the doctor to defend himself effectively against possible litigation.
10. Apportioning responsibility between the anaesthetist and the surgeon may be difficult in actual practice. Both have contractual obligations to the patient to exercise reasonable skill and care. Each one is responsible only for his own negligent act.
    a. The surgeon may be held vicariously responsible for negligence committed by his assistants and nurses, but not any member of the anaesthetic team.
    b. The anaesthetist is an independent contractor, and is solely liable for his acts of omission and commission, and vicariously responsible for mistakes committed by his assistants.

Autopsy Procedure

- Full clinical information is essential, especially in so-called 'anaesthetic deaths,' since the morphological findings may be minimal or even absent.

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- Surgical intervention and its sequelae such as exudate, sepsis, haemorrhage, oedema etc., may make the dissection difficult, especially if the particulars of the surgical procedure are not fully known. Postmortem changes can further complicate the appearances. Resuscitative intubation can cause artifactual injury that may mimic inflicted injuries caused by neck compression, including manual strangulation and law enforcement "neck holds." Similarly, defibrillator injuries must not be mistaken for something else (Fig. 15.2).

| Fig. 15.2 Defibrillator Injury |

- Surgical and anaesthetic devices introduced into the patient, such as airways, endotracheal tubes, indwelling needles, catheters, monitoring electrodes, etc., should not be removed prior to autopsy.
- Position of the endotracheal tube must be checked by a pre-autopsy radiograph. A ring of oedematous oesophageal mucosa at the level of the tube in the trachea, and distension of stomach and intestines indicate oesophageal intubation.
- Antemortem blood or body-fluid samples, if available, should be retained for analytical tests.
- The presence of the surgeon and the anaesthetist concerned, at autopsy, will make the interpretation of the findings easier.
- Care must be taken to detect any surgical emphysema, pneumothorax, or air embolism.

Recent Developments

The Supreme Court of India has expressed the view that doctors should be protected from frivolous or unjust prosecutions. It has issued strict guidelines regarding the prosecution of medical professionals for alleged offences involving rashness or negligence.

- A private complaint may not be entertained unless the complainant produces prima facie evidence before the court in the form of a credible opinion given by another competent doctor to support the charge of rashness or negligence on the part of the accused doctor.
- Similarly, an investigating officer, before proceeding against a doctor accused of rash or negligent act or omission, should obtain an independent and competent medical opinion, preferably from a doctor in government service qualified in that branch of medical practice, who can normally be expected to give an impartial and unbiased opinion.
- A doctor accused of rashness or negligence may not be arrested in a routine manner simply because a charge has been leveled against him. Unless his arrest is necessary for furthering the investigation, or for collecting evidence, or unless the investigating officer feels convinced that the doctor proceeded against, would not make himself available to face prosecution, a doctor must not be subjected to needless humiliation.
- In some Indian states, an allegation of medical negligence can be investigated only by a police officer of, or above, the rank of Deputy Superintendent. After registering the case, the police officer must refer the case to an expert panel consisting of the District Medical Officer (who will act as the Convenor), District Govt. Pleader, a senior Govt. Doctor in the speciality concerned, and a Forensic Medical Expert. The investigating officer must go by the views expressed by the expert panel.

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CHAPTER 16

Starvation

I asked the men, "What are you carrying wrapped in that hammock, brothers?" And they answered, "We carry a dead body, brother." So I asked," Was he killed or did he die a natural death?" "That is difficult to answer, brother. It seems more to have been a murder." "How was the man killed? With a knife or a bullet, brothers?" I asked. "It was neither a knife nor a bullet; it was a much more perfect crime. One that leaves no sign." "Then how did they kill this man?" I asked, and they calmly answered, "This man was killed by hunger, brother..."

—**Josue de Castro** (1908–1973; Brazilian Physician and Writer)

INTRODUCTION

- **Starvation** results from the deprivation of a regular and constant supply of food, which is necessary for the maintenance of the nutritional balance of the body. The term "starvation" includes both **subnutrition** (intake of an insufficient quantity of food), as well as **malnutrition** (feeding of inadequate quality). Malnutrition can and does occur as a separate entity, while subnutrition must always include some degree of malnutrition.
- Starvation is regarded as *acute*, when the necessary quantity of food and water are suddenly and completely withheld, and *chronic*, when there is a gradual deficiency in the supply of food.
- In India, starvation deaths due to famine are not an unknown occurrence, though it is not so common today.
- **Inanition** refers to the symptoms and effects of starvation, while **cachexia** refers to acute loss of body weight.
- Neglect and starvation are not synonymous, but are often so closely associated, that the two conditions are usually considered together. Death can occur from deliberate or negligent lack of provision of proper care and nutrition of children. In general, though there are many exceptions, nutritional neglect and physical battering tend to be mutually exclusive. The abused child is usually well nourished, while the emaciated child is usually uninjured.

CAUSES OF STARVATION

- Famine
- Fasting
- Malnutrition
- Overpopulation
- Poverty
- War
- Anorexia nervosa
- Bulimia nervosa
- Depression
- Coma
- Diabetes mellitus
- Digestive disease

GENERAL FEATURES OF STARVATION

A minimum of 1900 calories of food per day is the average dietary requirement for an adult, below which the effects of starvation will begin to manifest (Fig. 16.1). There is danger to life when more than 40 percent of the original body weight has been lost, though the speed of loss is relevant. Total lack of food is likely to cause death in about 50–60 days if adequate water is available, while if it is not, death is greatly accelerated. Total deprivation of water results in death in about 10 days. The rapidity of

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death also depends on the weather, temperature of the environment, and the original fitness (or fatness!) of the individual.

| Fig. 16.1 Starved Victim from a Prison Camp |

Signs and Symptoms of Starvation

- An acute feeling of hunger lasts for the first 2 days.
- Loss of fat and emaciation make their appearance in about 4 days.
- There is progressive loss of body weight.
- The skin becomes dry, pigmented, shrivelled, thin, parchment-like, fissured, and drawn tight over bony prominences.
- The cheeks become sunken, and lips are dry and cracked.
- The abdomen becomes scaphoid (Fig 16.2).
- The person feels extremely weak, and may look pale and cadaverous. Pallor is due to anaemia of nutritional type, resulting from inadequate intake of iron, proteins, vitamins and other required elements.
- Pupils get dilated.
- Tongue is dry and coated. The breath turns offensive.
- Hair becomes dry, lustreless, and brittle.
- Nails become brittle and ridged.
- Pulse is feeble, and blood pressure is low because of cardiac atrophy.

| Fig. 16.2 Scaphoid Abdomen - Starvation (Pic : Dr Shashidhar C Mestri) |

- There may be oedema of the feet due to decrease in blood proteins (hypoproteinaemic oedema).
- The temperature is subnormal.
- There is constipation at first, but later diarrhoea sets in.
- Urine is scanty and dark coloured.
- The mind usually remains clear till the end. The person may become delirious just before death.
- In contrast to the generalized drying up of tissues in most cases of starvation as listed above, some individuals may develop **wet starvation**: oedema of face, trunk, and extremities, in association with pleural effusion and ascites.

Factors Modifying the Effects of Starvation

1. **Age**: Old people generally withstand the effects of starvation better than young adults because of their lower food requirements. Similarly, a mature adult can withstand starvation better than a growing child.
2. **Sex**: Women can usually combat starvation better than men for the same reason as above, as also the fact that they generally possess more body fat.
3. **State of health**: Healthy people can endure the effects of starvation better than the sick.

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4. **Body fat**: Obese people can withstand the effects of starvation better than the lean.
5. **Cold**: Exposure to cold aggravates the effects of starvation, because it accelerates the basal metabolic rate.

TREATMENT

- Rest and warmth must be provided and maintained.
- Solid food must not be given straight away.
- Small sips of warm water mixed with glucose or fruit juice can be given at frequent intervals.
- Later solid food can be given in gradually increasing quantities. Administration of protein hydrolysate helps to raise the level of blood proteins and thus combat oedema.
- If treatment is hurried with immediate institution of normal feeding, there is a potential risk of precipitating the "refeeding syndrome," which can be fatal.
  - s usually occurs within four days of starting to feed. Patients can develop fluid and electrolyte disorders, especially hypophosphataemia, along with neurologic, pulmonary, cardiac, neuromuscular, and haematologic complications. Most effects result from a sudden shift from fat to carbohydrate metabolism, and a sudden increase in insulin levels after refeeding, which leads to increased cellular uptake of phosphate. Intracellular movement of electrolytes occurs, along with a fall in the serum electrolytes including phosphate, potassium, magnesium, glucose, and thiamine. Refeeding syndrome can cause confusion, coma, convulsions, and death.

POSTMORTEM FINDINGS

External

1. Emaciation: The degree of loss of weight is an indication of the duration of starvation.
2. Pupils: Dilated.
3. Skin: Dry, shrivelled, thin, parchment-like, fissured, and drawn tight over bony prominences (Fig 16.3). Trophic ulcers may be present.
4. Hair: Dry, lustreless, and brittle.
5. Nails: Brittle and ridged.
6. Lips: Dry and cracked.
7. Tongue: Dry and coated.
8. There may be oedema of the feet.

| Fig. 16.3 Extreme Emaciation Due to Starvat with Parchment-like Skin Drawn Tight Ove Bony Prominences *(Pic : Dr Nilesh Tumram)*

Internal

1. Loss of body fat (Fig 16.4) and atrophy muscles.

| Fig. 16.4 Depleted Subcutaneous Fat - Starvation Death *(Pic : Dr Pannag S Kumar)* |

2. Stomach and small intestine: Small and contracted.
3. Gall bladder: Distended with bile.
4. Omentum and mesentery: Devoid of fat.

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5. Large intestine: Contains hard faecal matter. There may be generalized ulceration of colonic mucosa.
6. All organs except brain, shrunken and reduced in size (Fig 16.5). Brain is often oedematous .
7. Bones: Demineralized.

| Fig. 16.5 Brown Atrophy of Heart |

CAUSE OF DEATH

In acute starvation, death occurs from inanition and circulatory failure. In partial/chronic starvation, the vitality of the individual is reduced, and death may result from intercurrent disease. Multiple organ failure with ventricular fibrillation as the terminal event is the usual end result.

MEDICOLEGAL IMPORTANCE

- Starvation may be accidental, suicidal, or homicidal.
- In cases of **accidental** starvation, the circumstances are self-explanatory, such as famine, shipwreck, entombment in mines, or diseases such as stricture of the oesophagus.
  - The right to food is not just a basic human right, but also a basic human need. It is the state's responsibility to ensure that its people do not starve and die due to hunger and starvation. Under the Indian Constitution, there is no fundamental right to food, but the fulcrum of justifiability of the right to food comes from a much broader Article 21, which guarantees the "Right to life and liberty" to all the citizens. The Supreme Court has recently directed that the Chief Secretary of a state would be held responsible for all starvation deaths in that state, if such deaths are reported and proved to have occurred.
- **Suicidal** starvation is rare, though it may be seen among mentally disturbed individuals, and occasionally among prisoners who go on a hunger strike as a form of protest. Voluntary starvation for religious or political reasons is well known. The world's longest 'hunger striker' is **Irom Sharmila** (Fig 16.6) a civil rights activist, political activist, and poet from the Indian state of Manipur. On 2 November 2000, she began a hunger strike which she ended on 9 August 2016, after **16 years** of fasting. On International Women's Day, 2014 she was voted the top woman icon of India by MSN Poll. Irom Sharmila is popularly referred to as the Iron Lady of Manipur.

| Fig. 16.6 Irom Sharmila - The Iron Lady of Manipur |

- In **homicidal** cases, the victim is usually an infant who has been deliberately and wilfully deprived of food. Successful prosecution in cases of fatal infant starvation depends on establishing the fact that the death resulted from failure to offer the child sufficient food. This deficiency

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must be coupled with evidence that the mother was aware of the gravity of the child's condition, and that she did nothing to ameliorate the situation in spite of availability of resources.

- The most horrific example of **mass homicide** by starvation was perpetrated by Nazi Germans on helpless Jews during the Second World War. Many deaths from starvation took place in Nazi concentration camps in Belsen and other places in Germany during that time. At Belsen, which was perhaps the worst camp of all, the entire organisation for the provision and distribution of food broke down during the last fortnight prior to liberation, and only those capable of fighting for food, managed to obtain the paltry supply available, which was just half a litre of soup per day! **(Fig 16.7)**

| **Fig. 16.7** The Horror of Belsen |

| **Fig. 16.8** Anarkali and Prince Salim (Jehangir) |

- Starvation has historically been used as a **death sentence**. From the beginning of civilization through to the Middle Ages people were **immured**, or starved to death.* By popular legend, Anarkali (a slave girl from Iran who migrated to Pakistan) was immured between two walls in Lahore, Pakistan by order of Mughal Emperor Akbar for having a relationship with crown prince Salim (later Emperor Jehangir) in the 16th century **(Fig 16.8)**. A bazaar gradually developed around the site, and was named Anarkali Bazaar in her honour. The legendary Hindi film 'Mughal-e-Azam' was based on this possibly apocryphal tale.

**Immurement is a form of execution where a person is walled up within a building and left to die from starvation or dehydration*

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Section III

Sexual Jurisprudence

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CHAPTER 17

Impotence, Sterility, Assisted Reproduction and Cloning

To succeed with the opposite sex, tell her you're impotent. She can't wait to disprove it.
—**Cary Grant** *(1904–1986; Legendary Hollywood Actor)*

IMPOTENCE

- Impotence, in its simplest meaning, is the inability to perform the act of coitus. Since in this act the male is usually the active partner and the female is relatively passive, the term **impotence** is generally applied to **the inability of the male to achieve and/or maintain penile erection and thus engage in copulation**.
- Today the term "**erectile dysfunction**" is preferred, which is defined as **male sexual dysfunction involving inadequacy of erection, or problems with emission, ejaculation or orgasm**.
- Impotence may be temporary or permanent.

Causes of Impotence

1. **Physiological causes**:
   Extremes of age – very young infant, very old male. This is however not the rule, and infants as well as old individuals may be quite potent.
2. **Organic causes**: Due to structural abnormalities in the reproductive system.
   a. *Congenital:*
      - Klinefelter's syndrome
      - Primary testicular failure
      - Cryptorchidism
      - Congenital deformities (e.g., phimosis, epispadias, etc).

   b. *Acquired:*
      - Partial/total amputation of the penis
      - Pre-pubertal castration
      - Local diseases (e.g., large hydrocoele, filariasis, infections such as gonorrhoea, and carcinomata).
3. **Atonic causes**: Due to paralysis of the motor nerves supplying the genitalia without evidence of any lesion of the central nervous system.
   a. *Traumatic:*
      - Blow to the external genitalia
      - Injury to the cauda equina

   b. *Pharmacogenic*: Excessive doses or prolonged use/abuse of sedatives, parasympatholytic agents, ethanol, opiates, cocaine, etc.
   c. *Diseases*: Autonomic neuropathies of varying aetiology, or tumours of the cauda equina.
4. **Paretic causes**: Due to lesions in the central nervous system or spinal cord.
   a. Hemiparesis or paraplegia, as a result of either trauma or a cerebrovascular accident.
   b. General paralysis of the insane (tertiary syphilis).
5. **Functional causes**: They are dependent on the mental complex, and are usually due to
   a. Fear, timidity and anxiety, all of which are responsible for what is commonly described as ***first-night*** or ***bridegroom impotence***.
   b. Aversion to a particular female (***impotentia quoad persona***) or to females in general (***sexual aversion disorder***, defined as a "persistent or recurrent aversion to, and avoidance of all genital sexual contact with a sexual partner").
   c. Excessive passion (leading to premature ejaculation).
   d. Sexual overindulgence.

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The commonest reason for impotence in males is generally due to one of the above functional causes.

Medicolegal Importance of Impotence

Civil Cases

1. Legally, a marriage is a contract between man and wife, in which sexual union between the two is presumed to take place periodically (**consummation**).
   a. If there is any cause, in either partner, which prevents such sexual intercourse (such as impotence existing either before or at the time of the marriage), the marriage cannot be consummated, and can therefore be declared by a court of law to be **null and void**.
   b. However, when impotence develops after the marriage has been consummated, it can only be cited as grounds for **divorce**, whether or not the consummation has resulted in conception and the production of offspring.
   c. A marriage that has been declared "**null and void**," i.e., a "**void marriage**," is one that is totally **invalid** as per law. In other words, even though it may have been solemnized by religious rites or by formal registration, the two individuals cannot be considered as husband and wife. On the other hand, the term "**divorce**" refers to the dissolution of a previously **valid** marriage between two individuals who were husband and wife.

   Table 17.1 mentions the important grounds under which a spouse can file for nullity (void marriage) or divorce.
2. In a case of **disputed paternity**, the putative father may claim that he is impotent, and therefore could not have fathered the child.
3. A man may claim **compensation** for an injury that has allegedly rendered him impotent.

Table 17.1 Legal Grounds for Nullity of Marriage (Void Marriage) and Divorce

Nullity (Void Marriage)	Divorce
1. Either party has a spouse living at the time of the marriage	1. Adultery
2. The parties are within prohibited degree of relationship (consanguinity) to each other	2. Cruelty
3. Impotence on the part of either spouse from the time of marriage leading to non-consummation	3. Desertion
4. Either party was mentally unsound from the time of marriage	4. Conversion to another religion
5. Consent of either party was obtained by force or fraud	5. Mental unsoundness developing after marriage
6. Either party was below the legal age for marriage	6. Venereal disease in a communicable form
	7. Renunciation (turning "sanyasi")
	8. Either spouse not being heard of for 7 years or more
	9. Husband found guilty of rape, sodomy, or bestiality
	10. Mutual consent

Adapted from Virendra Kumar, Vrinda. Nullity and dissolution of marriage and its medicolegal aspects. Int J Med Toxicol Legal Med 2001; 4: 27–37.

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Criminal Cases

1. In criminal cases of **natural/unnatural sexual offences**, the accused may plead that he is impotent, and so cannot be charged with the crime.

The role of a registered medical practitioner in the cases listed above is obvious. However, in no instance can he positively conclude that a person is potent. If on examination, he finds that a male is physically normal in all respects, including development of secondary sexual characteristics and external genitalia, and if all the causes of impotence enumerated above are excluded, he is justified in opining that he "*finds nothing to suggest that the person is incapable of participating in normal sexual intercourse*." In other words, a **medical certificate of potency** should be couched in **double negative language**. But if there is gross anomaly such as amputation of penis or emasculation, he can opine conclusively that the said individual *is incapable of participating in normal sexual intercourse*.

It is however the opinion of some experts that there is nothing wrong in exceptional cases, in giving an opinion that a particular individual is capable of participating in sexual intercourse if there is convincing evidence that the individual is potent. To exemplify this, they quote an actual instance in which a renowned forensic expert did opine categorically that a particular male he had examined was capable of participating in sexual intercourse. The expert in question was the renowned English forensic pathologist **Professor Keith Simpson** who gave such an opinion in a case, and was subsequently grilled by the opposing lawyer on this issue during cross examination. When asked how he could be so certain that the individual was potent, Prof Simpson stated that when he performed per rectal examination (to palpate the prostate) as part of his thorough physical examination, he noticed that the individual had developed an erection of his penis. He said that was confirmation enough for him that the individual was potent. The lawyer then sarcastically remarked loudly to the court, "Oh, I see. But that only means that whenever this gentleman desires to have an erection, the good doctor's finger becomes necessary!" The court erupted in laughter. Prof Simpson waited calmly until the laughter had subsided, and then said with perfect composure, "That is not quite correct, Sir. You see, your finger will do equally well!"

FRIGIDITY

- **Frigidity** is the correct term for impotence in the female. In other words, it refers to a **difficulty or inability to take part in sexual intercourse by a female**.
- Like male impotence, frigidity could be either temporary or permanent.

Causes of Frigidity

1. **Permanent frigidity** is invariably psychogenic in nature, resulting most often from either sexual abuse during childhood, or a traumatic sexual assault during adulthood, manifesting as either a
   a. **Sexual aversion disorder**: Persistent or recurrent aversion to, and avoidance of all genital sexual contact with a sexual partner
   b. **Female sexual arousal disorder**: Persistent or recurrent lack of a subjective sense of sexual excitement and pleasure in a female during sexual activity
2. **Temporary frigidity** manifests only as **female sexual arousal disorder**. It may be due to either
   a. **Dyspareunia**, a term loosely used to describe both difficult and painful coitus, or
   b. **Vaginismus**, which is hyperaesthesia leading to painful spasms of the sphincter vaginae and levator ani, with simultaneous spasmodic contractions of the adductor muscles of the thighs and the erector spinae, making penetration impossible:

      Vaginismus may be:
      i. *Primary* (where there is no organic lesion)
      ii. *Secondary* (due to a painful local inflammation or lesion, or during menstruation)
      iii. *Psychogenic* (due to fear, timidity, anxiety).

Box 17.1 details a humorous fictional letter about vaginismus allegedly written by a physician for a journal.

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Box 17.1 A Case of Vaginismus

Through the courtesy of the Editor of the Canadian Medical and Surgical Journal, we are in receipt of the following note:

Dear Sir,

The reading of an admirably written and instructive editorial in the Philadelphia Medical News for 24th November, on forms of vaginismus, has reminded me of a case in point which bears out, in an extraordinary way, the statements therein contained. When in practice at Pentonville, Eng., I was sent for, about 11 PM by a gentleman whom, on my arriving at his house, I found in a state of great perturbation, and the story he told me was briefly as follows:

At bedtime, when going to the back kitchen to see if the house was shut up, a noise in the coachman's room attracted his attention, and, going in, he discovered to his horror that the man was in bed with one of the maids. She screamed, he struggled, and they rolled out of bed together and made frantic efforts to get apart, but without success. He was a big, burly man, over six feet, and she was a small woman, weighing not more than ninety pounds. She was moaning and screaming, and seemed in great agony, so that, after several fruitless attempts to get them apart, he sent for me. When I arrived I found the man standing up and supporting the woman in his arms, and it was quite evident that his penis was tightly locked in her vagina, and any attempt to dislodge it was accompanied by much pain on the part of both. It was indeed, a case of "de cohesione in coitu." I applied water, and then ice, but ineffectually, and at last sent for chloroform, a few whiffs of which sent the woman to sleep, relaxed the spasm, and relieved the captive penis, which was swollen, livid, and in a state semi-erection, which did not go down for several hours, and for days the organ was extremely sore. The woman recovered rapidly, and seemed none the worse.

I am sorry that I did not examine if the sphincter ani was contracted, but I did not think of it. In this case there must have been also spasm of the muscle at the orifice, as well as higher up, for the penis seemed nipped low down, and this contraction, I think, kept the blood retained and the organ erect. As an instance of Jago's "beast with two backs," the picture was perfect.

Yours truly,
Egerton Y Davis
Ex. US Army
Caughnawaga, Quebec, 4th December, 1884

Reprinted from Medical News, 1884; 45: 673. (edited version of the original).

Medicolegal Importance of Frigidity

- If a woman is so frigid as to prevent sexual intercourse after being married, preventing it from being consummated, such a marriage can be declared by a court of law to be **null and void**.
- But if the frigidity develops after the marriage has been consummated, it can only be cited as grounds for **divorce**, whether or not the consummation has resulted in conception and the production of offspring.

STERILITY

- **Sterility** is defined as **the incapability of fertilisation or reproduction**. However, the term "sterility" has fallen out of favour, and has been replaced by the phrase "**absolute infertility**."
- **Absolute infertility** in the **male** is the *inability to fertilise the ovum*. Impotence and absolute infertility may co-exist, but not invariably – a person may be potent but sterile; conversely, he may be impotent, but not necessarily sterile.

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- **Absolute infertility** in the **female** is her *inability to conceive, due to inadequacy in genital structure or function.*
- Absolute infertility is complete and usually irremediable. On the other hand, **relative infertility**, which is the diminished capacity to produce offspring, can often be corrected. A forensic expert's opinion is usually sought only in cases of absolute infertility (either male or female). Opinions regarding relative infertility are better given by a practising genitourinary surgeon or obstetrician.

Causes of Absolute Infertility in the Male

The factors essential for fertilisation of the ovum are normal spermatogenesis, transport of the spermatozoa to the external urethral meatus, and deposition of these spermatozoa in the female genital tract (insemination). Taking these factors into consideration, the causes of absolute infertility in the male (excluding the physiological infertility that exists before puberty and in extreme old age) can be classified as:

1. **Azoospermatogenic** (total failure to produce living spermatozoa)
   a. *Seminiferous tubular necrosis*, e.g., Klinefelter's syndrome.
   b. *Germinal aplasia*, either idiopathic, or due to the XYY syndrome, or exposure to radiation/drugs.
   c. *Arrest of maturation*, as in varicocele.
   d. *Endocrinopathies*.
2. **Oligospermatogenic** (failure to produce living spermatozoa in sufficient numbers)
   a. *Congenital conditions*, e.g., Frohlich's and Klinefelter's syndromes, primary testicular failure, and cryptorchidism
   b. *Acquired conditions*, e.g., general debilitating diseases, local diseases such as adolescent mumps orchitis/ tuberculous epididymo-orchitis/varicocele/carcinomata, and drug-induced (nicotine, alcohol, cannabis, cocaine).
3. **Asthenospermatogenic** (defects in sperm movement)
   a. Idiopathic
   b. Spermatozoal structural defects
   c. Antisperm antibodies
   d. Genital tract infections
   e. Prolonged abstinence
4. **Normospermatogenic**
   a. Structural/functional abnormalities in the male
   b. Abnormal coital habits (including poor timing)
   c. Acrosomal defects in the spermatozoa
   d. Immunological causes
   e. Unexplained causes
5. **Absent ejaculation** due to
   a. Surgery (e.g., vasectomy)
   b. Vascular occlusion
   c. Diabetes mellitus
   d. Psychological disturbances
   e. Drug-induced

Causes of Absolute Infertility in the Femal

1. **Organic Causes**
   a. *Congenital defects*
      i. of the **vagina**, which may not have deve oped at all, may not be canalised, may b septate, or may manifest an imperforate hy men.
      ii. of the **cervix**, which may be elongated c conical, or may have a pinhole os (hostil cervical mucosa may also obstruct/imped penetration of the ovum by the sperm).
      iii. of the **uterus**, which may be either absen or retroflexed.
      iv. of the **fallopian tubes**, which may b stenosed (an extremely rare condition).
   b. *Acquired causes*
      i. Diseases of genital tract, e.g., gonorrhoea leading to salpingitis.
      ii. Diseases of ovaries, uterus or fallopian tubes.
      iii. Exposure to radiation.
      iv. Exposure to drugs.
2. **Hormonal dysfunction** leading to menstrual irregularities may occur from pituitary dysfunction, adrenogenital syndrome, or prolonged use of contraceptives.
3. **Chromosomal abnormalities**, e.g., Turner's syndrome.

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Medicolegal Aspects of Sterility (Absolute Infertility)

Civil Cases

- The putative father, in a suit of disputed paternity, may plead that he is sterile, and so could not have fathered the child.
- A patient may claim damages for loss/diminution of reproductive capability as a result of professional negligence during a surgical operation.
- Absolute infertility in the male is the prime indication for artificial insemination (donor) or adoption of a child.

Criminal Cases

- Battery or criminal negligence may be cited as the cause for the incapability of a male for fertilisation, or of a female for conception.

Investigation of a Case of Sterility (Absolute Infertility)

1. In both **males** and **females**, a detailed physical and marital history, general examination, and scrutiny of secondary sexual characteristics are mandatory. A psychological assessment may also be carried out when indicated.
2. In the **male**, the specific investigations to be conducted include:
   a. *Initial basic laboratory evaluation*
      i. of seminal fluid for its physical characteristics, morphology and motility of spermatozoa, and presence and level of fructose; and
      ii. of hormonal levels with particular reference to follicle-stimulating hormone (FSH), gonadotropin and gonadotropin-releasing hormone (GnRH), testosterone and prolactin, and luteinising hormone (LH).
   b. *Transrectal ultrasonography* (TRUS) to detect absence of or anatomical abnormalities of the seminal vesicles or ejaculatory ducts
   c. *Second-level testing* (not all patients need these):
      i. to rule out antisperm antibodies
      ii. leucocyte staining of semen
      iii. testicular biopsy
      iv. vasography
      v. functional evaluation of spermatozoa
3. In the **female**, the specific investigations to be conducted include
   a. *Evaluation of ovulation* by several methods, including basal body temperature charting, and testing of urinary LH, mid-luteal progesterone levels, endometrial biopsy, and ultrasonic monitoring of the development and disappearance of the ovarian follicles.
   b. *Evaluation of the fallopian tubes* by hysterosalpingogram using either oil or water-based dyes, to determine the patency of the fallopian tubes as well as the shape of the uterus. It is generally performed in the early follicular phase of the cycle, once menstrual bleeding ceases.
   c. *Laparoscopy* may be indicated when clinical examination or prior investigations have raised a suspicion of pelvic pathology, or when all other investigations have proved normal.
   d. *Additional investigation* of the functional relation between spermatozoa and ova may be performed when considered necessary.

ASSISTED REPRODUCTION

Artificial Insemination

- Having considered impotence and absolute infertility, it would be appropriate to know how a woman may be enabled to conceive by artificial means. The oldest and simplest of these is **artificial insemination**, defined as **the introduction of semen into the vagina other than by coitus**.
- The procedure employs a sterile syringe to introduce 1 mL of semen into the uterus at about the time of ovulation (Fig. 17.1). The semen should be collected by masturbation into a wide-mouthed sterile glass container, after 3 days' abstinence. The specimen should be used within 2 hours of collection, during which it should be subjected to examination to ensure its normalcy with respect to its physical characteristics and the quality of spermatozoa (number, morphology, and motility).

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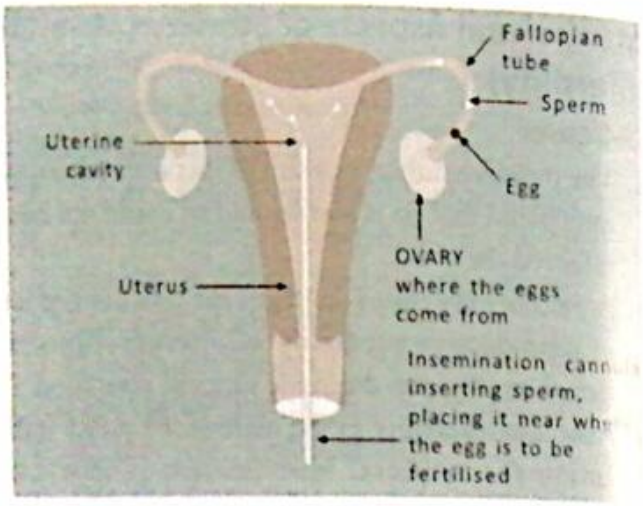
- If the semen used for this purpose is derived from the woman's husband himself, the procedure is called **homologous artificial insemination (AIH)**.
- If it is obtained from a person other than the husband, the method is termed **heterologous artificial insemination**, or, for differentiation from the first type, **artificial insemination (donor) (AID)**. The use of frozen semen stored in sperm banks for heterologous artificial insemination is becoming increasingly popular, as is pooling of the husband's semen with that of a donor (which is psychologically advantageous to both the husband and his wife).

- **Indications** for artificial insemination:
  - For AIH: An impotent but fertile husband.
  - For AID:
    - A sterile husband
    - Genetic defects in the husband, carrying a high risk of mortality, which would definitely be transmitted to the child (e.g., blood dyscrasias)
    - Rh incompatibility between husband and wife, which would result in erythroblastosis foetalis in the child.

Ethical Aspects of Artificial Insemination

- Homologous artificial insemination is not associated with significant legal or ethical problems, so no special precautions are called for.
- On the other hand, when AID is contemplated, the registered medical practitioner who undertakes the procedure must observe with greatest care, the following precautions in the selection of the donor, lest he be accused of ethical malpraxis:
  - The expressed written informed consent of both the recipient and her husband, and of the donor and his wife
  - Absolute confidentiality must be maintained
    - Neither should the identity of the donor be revealed to the recipient, her husband, or their children,
    - Nor should the identities of the recipient, her husband, or the child be made known to the donor, his wife, or children



| Fig. 17.1 Artificial Insemination |

  - The donor
    - Should be less than 40 years of age.
    - Should not be related by blood to either recipient or her husband (however, preferable that he resemble the husb physically, socially, and intellectually closely as is possible).
    - Should be in sound physical and me health, and should be free of hereditary, milial, and sexually transmitted disease
    - Should be potent and fertile (if married should have at least two healthy childre his own).

Medicolegal Aspects of Artificial Insemination

- The medicolegal aspects of artificial insemi tion vary from country to country. Although pr tised widely in the West, it has not gained mu popularity in India (except in veterinary practice

  Strangely, even abroad, it has no definitive le gal sanction in statutory or case law. Thus, multiple legal questions arise about the procedure:
  - Does artificial insemination (donor)
    - Amount to **rape** or **adultery**?: *Not in India or in the United Kingdom, where sexual intercourse is necessary to constitute the offence*
    - Constitute a valid ground for **divorce** by reason of adultery?: *Again, this is not a valid reason (because of the definition of the offence), unless the procedure was performed without the expressed written informed consent of the husband*

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- Lead to **annulment of marriage** by reason of non-consummation?: *This question would definitely arise if the husband was both impotent and sterile prior to the marriage. However, no such instance seems to have been reported to date, for obvious reasons.*
- Is a child born of artificial insemination **legitimate**?: *Peculiarly, the law says "No," regardless of whether the child was born of AIH or AID! This view raises further queries, such as:*
  - If the husband is not the father of the child, then who is? Or is the child to be considered fatherless? This is an anomaly, because no child can be begotten without a father (at least, until the advent of cloning!).
  - Would naming the father of the child born of AID, as the father in legal documents (birth certificate, applications for various purposes, etc.), amount to a false declaration?
  - How could the child lawfully inherit the property of the "father"?
  - The general consensus of opinion as to the above question of **legitimacy** and its corollaries is that the child born of artificial insemination must be legally adopted by its parents, so that
    - the husband is legally considered as the father of the child, even though he may not have contributed to its conception, and
    - the child can lawfully inherit the property of its parents, or be entitled to maintenance should its parents divorce.
- Does sexual intercourse between a child born of AID and the children of the donor born in wedlock amount to incest? *Theoretically it would, but practically, the probability of such an event is extremely remote.*

- Finally, it must always be kept in mind that the physician who conducts an artificial insemination can be held liable for civil negligence, indecent assault, or breach of trust, unless he:
  - exercises skill and care in the selection of a donor, & in the performance of the procedure,
  - ensures that a registered nurse is present throughout the procedure,
  - himself conducts the delivery of the child conceived by the procedure which he has performed, and
  - maintains records pertaining to the procedure meticulously and in the strictest confidence.

Other Methods of Assisted Reproduction

1. **In vitro fertilisation and embryo transfer** (IVF-ET), which consists of controlled ovarian hyperstimulation (COH) using one or more ovulation-inducing drugs, aspiration of oocytes, insemination of these oocytes in vitro, and transfer of the cleaved embryos back into a woman's uterus.
2. **Gamete intra-fallopian transfer** (GIFT), an option used only in patients who have at least one patent fallopian tube, and whose infertility is longstanding and not responding to other measures. This method involves COH, aspiration of oocytes by laparotomy or minilaparotomy, and transfer of oocytes and sperm back into the fallopian tube.
3. **Pronuclear stage tubal transfer** (PROST), another option only for those with at least one normal fallopian tube. In this procedure, COH is followed by *ultrasound-guided egg aspiration* (USGEA), and fertilisation in vitro. The eggs are observed 24 hours after insemination for the development of pronuclei as proof of fertilisation. If these are identified, three or more zygotes are laparoscopically transferred into the fallopian tubes.
4. **Micromanipulation techniques** to assist fertilization, which have been rapidly developed during the past several years as adjuncts to the ARTs already described. These are attempted predominantly in those infertilities associated with the male factor as a cause or component. Those presently in use are **zona drilling, partial zona dissection, perivitelline sperm transfer (PST)**, and **intra-cytoplasmic sperm injection (ICSI)**

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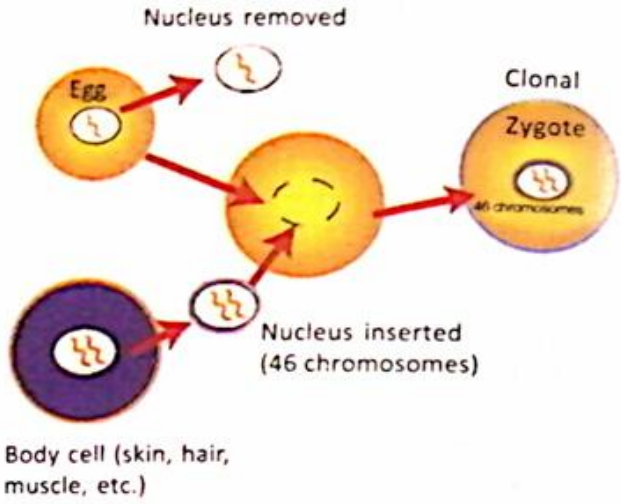
CLONING

Introduction

- The term **clone** is derived from the Greek word for "twig," or "branch," referring to the process whereby a new plant can be created from a twig.
- **Cloning** in biology is the process of producing populations of genetically-identical individuals that occurs in nature when organisms such as bacteria, insects, or plants reproduce asexually.
- Cloning in biotechnology refers to creating copies of DNA fragments (molecular cloning), cells (cell cloning), or organisms.
- More generally, the term refers to the production of multiple copies of a product such as digital media or software.
- Somatic cell nuclear transfer can also be used to create a clonal embryo. The main purpose for this is to produce embryos for use in research, particularly stem cell research. This process is also called "**research cloning**" or "**therapeutic cloning**." The goal is not to create cloned human beings, but rather to harvest stem cells that can be used to study human development and to potentially treat disease.

Reproductive Cloning

- **Reproductive cloning** uses "somatic cell nuclear transfer" (SCNT) to create animals that are genetically identical. This process entails the transfer of a nucleus from a donor cell (somatic cell) to an egg which has no nucleus. If the egg begins to divide normally it is transferred into the uterus of the surrogate mother (Fig. 17.2).
  - Such clones are not strictly identical since the somatic cells may contain mutations in their nuclear DNA. Additionally, the mitochondria in the cytoplasm also contains DNA and during SCNT this DNA is wholly from the donor egg; thus, the mitochondrial genome is not the same as that of the nucleus in the donor cell from which it was produced. This may have important implications for cross-species nuclear transfer in which nuclear-mitochondrial incompatibilities may lead to death.



| Fig. 17.2 Mechanics of Cloning |

- **Dolly**, an ewe (a female sheep) (Fig. 17. was the first mammal to have been succe fully cloned from an adult cell on 5 July 19 though the first vertebrate to be cloned wa tadpole in 1952. Dolly was named after mous country music singer **Dolly Parton** cause the cells cloned to make her were fr a mammary gland cell, and Ms Parton is kno for her ample bosom! (Fig 17.4). Dolly v cloned at the Roslin Institute in Scotland a lived there until her death when she was s Dolly was publicly significant because t effort showed that the genetic material from specific adult cell, programmed to expre only a distinct subset of its genes, can be re programmed to grow an entire new organism Before this demonstration, there was no proof for the widely spread hypothesis that differentiated animal cells can give rise to entire new organisms. There were early claims that Dolly had pathologies resembling accelerated aging. Scientists speculated that Dolly's death in 200 was related to the shortening of telomeres, DNA-protein complexes that protect the end of linear chromosomes. However, the researchers who led the team that successfully cloned Dolly, argue that Dolly's early death due to respiratory infection was unrelated to deficiencies with the cloning process.

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| Fig. 17.3 Dolly |

| Fig. 17.4 Dolly Parton |

- Modern cloning techniques involving nuclear transfer have been successfully performed on several other species. **Noori** is the first cloned Pashmina goat (Fig 17.5). Scientists at the faculty of veterinary sciences and animal husbandry of Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir successfully cloned the first Pashmina goat* using the advanced reproductive techniques under the leadership of **Dr Riaz Ahmad Shah**.

| Fig. 17.5 Dr Riaz Ahmad Shah with Noori |

- Human cloning is the creation of a genetically identical copy of an existing or previously existing human (Fig. 17.6). The term is generally used to refer to **artificial human cloning**: human clones in the form of identical twins are commonplace, with their cloning occurring during the natural process of reproduction. There are three types of human cloning: therapeutic cloning, reproductive cloning and replacement cloning.
  - **Therapeutic cloning** involves cloning cells from an adult for use in medicine, and is an active area of research.
  - **Reproductive cloning** involves the making of cloned human beings. Such reproductive cloning has not been performed and is illegal in many countries.
  - **Replacement cloning** involves a combination of therapeutic and reproductive cloning. It entails the replacement of an extensively damaged, failed, or failing body through cloning, followed by whole or partial brain transplant.

*A rare Himalayan goat famed for its silky soft undercoat that is used to make pashmina wool or 'cashmere'.

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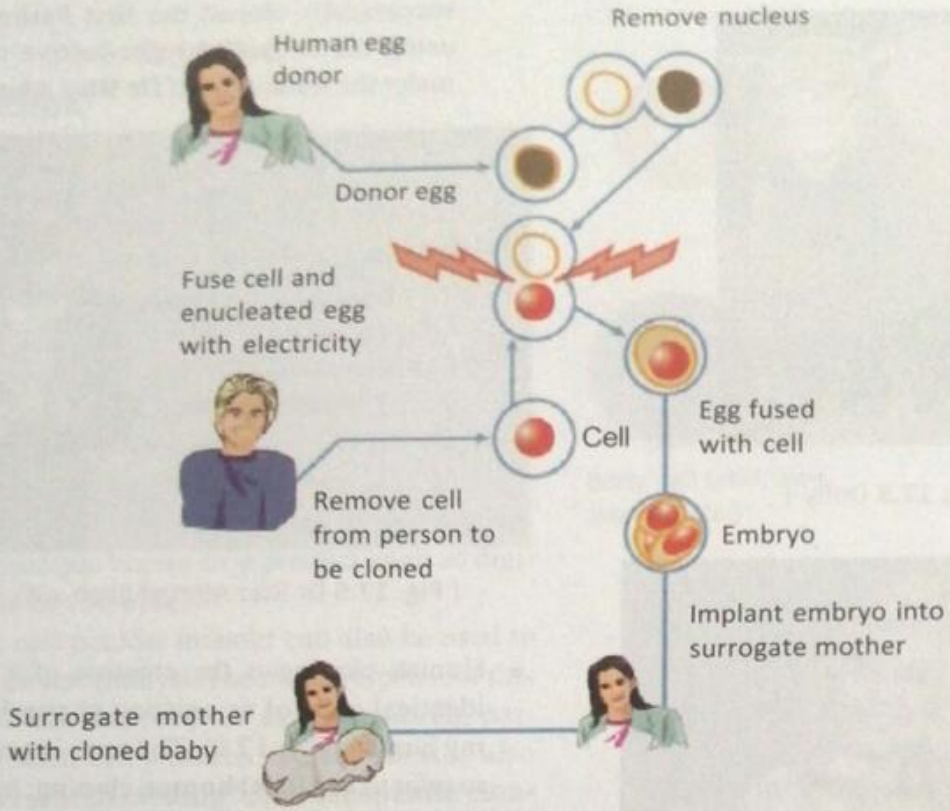

| Fig. 17.6 Process of Human Cloning |

Ethical Issues in Cloning

- Human cloning is a highly controversial subject. There have been numerous demands for all progress in the human cloning field to be stopped. Some people and groups oppose therapeutic cloning, but most scientific, governmental and religious organizations oppose reproductive cloning.
- Serious ethical concerns have been raised by the idea that it might be possible in the future to harvest organs from clones.
  - To overcome this, some people have considered the idea of growing organs separately from a human organism – in doing this, a new organ supply could be established without the moral implications of harvesting them from humans.
  - Research is also being done on the idea of growing organs that are biologically acceptable to the human body inside of other organisms, such as pigs or cows, then transplanting them to humans, a form of xenotrans-plantation.
- The first human clone was created in November 1998, by American Cell Technologies. It was created from a man's leg cell, and a cow's egg whose DNA was removed. It was destroyed after 12 days. Since a normal embryo implants at 14 days, the scientists claimed that this was done because the embryo could not be seen as a person earlier than 14 days. In January 2008, Stemagen Corporation in California, announced that they had successfully created the first 5 mature human embryos using DNA from adult skin cells, aiming to provide a source of viable embryonic stem cells. However, all of them were subsequently destroyed.
- Advocates of human therapeutic cloning believe the practice could provide genetically identical cells for regenerative medicine, and tissues and organs for transplantation. Such cells, tissues, and

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organs would neither trigger an immune response nor require the use of immunosuppressive drugs. Both basic research and therapeutic development for serious diseases such as cancer, heart disease, and diabetes, as well as improvements in burn treatment and reconstructive and cosmetic surgery, are areas that might benefit from such new technology.

- At present, the main non-religious objection to human cloning is that cloned individuals are often biologically damaged, due to the inherent unreliability of their origin; for example, researchers currently are unable to safely and reliably clone non-human primates. UNESCO's Universal Declaration on Human Genome and Human Rights asserts that cloning contradicts human nature and dignity: cloning is an asexual reproductive mode, which could distort generation lines and family relationships, and limit genetic differentiation.
- Cloning can also imply an instrumental attitude toward humans, which risks turning them into manufactured objects, and interferes with evolution, the implications of which we lack the insight or prescience to predict.
- Other ethical (and legal) concerns surround the concept of 'identity': since both the 'original' and the 'copy' are genetically the same person, which one is legally the 'real' individual? Moreover, since they are both 'the same person,' for all practical purposes, how are criminal actions prosecuted when one individual is indistinguishable from another?

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CHAPTER 18

Virginity, Pregnancy and Delivery

The world has suffered more from the ravages of ill-advised marriages than from virginity.
—Ambrose Bierce (1842–1914, American writer)

VIRGINITY

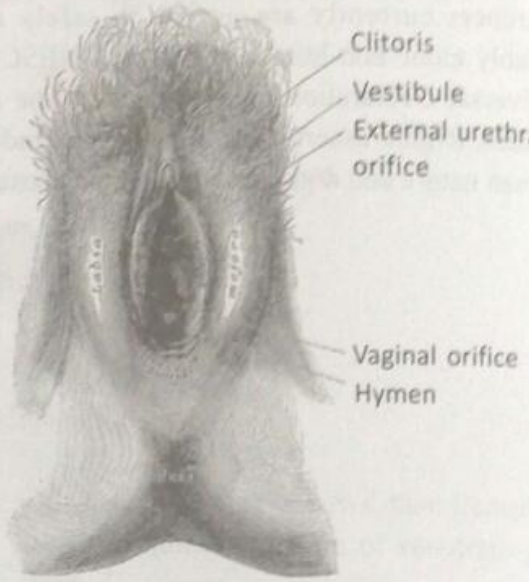
- **Virginity**, also referred to as **chastity**, is defined as "the state of being *virgo intacta*, i.e., one who has never had sexual intercourse."
- In contrast, **defloration** refers to the "deprivation of virginity; the rupture of the hymen, either in coitus or in vaginal examination."
- These terms were formerly applied only to females, and only with respect to penile-vaginal sexual intercourse, but now describe penile-anal sexual intercourse in both females and males as well. However, from the medicolegal point of view, the term "virginity" is always applied to females in the context of penile-vaginal intercourse only.

Signs of Virginity

- These may be considered under two heads: **extragenital** (i.e., in the **breasts**) and **genital**. It is important to be aware here of the condition of **false virginity**, in which the hymen may persist even after repeated coitus.
- The signs of true virginity, by which it can be differentiated from false virginity, are presented in Table 18.1.

The Hymen and its Medicolegal Importance

- The hymen is a thin (but firm) fold of connective tissue, covered by mucous membrane, about 1 mm in overall thickness, situated at the vaginal orifice (Fig. 18.1).



| Fig. 18.1 Location of Hymen |

- Commonly, it is deficient anteriorly, and usually has a central aperture, but may be any of the following types (Plate 18.1):
  - **Annular** – the hymen forms a ring around the vaginal opening.
  - **Semilunar or Crescentic** – forms a crescent shape, like a half moon, above or below the vaginal opening.
  - **Cribriform** – characterized by many small holes.
  - **Septate** – a piece of hymen makes a septum, or bridge, across the vaginal opening.
  - **Subseptate** – Same as septate hymen, but does not make a bridge all the way across (similar view on examination as one gets when viewing the throat, with the uvula hanging down).

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Table 18.1 Differences Between True and False Virginity

Feature	True virginity	False virginity
1. Extragenital signs (in the breasts)		
a) Shape & consistency	Hemispherical and firm	Pendulous*
b) Areolae	Pink	Pigmented, with Montgomery's tubercles
c) Nipples	Small, and pink in colour	Enlarged and pigmented*
2. Genital signs		
a) Labia majora	Firm, and lie in apposition	Separated and flabby
b) Labia minora	Pink; soft and sensitive to touch	Elongated, brownish; separate flabby; not sensitive to touch
c) Clitoris	Small	Enlarged
d) Fourchette & posterior commissure	Intact	Torn
e) Vestibule	Narrow	Wide
f) Vagina	Narrow (H-shaped on cross section); walls firm; rugosity easily discernible	Enlarged and roomy; walls yielding; rugosity ironed out
g) Hymen	Intact; membranous; admits only the tip of the little finger through the orifice painfully	Loose/folded/elastic, thick, tough and fleshy, or relaxed, undulant and permits depression; easily admits two fingers through the orifice

*These are significant only if pregnancy has resulted. Even then, more weightage is given to the nipples and areolae than to shape & consistency.

- **Fimbriate** – makes an irregular pattern around the vaginal opening.
- **Denticular** – so called because it looks like a set of teeth surrounding the vaginal opening.
- **Infundibuliform** – funnel-shaped.
- **Labial hymen** – the opening is in the form of a vertical slit in the centre, giving the hymen an appearance of a third set of vulvar lips.
- **Imperforate** – does not have any opening, and needs surgical correction before menarche for menstrual flow to occur.

- Occasionally, the hymen may be **congenitally absent**, which need not be a matter of concern at all. Embryologically, the hymen is the remnant of the vaginal plate that develops between the Mullerian ducts and the cloaca; it has no useful function.

Causes of Hymenal Rupture

1. As a result of sexual intercourse, the hymen is usually torn posteriorly, with unilateral or bilateral tears extending to the point of its attachment to the vaginal wall. These ruptures bleed freely when fresh, and heal by scar formation.
2. After the delivery of a child per vaginum, the hymen is almost completely torn, leaving only small remnants called "**carunculae myrtiformes**" or "**carunculae hymenalis**."
3. In a true virgin, the hymen may be ruptured because of:
   a. **Trauma**, due to
      i. An accidental fall on a protruding substance/object (this is not usually possible by strenuous physical exercise or by merely forcible separation of the thighs).

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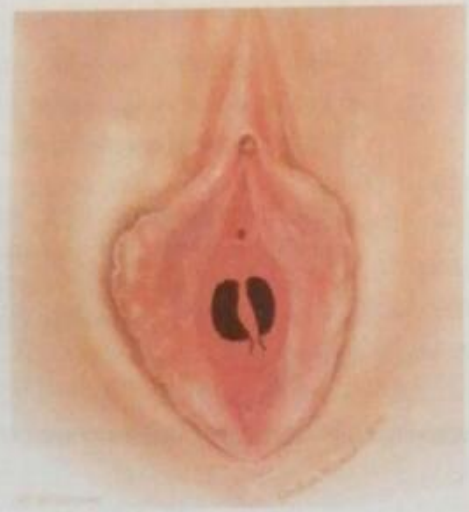
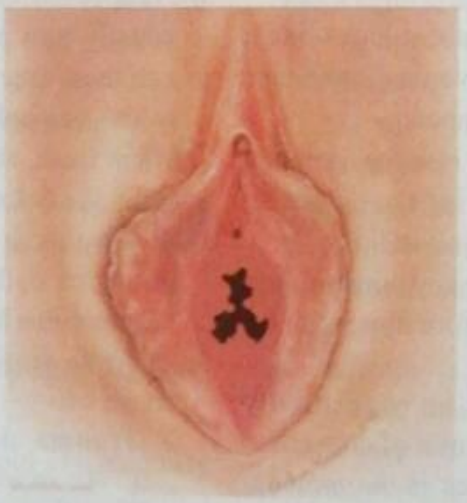
| Fig. 18.2 Annular Hymen |

| Fig. 18.3 Semilunar (Crescentric) Hymen |



| Fig. 18.4 Septate Hymen |

| Fig. 18.5 Sub-septate Hymen |



| Fig. 18.6 Fimbriate Hymen |

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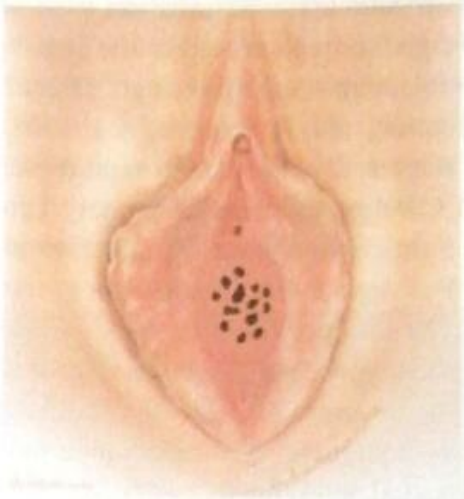
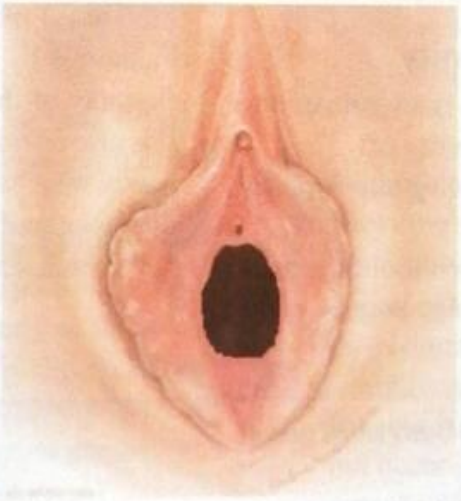
| Fig. 18.7 Denticular Hymen |



| Fig. 18.8 Cribriform Hymen |

| Fig. 18.9 Labial Hymen |

| Fig. 18.10 Imperforate Hymen |



| Fig. 18.11 Carunculae Myrtiformes |

Plate 18.1 Types of hymen

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ii. Instrumental masturbation with large foreign bodies (provided the instrument or object enters deep enough. Digital masturbation, unless practiced with two or more fingers, does not usually rupture the hymen).
iii. Careless insertion of sanitary tampons.
iv. Surgical operation for imperforate hymen.
v. Per vaginal examinations on a virgin.
vi. The introduction of foreign bodies for reasons other than those described above, e.g., the insertion of sola pith into the vagina of very young girls to render them suitable for sexual intercourse.

b. **Ulceration** as a result of disease (especially diphtheria). In such cases, the entire hymen is destroyed leaving only scar tissue.

4. Besides being of limited anatomical value, the hymen, from a medicolegal viewpoint, is a grossly overrated piece of tissue* – even experts can never be certain of virginity because of false virginity and hymenoplasty (surgical repair). In this latter condition, however, the hymen is usually taut, has an unusually narrow aperture, and exhibits fine scars at the sites of repair of previous tears.
5. It is important to remember that the annular type of hymen may appear intact even when sexual intercourse has taken place (especially when there is only a thin rim of hymen), while the fimbriated type may appear torn even in the intact state.

Medicolegal Aspects of Virginity

1. In **civil cases**, whether a woman is a virgin or not may have to be decided in instances of:
   a. **Nullity of marriage**, where virginity is proof of *non-consummation*,
   b. **Divorce**, when deliberate withholding of a non-virgin state before marriage may be cited as grounds, and
   c. **Defamation of character**, when a woman brings an action for tort for illegal damage to reputation, against a person who has alleged that she is not a virgin.
2. In **criminal cases**, loss of virginity may be offered as an *index* of sexual intercourse to substantiate a charge of **rape**.

PREGNANCY (GESTATION, FOETATION, GRAVIDITY)

- **Pregnancy** is the physiological condition of having a developing embryo or foetus in the body, from the time of fertilisation of an ovum by a spermatozoon until the birth of a child.**
- Since it is not possible to determine the precise moment at which the spermatozoon fertilises the ovum, the exact moment of commencement of pregnancy is usually uncertain. About 7 days after fertilisation, the ovum reaches the uterine cavity and implants itself in the uterine wall.
- In obstetric practice, it is customary to estimate the expected date of delivery by employing the **Naegele's rule**. This rule estimates the expected date of delivery (EDD) from the first day of the woman's last menstrual period (LMP) by adding a year, subtracting three months and adding seven days to that date. This approximates to the average normal human pregnancy which lasts 40 weeks (280 days) from the LMP, or 38 weeks (266 days) from the date of fertilization. Another method is by adding 9 months and 7 days to the first day of the last menstrual period.
- It is also customary to divide the duration of pregnancy into "trimesters," to facilitate both ease of diagnosis and awareness of the problems particular to each stage of pregnancy.

*A ridiculously big issue over a ridiculously small tissue!
**Jack told Jill to take her pill
With a glass of water
Jill forgot, and Jack begot
A bouncing baby daughter!
—**Chatton MJ**. *JAMA* 1966; 195: A224.

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Diagnosis of Pregnancy

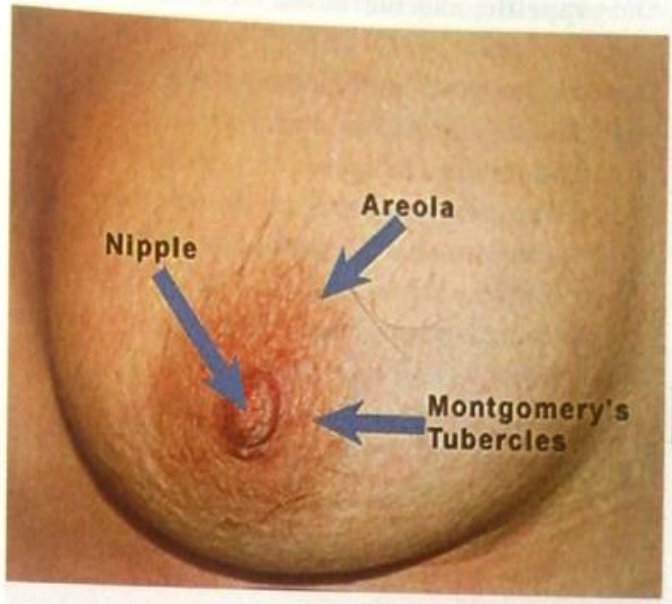
In medicolegal cases involving pregnancy (*see below*), the woman in question may be sent to a registered medical practitioner for examination and certification as to whether she is really pregnant or not (the expressed written consent of the woman, duly witnessed, is mandatory). To perform this duty, one must be familiar with the symptoms and signs of pregnancy, as well as the laboratory and other examinations that are useful in the diagnosis of pregnancy. These may be classified under three heads: **presumptive, probable** and **positive**.

Presumptive Evidence of Pregnancy

This is based largely on the **signs** and **symptoms** experienced by the woman.

A. **Presumptive Signs of Pregnancy**

1. **Secondary amenorrhoea** – Though strongly suggestive of pregnancy, this is not reliable until 10 or more days have passed after the expected date of the first day of menstruation. It must be noted that:
   a. There are rare instances of pregnancy in women who have never menstruated or who are supposedly menopausal.
   b. Menstruation may continue even after conception.
   c. There are several causes for amenorrhoea other than pregnancy, e.g., environmental, nutritional, organic diseases such as severe anaemia and tuberculosis, and psychogenic causes.
2. **Mammary changes** – They are more marked in primigravidae (women who are pregnant for the first time):
   a. Progressive enlargement and tenderness.
   b. Easily visible superficial veins.
   c. In the second month, hyperpigmentation of the areolae and nipples, with the appearance of *Montgomery's tubercles* (raised spots due to enlargement of the sebaceous glands) (Fig. 18.12).
   d. From the fourth month onwards, *colostrum*, which consists of free fat globules and large phagocytic cells filled with droplets of fat, can be squeezed from the breasts. (All these changes can also be seen in tumours of the ovary which secrete prolactin, women who take tranquilisers which induce prolactinaemia, women who suffer from psychogenic pseudocyesis, and after repeated stimulation of the breasts.)



| Fig. 18.12 Montgomery's Tubercles |

3. **Changes in the vagina**
   a. **Jacquemir's/Chadwick's sign,** i.e., bluish discolouration of the vaginal mucosa (this is not a reliable sign, since it can be caused by anything that obstructs proper venous return).
   b. **Barnes' sign,** i.e., flattening of the anterior vaginal wall because of upward tilting of the cervix.

B. **Presumptive Symptoms of Pregnancy**

1. **Morning sickness** – It refers to the nausea, often followed by vomiting, soon after waking, and which usually disappears on its own later on during the pregnancy. Like many other presumptive symptoms, this is not to be relied on because it is seen mostly in primigravidae, may not occur in all cases, and may also be a symptom of several gastrointestinal disorders. It may occasionally persist as **hyperemesis gravidarum**.

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2. **Disturbances in micturition** – Such as increased frequency during the first trimester, a return to normal as the uterus grows into the abdomen, and reappearance of the increased frequency at or near the end of term because of the descent of the foetal head into the pelvis.
3. **Easy fatiguability, hypersalivation, unusual appetite**, and **increased irritability**.

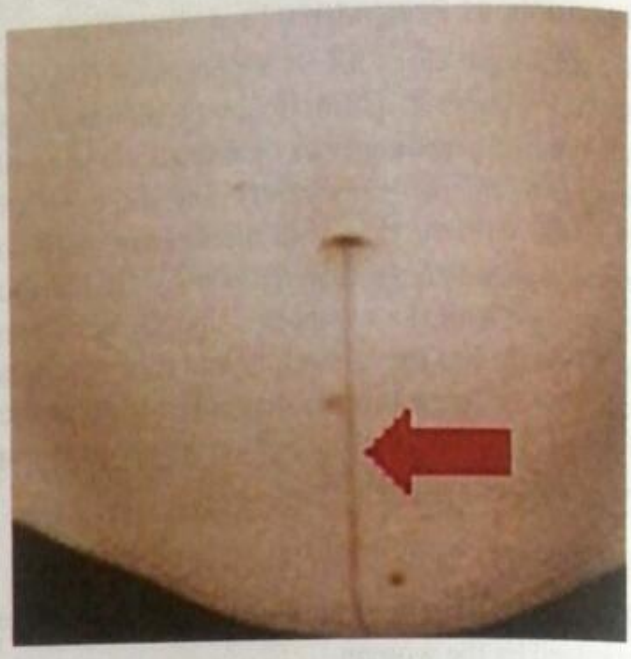
Probable Evidence of Pregnancy

A. Probable Signs of Pregnancy

1. **Abdominal changes**
   a. Progressive enlargement after the 12th week, so that the umbilicus becomes flush with the skin.
   b. Increased pigmentation (Fig. 18.13 & 18.14)

| Fig. 18.13 Striae Gravidarum |

   i. **Linea albicantes** (these lines, and progressive enlargement are merely signs of abdominal distension)
   ii. **Striae gravidarum** (more pronounced in primigravidae)
   iii. **Linea nigra**
2. **Changes in the uterus**
   a. Mucus becomes a thick and viscid plug, blocking the cervical canal.



| Fig. 18.14 Linea Nigra |

   b. **Goodell's sign** (softening of cervix because of increased vascularity) can first be appreciated at 6 to 8 weeks. The cervix becomes more and more patulous as pregnancy advances, but this change may also occur in acute cervicitis, haematometra, and in women who are long-term regular users of combined contraceptives.
   c. Towards term, there is apparent shortening of the cervix, the cervical canal becomes circular, and the external os admits the tip of a finger with ease and to a greater depth.
   d. **Uterine souffle*** (a soft, blowing murmur, synchronous with the maternal pulse, which can be heard with a stethoscope applied just above the midline of the inguinal ligament) is usually audible from the 16th week onwards.
   e. **Hegar's sign** (softening and easy compressibility of the lower uterine segment) first appears at 6 to 8 weeks. This sign is elicited by introducing two fingers of one hand into the posterior fornix while the other hand rests on the pelvis just above the pubic symphysis. On pressing upwards with the

**Pronounced "soofl" which is different from soufflé that is pronounced "sooflay" (a French sweet dish!)*

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first hand, it appears as if there is no intervening uterus between the two hands.

f. **Braxton Hicks' sign**: The appreciation of intermittent painless contractions of the uterus from the 16th week onwards by palpation of the abdomen, occurring at intervals of 5 to 20 minutes, each lasting for about 1 to 5 minutes.

g. **Ballottement** (tossing of a ball), i.e., the method of eliciting the presence of the foetus floating in the liquor amnii. This can be determined either **externally** or **internally**. *External ballottement* is elicited by placing the palms of both hands over the abdomen on either side of the midline, and pushing firmly with one hand towards the other, whereupon the impetus thus given to the foetal head can be felt against the other. *Internal ballottement* is done by inserting two fingers of one hand into the posterior fornix and pushing sharply upwards. The foetal head will first move upwards in the liquor, then settle down onto the fingers.

B. Probable Symptoms of Pregnancy

1. The only **symptom** that could be taken as probable evidence of pregnancy is **quickening**, i.e., the first perception of foetal movements by the mother. This is possible from the 16th to 20th week onwards, and increases in intensity as pregnancy advances.

C. Laboratory Investigations

1. Laboratory investigations for pregnancy all depend upon increased levels of **human chorionic gonadotropin (HCG)** in the urine, using either **biological** or **immunological methods.** The morning midstream urine of the woman suspected to be pregnant is used for these tests.
   a. The **biological (animal) tests,** which are easy to perform but time-consuming, include
      i. **Ascheim-Zondek** (female mouse) **test**
      ii. **Friedman** (female rabbit) **test**
      iii. **Hogben** (female toad or frog) **test**
      iv. **Galli-Mainini** (male toad) **test**

   All these tests are, however, obsolete and only of historical interest, having given way to the immunological tests.

   b. The **immunological tests** are much faster, more specific, less cumbersome, more sensitive, and do not require laboratory animals, equipment or special skills. All these tests take advantage of the antigenic properties of HCG. They include
      i. **Haemagglutination** (Prognosticon) **test**
      ii. **Latex-agglutination** (Gravindex) **test**, which can deliver a result in two hours, and its improvement, the **Pregcolor test**, which can be read in **two minutes**
      iii. **Radioreceptor assay**, which is highly sensitive and 98 per cent accurate. However, all these HCG-based tests will also be positive in those conditions in which abnormal or pathological products of conception are formed, viz., hydatidiform mole and chorionepithelioma. Further, false positives could also occur because of the biological and immunological similarities between HCG and luteinising hormone (LH).

Positive Evidence of Pregnancy

Absolute/certain/conclusive/sure signs can be grossly appreciated only from the 4th to 5th month (16th to 20th week) of gestation onwards.

They include:

1. **Foetal parts and foetal movements,** discernible by bimanual palpation. This may be difficult when the abdominal wall is fatty, or in hydramnios.
2. **Foetal heart sounds,** with a normal rate of 120 to 160 per minute, which sound like the muffled ticking of a watch. These can be heard on auscultation of the abdominal wall with a foetoscope. Foetal heart sounds can be detected much earlier if more advanced techniques are used, e.g., at 10 to 12 weeks by Doppler principle with ultrasound, at about 8 weeks by pulse-echo and real-time sonography, and even as early as 7 weeks by echocardiography.

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3. **Radiological demonstration of the foetal skeleton**, which, although possible in some cases at the 20th week of pregnancy, is contraindicated during the first trimester. By ultrasonography, a small white gestational ring can be seen as early as the 6th week of gestation, and distinct echoes from the embryo within this gestational ring can be discerned by careful scanning 2 weeks later (Fig. 18.15).

| Fig. 18.15 Abdominal Sonography. 40-days-old Foetus |

Medicolegal Aspects of Pregnancy

Civil Cases

- Malicious persons may allege either verbally (*slander*) or in writing (*libel*), that an unmarried woman or widow is pregnant, in which case she would definitely want to vindicate herself.
- A concealed pregnancy before marriage, or after marriage by a person other than the lawfully wedded spouse, would constitute valid grounds for divorce.
- The duration of pregnancy assumes importance when the legitimacy of a **posthumous child** (one born after the death of its father) is questioned.

Criminal Cases

- Pregnancy is positive proof of sexual intercourse in a trial for rape.
- Pregnancy may be a motive for the suicide of a married or unmarried woman, or for the murder of a married woman by her husband, when it is the result of an illicit sexual relationship.
- Such a situation has also driven women to criminal abortion and to foeticide or infanticide.

Civil and Criminal Cases

- A woman may feign pregnancy (a condition termed **pseudocyesis**, or false/imaginary pregnancy) in order to:
  - Avoid capital punishment (Because the unborn child is innocent of any crime its mother may have committed, and must not be punished for it, the death sentence is either commuted to imprisonment for life, or is postponed till after the delivery of the child).
  - Compel a person to marriage.
  - Secure more maintenance in a case of divorce. Pseudocyesis is also encountered in sterile or infertile women who long for children.
- Also to be considered here are the conditions of **superfoetation** (where two or more pregnancies result from the fertilisation of two or more ova of ***different*** ovulatory periods), and **superfecundation** (in which two or more ova of the ***same*** ovulatory period are fertilised by ***separate*** acts of sexual intercourse with the same person, or two different persons).
  - Although superfoetation is theoretically possible, it has not been demonstrated beyond doubt in human females (though it is known to occur in certain lower animals, e.g., mares).
  - On the other hand, superfecundation is not only a more likely possibility, but has also been described in literature.

DELIVERY

- **Delivery** is defined as **complete evacuation of a foetus (that has attained viability) and other products of conception from within the uterus and genital passages into the external environment**.
  - This process may be spontaneous or assisted.

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- When delivery occurs after the full period of gestation, i.e., 280 days, it is called a "full-term delivery." If it occurs earlier or later than this, it is said to be "pre-term/premature" and "post-term/postmature" respectively.

Symptoms and Signs of Recent Delivery in the Living (At Full Term)

Symptoms of Recent Delivery

1. **Fatigue**, which is most pronounced immediately after delivery, and more so when labour has been prolonged.
2. **Loss of weight** mainly because of expulsion of the contents of the uterus.
3. **Diuresis** during the 2nd to 5th day, because of physiological reversal of the increased intracellular fluid during pregnancy.
4. **Afterpains** experienced by primiparae as tonic contractions, and by multiparae as vigorous contractions, at intervals. They are occasionally painful and/or severe, become mild after 3 days, and usually disappear after 7 days, but may last longer in some patients.
5. A sharp **rise in temperature** for the first 24 hours postpartum (*milk fever*) – any fever which lasts longer is most likely due to infection.
6. **Transient depression**, a common feature which is usually self-limiting and responsive to treatment or reassurance, but may progress to **puerperal (postpartum) psychosis**, as a result of which the mother may neglect, ill-treat, or even kill her child.

Signs of Recent Delivery in the Living

1. In the **breasts**, similar to those of pregnancy, but more marked (**colostrum** can be squeezed out for the first 2 days, after which it is replaced by mature milk).
2. In the **abdomen**, which remains soft and flabby for several weeks (although tone and contour can often be regained by exercise), displays silvery-white **linea albicantes**, and, when Caesarean section has been performed, the operative incision in the lower segment.
3. In the **vagina and its outlet**, which may display the following features:
   a. **Smooth-walled, relaxed and wide** (the width progressively decreases, but nulliparous dimensions are never regained).
   b. **Ironed-out rugae** (these reappear by the 3rd week in primiparae, but never in multiparae).
   c. **Lacerated walls** which heal rapidly.
   d. **Carunculae myrtiformes** of the hymen.
   e. The **labia** in primiparae, appear swollen, tender, gaping, bruised and/or lacerated.
   f. The **perineum**, which shows ruptures of the fourchette and posterior commissure with or without a sutured/healing incision of episiotomy.
   g. **Lochia**, i.e., an alkaline discharge with a peculiar, sour, disagreeable odour, consisting of red blood cells, leukocytes, shreds of decidua, epithelial cells and bacteria. The appearance of this discharge changes as the puerperium progresses, so that
      i. for the first few days, it is red (*lochia rubra*),
      ii. from the 5th to 10th days, it is watery and pale (*lochia serosa*),
      iii. from the 10th day onwards, it becomes thicker, scantier, and white or yellowish-white (*lochia alba*), and
      iv. it disappears in 2 to 3 weeks.
4. In the **cervix** (which is thin, collapsed and flabby soon after delivery):
   a. **External os**
      i. shows lacerations of its outer margins (these heal rapidly to leave permanent bilateral depressions), and
      ii. contracts slowly, so that for the first 2 days, it admits 2 fingers easily, and at the end of 1 week, 1 finger with difficulty.
   b. The **walls** simultaneously thicken to re-establish the cervical canal.
5. In the **uterus**: because of *involution*, the fundus of the uterus keeps dipping progressively after delivery **(Fig. 18.16)**:

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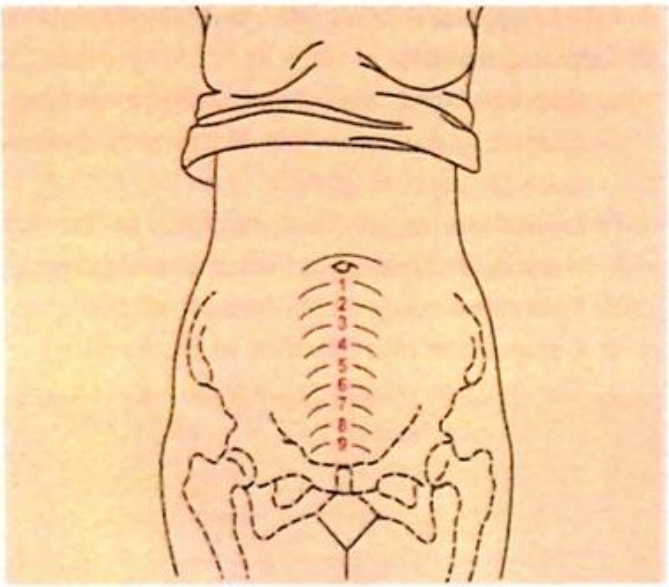

| Fig. 18.16 Involution of Uterus |

a. Immediately after delivery – just above the level of the umbilicus.
b. Twelve hours after delivery – at the umbilicus.
c. After that – the fundus descends about one fingerbreadth every 24 hours.
d. After the tenth day of postpartum – the uterus should not be palpable abdominally.
e. In 5 to 6 weeks postpartum, it attains its normal non-pregnant size (Table 18.2).

Laboratory Investigations

The **biological tests** for pregnancy are positive for about 7 to 10 days after delivery.

Signs of Recent Delivery in the Dead

1. Besides observing the gross changes in the breasts, abdomen, the vagina and its outlet, and the cervix, and palpating the uterus per abdomen, the **uterus, ovaries** and **peritoneum** are also examined.
2. The weights and dimensions of the involuting uterus are listed in Table 18.2.
3. Morphology of the involuting uterus:
   a. If lower segment caesarean section has been performed, its fresh or healing incision will be seen.
   b. *Cut section* soon after delivery shows
      i. anterior & posterior walls 4 to 5 cm thick
      ii. a body made up mostly of myometrium, lined by basal decidua
      iii. a placental site about the size of a palm, which rapidly decreases in size, and
      iv. an ischaemic appearance because the vessels are compressed by the contracting myometrium.
   c. *Cut section* 2 to 3 days after delivery shows that the remaining decidua has differentiated into two layers:
      i. a superficial layer which is necrotic (shed in lochia) and
      ii. a basal layer, which is the foundation of a new endometrium.
   d. *Cut section* 2 weeks after delivery shows
      i. that the rapidly growing endometrium has covered the entire surface except for the placental site, and
      ii. a placental site 3 to 4 cm in size.
   e. At 6 weeks after delivery, even the placental site gets covered by new endometrium.
4. The ovaries and fallopian tubes are congested. On microscopic examination, an intact or degenerating corpus luteum can be seen (Fig 18.17).
5. The peritoneum covering most of the uterus is folded and wrinkled.
6. The broad and round ligaments are lax; they take a long time to recover their pre-pregnancy consistency.

| Fig. 18.17 Corpus Luteum of Pregnancy *(Pic : Dr Geetha O)* |

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Table 18.2 Weight and Dimensions of Involuting Uterus

Duration after delivery	Weight	Dimensions
Freshly delivered	1000 to 2000 g	Variable
Immediately after delivery	Variable, but less than above	22 cm x 15 cm
2 to 3 days postpartum	Variable, but still less	Less than above
End of the 1st week	500 g	13 to 15 cm x 8 cm
End of the 2nd week	300 g	10 cm x 5 cm
Soon thereafter	100 g or less	Variable, but less than above
5 to 6 weeks	Normal nonpregnant weight	Normal nonpregnant size

Signs of Remote Delivery in Both the Living and the Dead

1. These include the permanent morphological alterations that have been previously described, with linea albicantes of the breasts and slight concavity inwards of the inner surface of the uterus.
2. If there is any doubt from naked-eye appearances as to whether delivery has taken place or not, the endometrium must be examined under the microscope for the presence of trophoblastic endothelium and chorionic villi.

Medicolegal Aspects of Delivery

Civil Cases

In **civil cases**, whether a woman has delivered or not needs to be determined in instances of:

1. **Feigned delivery**, when a woman may pretend to have been pregnant for some time and later produce a child, alleging that it is hers to claim property of a deceased husband. Such a child is called a **suppositious child**.
2. **Affiliation cases** (*affiliation = adoption*), in which a woman claims that her child has been fathered by a person who is not her lawfully wedded spouse, or by a husband who has subsequently divorced her, and who must therefore adopt the child as his own and pay for its upkeep.
3. **Contested legitimacy of a child**, when, as part of the evidence that a child was born of a particular woman and her husband, it must be proven that the woman did indeed deliver a child at the time claimed by her.

Criminal Cases

In **criminal cases**, the question of delivery assumes importance in trials for

1. **Abortion** and **infanticide**
2. **Concealment of a child** begotten out of an illicit sexual relationship
3. When an **affiliation case** proceeds to the degree of **blackmail**

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CHAPTER 19

Abortion

Some forms of motor neuron disease are genetically linked, but I have no indication that my kind is. No other member of my family has had it. But I would be in favour of abortion if there was a high risk.

—**Stephen Hawking** (Born: 1942; English physicist)

DEFINITION

- **Abortion is defined as the premature expulsion of products of conception from the uterus, at any time before the complete period of gestation.** The word 'abortion' is derived from the Latin word 'aboriri,' which means "to get detached from the proper site."
- By convention however, **abortion** is the term used to denote termination of pregnancy during the first trimester **(Fig. 19.1)**, while that occurring in the second trimester is called **miscarriage (Fig. 19.2)**, and that occurring in the last trimester of pregnancy is called **premature birth**.

| **Fig. 19.1** Foetus with Placenta - 8 Weeks *(Pic : Dr Shashidhar C Mestri)* |

CLASSIFICATION

- Abortion is classified into two types: **natural** and **artificial**.
  - **Natural (spontaneous) abortion** occurs invariably in the first trimester of pregnancy.
    - ***Causes:***

1. Maternal Infections: rubella, cytomegalovirus, malaria, toxoplasmosis
2. Maternal Hypoxia & Shock: respiratory diseases, heart failure, severe anaemia
3. Trauma: Direct trauma to the abdominal wall may result in abortion
4. Immunological: Antiphospholipid antibody increases the risk of abortion
5. Toxic Agents: Environmental toxins such as lead, arsenic, tobacco, alcohol and caffeine increase the risk of abortion.

| **Fig. 19.2** Foetus with Placenta - 16 Weeks *(Pic : Dr Shashidhar C Mestri)* |

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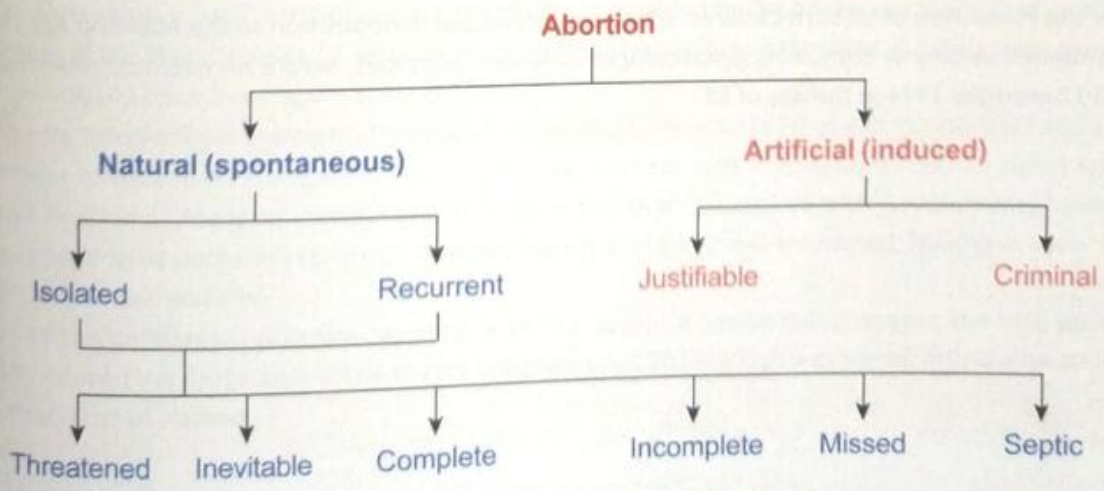
- **Artificial abortion** is that which is deliberately induced.
  - It is further subdivided into **justifiable (therapeutic)** and **criminal** (Fig. 19.3):
    1. **Therapeutic and Criminal Abortion**: Before medical termination of pregnancy became a legal option, women were not allowed to abort, unless there was a proven threat to life. Those women who were denied legal abortion (unmarried females, widows, and rape victims), therefore had to resort to alternative means of abortion, i.e., criminal abortion.
    2. Nowadays, criminal abortion has come to mean the termination of pregnancy by the woman herself, or by another party not qualified to perform the termination, or when it does not conform to the **MTP Act of 1971**.

THE MEDICAL TERMINATION OF PREGNANCY ACT - 1971 (AMENDED 1975 & 2002)

Introduction and Principles

- The liberalisation of rules relating to the performance of abortions in the Western world owes much to **Dr Aleck Bourne** (Box 19.1). However, even today there are some Western countries which are very rigid and do not allow abortions to be carried out in any case except those in which the mother's life is in danger. Restrictions on abortion are most stringent in countries that are strongly observant of the Catholic faith. Ireland is a prominent example (Box 19.2). A few countries do not allow abortion even if the woman's life is threatened - Malta, Dominican Republic, El Salvador, and Nicaragua.
- The **MTP Act of 1971** was passed to liberalise abortions in India, on the basis of clearly specified guidelines. This liberalisation was decided upon with the idea of saving the lives of millions of women, who would otherwise resort to criminal abortion out of desperation, thereby succumbing to its complications. As per this Act, pregnancy can be terminated on the following **grounds**:
  - **Therapeutic**: If the pregnancy, when allowed to continue, is likely to endanger the life of the woman, or cause serious injury to her physical or mental health.
  - **Eugenic**: If there is evidence to suggest that the child to be born would suffer from severe physical or mental abnormalities, e.g., the mother has contracted any of the TORCH group of infections (toxoplasmosis, rubella, cytomegalovirus or herpes) in the first trimester.
  - **Humanitarian**: When pregnancy results from rape.



| Fig. 19.3 Classification of Abortion |

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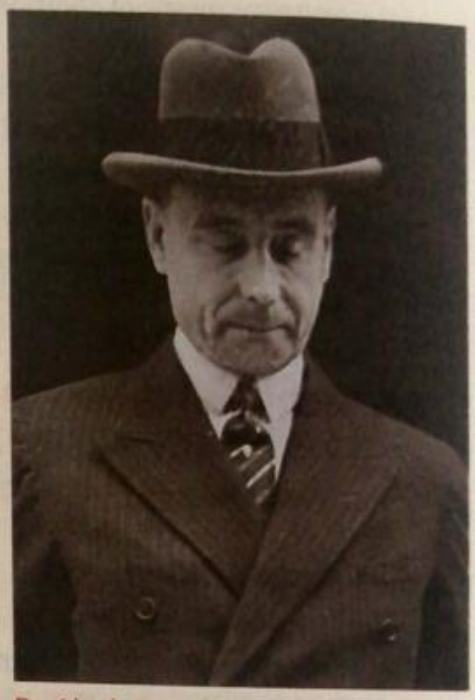
Box 19.1 The Aleck Bourne Case

Aleck William Bourne (4 June 1886–30 December 1974) was a British gynaecologist who is best known for his 1938 trial, a landmark case, for performing an "illegal" abortion on a 14-year-old rape victim.

Bourne was a very good student at school, and earned for himself a senior university scholarship, by which he secured admission to St Mary's Hospital, and in 1911 qualified as an MRCS, LRCP. He subsequently obtained an MB, BCh, from Cambridge, and also FRCS. In 1912, he married Bessic Hayward, the eldest daughter of GW Hayward, with whom he had three daughters.

Enlisting in the British Army, he served as a surgical specialist with the 17th General Hospital in Egypt and the 2nd General Hospital in France between 1914 and 1917 and, in the years following the war, he began a successful consulting practice in obstetrics and gynaecology. In 1929, he was elected a foundation member of the Royal College of Obstetricians and Gynaecologists and, founding its museum in 1938, served as curator of its museum which he built up considerably during the following years.



Dr Aleck Bourne

On 14 June 1938, Bourne was arrested after performing an operation (without fee) at St Mary's Hospital, London, to terminate the pregnancy (of six weeks) of a 14-year-old girl who had been sexually assaulted by five off-duty British soldiers, officers in the Royal Horse Guards, in a London barracks. She asked for an abortion on humanitarian grounds, but several other obstetricians refused.

Tried at the Central Criminal Court in July 1938, Bourne was acquitted on charges of procuring abortion as his actions were later defended by Lancet as *"an example of disinterested conduct in consonance with the highest traditions of the profession."*

Serving as president of the Obstetrical and Gynaecological Section of the Royal Society of Medicine from 1938 to 1939, Bourne later wrote several important books in his field of specialization.

During the 1960s, Bourne became a founding member of the Society for the Protection of Unborn Children which was organized in opposition to the Abortion Act 1967.

He continued serving as consulting gynaecologist at several hospitals, before his eventual retirement and death on 30 December 1974 at the age of 88.

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Box 19.2 The Savita Halappanavar Case (Ireland)

Abortion in Ireland is illegal unless it occurs as the result of a medical intervention performed to save the life of the mother. The availability of abortion services can be even more restricted in the absence of a readily available method of determining the circumstances in which an abortion might be lawfully obtained. Abortion has always been a controversial issue in Irish politics and several national referendums have been held on the topic in the last few decades. In 2013, Ireland passed a new law allowing abortion under certain circumstances. The new law provides for a woman's right to an abortion if her life is at risk, including from suicide. This was mainly due to the sensational death of Savita Halappanavar, which led to protests in 2012 demanding changes to Ireland's anti-abortion laws and a highly public investigation by the Health Service Executive. Savita was denied an abortion because the foetus's heart was still beating after a miscarriage had been diagnosed. On 30 July 2013, President Michael Higgins signed the Protection of Life During Pregnancy Act 2013.

Savita Halappanavar

Savita Halappanavar, a 31-year-old citizen of India, originally from Belgaum, Karnataka, was working in Ireland as a dentist, and died at University Hospital, Galway. She was suffering from a miscarriage when she was some 17 weeks pregnant on 21 October 2012. She repeatedly asked for an abortion, but it was reported that she was told that, because Ireland was a "Catholic country," she could not have one while the foetal heartbeat was still present. The foetal remains were removed only three days later on 24 October. Savita Halappanavar suffered septicaemia and organ failure and died a few days later on 28 October 2012.

The news of Halappanavar's death spread rapidly through both traditional and social media outlets. Rallies and protests were held, calling for a change in the abortion laws in Ireland, which the protesters claimed led to Halappanavar's death. Indian diplomatic and consular officials requested an official inquiry into the events surrounding Halappanavar's death. The United Nations Special Rapporteur for physical and mental health also became involved, saying abortion should be legal if a pregnancy is adversely impacting a woman's health. Ireland's Health Service Executive (HSE) then named Professor Sir Sabaratnam Arulkumaran to head a seven-member panel to look into the case. The investigation into her death determined that had the patient received intervention with antibiotics as a prophylaxis immediately following the spontaneous rupture of membranes at 00:20 on October 22, instead of first administration occurring some 21 hours later, the outcome would potentially have been quite different.

Amnesty International stated that Halappanavar's death "illustrates [the] gap in Irish law" and asked the government of Ireland to change the law on abortion "in line with international human rights laws." The executive director of Amnesty International in Ireland said that "successive Irish Governments have failed in their duty to provide necessary clarity on how this right is protected and vindicated, leaving women in Ireland in a very vulnerable position".

Due to the unrelenting pressure resulting from the death of Savita Halappanavar, the Irish government finally introduced the Protection of Life During Pregnancy Act 2013, which was signed into law on 30 July 2013 by the President of Ireland.

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- **Social**: If pregnancy has resulted due to contraceptive failure in a married woman, or if there are severe economic constraints in bringing up a child which can cause substantial burden on the family.

- **Qualifications Required**: As per the Act, a medical officer is qualified to perform MTP if:
  - He, as a registered medical practitioner, has assisted in at least 25 cases of MTP in a recognised hospital.
  - He is a specialist with MD (obstetrics) or DGO qualification, or he has 6 months of experience as a house surgeon in obstetrics, in a recognised hospital.
- **Place**: MTP can be carried out in any government hospital, or non-government institution, provided that a license has been procured from the Chief Medical Officer of the district.
- **Consent**: Any woman over the age of 18 years can give written consent for an abortion. In the case of a minor or a lunatic, the consent of the guardian/parent is required.
- **Duration of gestation**: For a pregnancy of below 12 weeks duration, one medical officer alone can take the decision of performing an abortion, while if it is between 12–20 weeks, two medical officers are required to terminate the pregnancy. However if it is an emergency situation, a pregnancy exceeding 12 weeks can be terminated even if only one doctor is available.

  On 25 July 2016, the Supreme Court of India allowed an alleged rape survivor to terminate her pregnancy beyond the law-mandated 20 weeks after noting that the woman's life was in danger. This is the first such decision by the top court, when it has given the benefit of an exceptional provision in the law after the Medical Termination of Pregnancy Act of 1971 put a ceiling of 20 weeks for an abortion. A bench of Justices J S Khehar and Arun Mishra granted the benefit of Section 5 in the Medical Termination of Pregnancy Act, 1971, which allows abortion even after 24 weeks if there is a threat to the life of the mother. The Mumbai-based woman, in her petition had stated that she was raped by her ex-fiance on the false promise of marriage and became pregnant.
- **2002 amendments**:
  - No termination of pregnancy shall be made in accordance with this Act at any place other than:
    - a hospital established or maintained by the Government, or
    - a place for the time-being approved for the purpose of this Act by the Government or a District Level Committee constituted by that Government with the Chief Medical Officer or District Health Officer as the Chairperson of the said Committee: *provided that the District Level Committee shall consist of not less than three, and not more than five members including the Chairperson, as the Government may specify from time to time.*
    - Notwithstanding anything contained in the Indian Penal Code, the termination of pregnancy by a person who is not a registered medical practitioner shall be an offence punishable with rigorous imprisonment for a term which shall not be less than two years but which may extend to seven years under that Code, and that Code shall, to this extent, stand modified.
    - Whoever terminates any pregnancy in a place other than that mentioned in this Act, shall be punishable with rigorous imprisonment for a term which shall not be less than two years but which may extend to seven years.
    - Any person being the owner of a place which is not approved as per this Act, shall be punishable with rigorous imprisonment for a term which shall not be less than two years but which may extend to seven years.
- All the regulations for conducting abortions under the MTP Act are laid out in the **Medical Termination of Pregnancy Regulations, 2003**
- The international status of abortion as per the **UN 2013 Report on Abortion Law** has been depicted in Fig 19.4.

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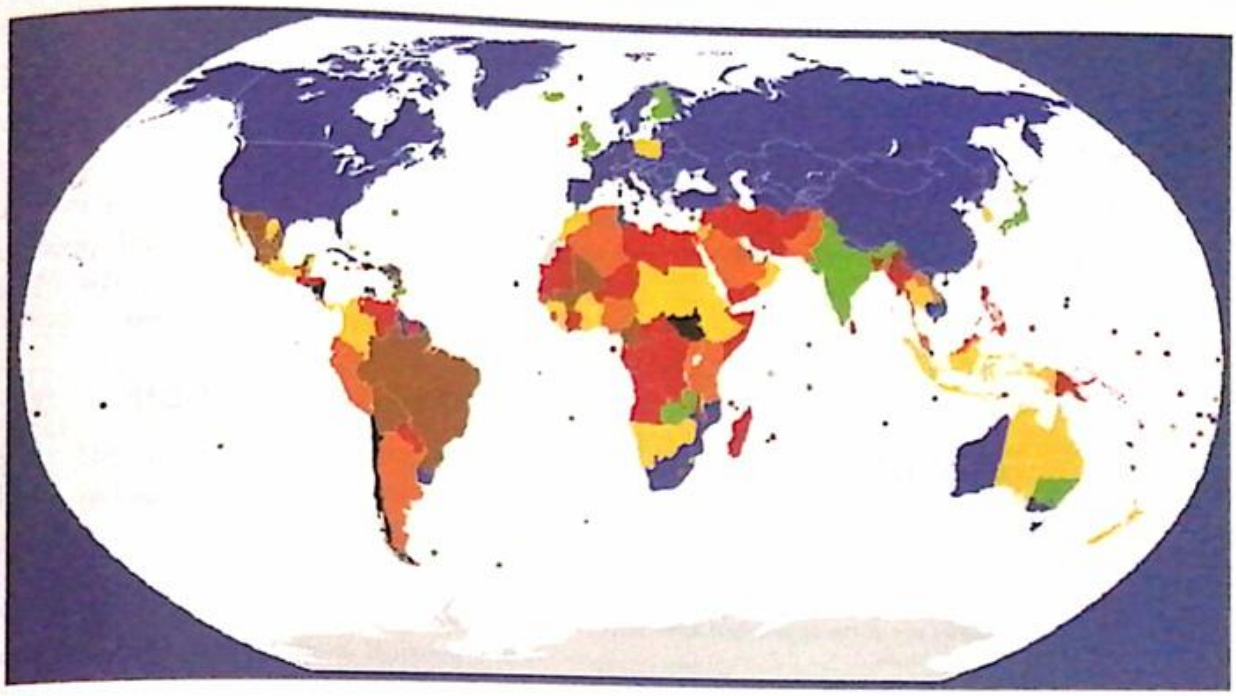
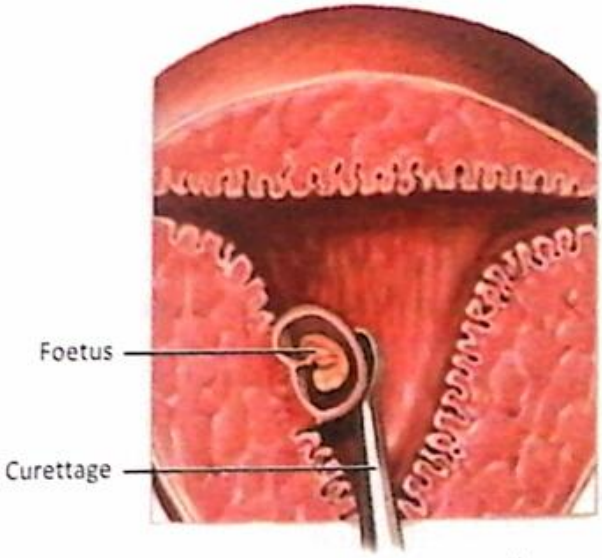


Legal on request.
Illegal with exceptions for maternal life, mental health, health, rape, fetal defects, and/or socioeconomic factors.
Illegal with exceptions for maternal life, mental health, health, rape, and/or fetal defects.
Illegal with exceptions for maternal life, mental health, health, and/or rape.
Illegal with exceptions for maternal life, mental health, and/or health.
Illegal with exceptions for maternal life.
Illegal with no exceptions.
No information.

| Fig. 19.4 International Status of Abortion - UN 2013 Report on Abortion Law |

Common Methods of Terminating Pregnancy under the MTP Act

- Dilatation and curettage (Fig. 19.5)
- Dilatation followed by oxytocin infusion
- Vacuum aspiration technique (VAT) or Surgical abortion (Fig. 19.6)
- Intraembryonic instillation of prostaglandin
- Extraembryonic instillation of hypertonic saline
- With drugs: mifepristone (RU486) and prostaglandin (misoprostol) (*only in early pregnancy*). Medical abortion using mifepristone plus prostaglandin is said to be the most effective method of abortion at gestations of less than 7 weeks. Mifepristone can also be used in smaller doses as an emergency contraceptive; if taken after sex but before ovulation, it can prevent ovulation and so prevent pregnancy. Mifepristone was approved for use in India in 2002 for medical termination of pregnancy. It is only available under medical supervision, not by prescription, due to adverse



| Fig. 19.5 Dilatation and Curettage |

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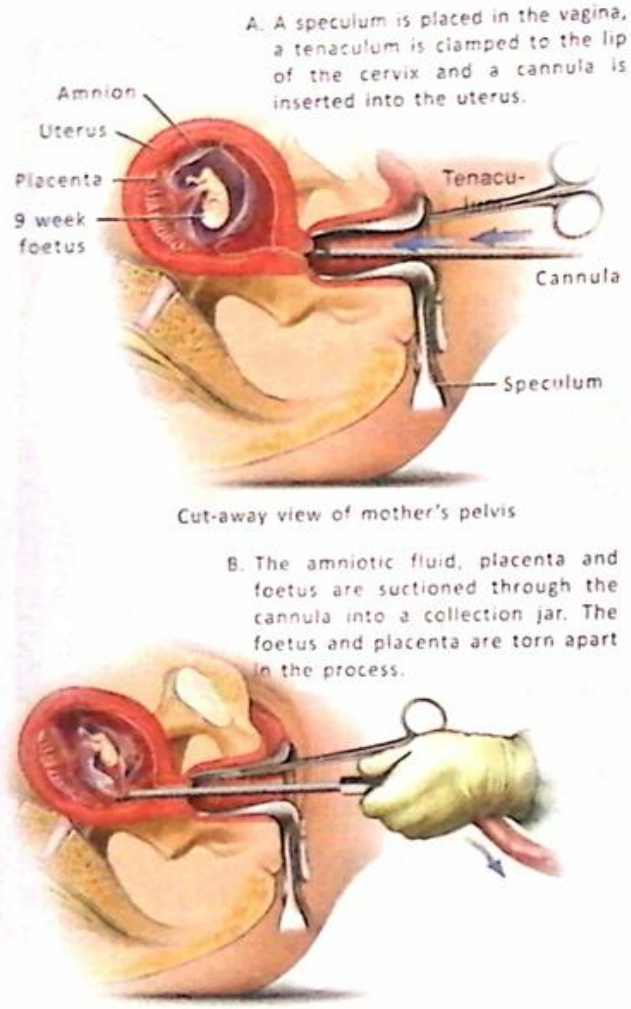

| Fig. 19.6 Vacuum Aspiration |

reactions such as excessive bleeding, and criminal penalties are inflicted for buying or selling it on the black market or over-the-counter at pharmacies.

- Hysterotomy (*after 12 to 14 weeks*)

Complications

- **Immediate complications**:
  - Haemorrhagic shock
  - Perforation of uterus, peritoneum or intestine
  - Laceration of cervix or vagina
  - Incomplete abortion
  - Embolism
  - Thrombophlebitis
- **Delayed complications**:
  - Pelvic inflammatory disease
  - Menstrual irregularities
  - Sterility
  - Endometritis
  - Cervicitis
  - Vaginitis

Abortion, like euthanasia, has always been an emotive issue with fierce proponents and opponents arguing for and against it. Box 19.3 gives a brief overview of the **Great Abortion Debate**.

CRIMINAL ABORTION

- Any abortion conducted outside the purview of the Medical Termination of Pregnancy Act is called **criminal abortion**.
- **Common methods**
  - When the pregnancy is in its initial stages, heavy physical exercise, hot baths, ingestion of purgatives, etc., are some of the (useless) methods advocated by criminal abortionists.
  - When the pregnancy is in a more advanced stage, **abortifacient drugs** or **mechanical trauma** are favoured.
  - **Abortifacient drugs** are quaintly classified as **ecbolics** and **emmenogogues**:
    - **Ecbolics** stimulate uterine contractions and bring about abortion. Ergot preparations are usually used for this purpose. Lead oleate is also used, which is toxic to the foetus leading to its death. It may cause lead poisoning in the mother. Pituitary extract administered parenterally behaves in the same way as oxytocin.
    - **Emmenogogues** are drugs which promote uterine congestion and bleeding, resulting in the expulsion of products of conception. Examples include borax, oil of savin, rue, laburnum and sanguinarine.
    - Other **abortifacient drugs** (which act indirectly) include
      - **Genito-urinary tract irritants** such as cantharides, turpentine oil, etc., which act by producing inflammation of the genito-urinary tract, thereby reflexly irritating the uterus and stimulating its contractions.

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Box 19.3 The Great Abortion Debate

The abortion debate is the ongoing controversy surrounding the moral and legal status of induced abortion. The sides involved in the debate are the self-described "**pro-choice**" movement (emphasizing the right of women to decide whether to terminate a pregnancy) and the self-described "**pro-life**" movement (emphasizing the right of the embryo or foetus to gestate to term and be born). Both terms are considered loaded in mainstream media, where terms such as "**abortion rights**" or "**anti-abortion**" are generally preferred. Each movement has, with varying results, sought to influence public opinion and to attain legal support for its position, with small numbers of anti-abortion advocates sometimes using violence.

For many people, abortion is essentially a moral issue, concerning the commencement of human personhood, the rights of the foetus, and a woman's rights over her own body. The debate has become a political and legal issue in some countries with anti-abortion campaigners seeking to enact, maintain and expand anti-abortion laws, while abortion rights campaigners seek the repeal or easing of such laws while expanding access to abortion. Abortion laws vary considerably between jurisdictions, ranging from outright prohibition of the procedure to public funding of abortion. Availability of safe abortion also varies across the world.

In the US, the case of **Roe v. Wade** struck down state laws banning abortion in **1973**. Over 20 cases have addressed abortion law in the United States, all of which upheld Roe v. Wade. Since Roe, abortion has become legal throughout the country, but states have placed varying regulations on it, from requiring parental involvement in a minor's abortion to restricting late-term abortions.

Pro-choice advocates argue that criminalisation of abortion increases the incidence of unsafe abortions, as the availability of professional abortion services decreases, and leads to increased maternal mortality. According to a global study collaboratively conducted by the World Health Organization and the Guttmacher Institute, most unsafe abortions occur where abortion is illegal.

Although the two main sides of the abortion debate tend to agree that a human foetus is biologically and genetically human, they often differ in their view on whether or not a human foetus is, in any of various ways, a "person". Pro-life supporters argue that abortion is morally wrong on the basis that a foetus is an innocent human person, or because a foetus is a potential life that will develop into a fully functional human being. Others reject this position by drawing a distinction between human being and human person, arguing that while the foetus is innocent and biologically human, it is not a person with a right to life. In support of this distinction, some propose a list of criteria as markers of personhood. For example, consciousness (at least the capacity to feel pain), reasoning, self-motivation, the ability to communicate, and self-awareness. According to this view, a "being" need not exhibit all of these criteria to qualify as a person with a right to life, but if a "being" exhibits none of them (or perhaps only one), then it is certainly not a person.

Critics of this view typically argue that some of the criteria for personhood would disqualify reversibly comatose patients from having a right to life, since they, like foetuses, are not self-conscious, do not communicate, and so on. Defenders of the criteria respond that the reversibly comatose do satisfy the relevant criteria because they "retain all their unconscious mental states", or at least some higher brain function (brain waves).

Can a foetus feel pain?

Foetal pain, its existence, and its implications are part of a larger debate about abortion. A 2005 multidisciplinary systematic review in JAMA in the area of foetal development found that a foetus is unlikely to feel pain until after the 6th month of pregnancy. Developmental neurobiologists say that the establishment of thalamocortical connections (at about 26 weeks) is critical to foetal perception of pain. The 2005 JAMA review concluded that data from dozens of medical studies indicate that foetuses are unlikely to feel

contd.

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pain until the 3rd trimester of pregnancy. However a number of medical critics have since disputed these conclusions. Researchers have challenged the idea that pain cannot be felt before 26 weeks, positing instead that pain can be felt at around 20 weeks. This suggestion is however disputed in a March 2010 report on Foetal Awareness published by the Royal College of Obstetricians and Gynaecologists, citing a lack of evidence. The report definitively states that the foetus cannot feel pain prior to week 24.

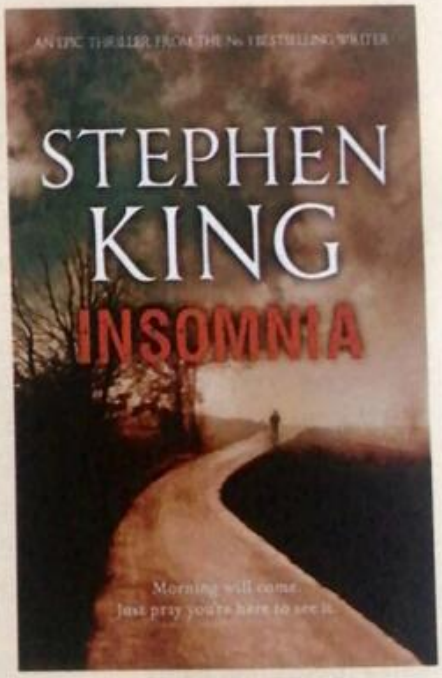
Some 'pro-choice' activists consider the question to be irrelevant. They state that the majority of surgical abortions were performed under general anaesthesia which affects the foetus, and consider the discussion "to be unhelpful to women and to the scientific debate." Others caution against unnecessary use of foetal anaesthetic during abortion, as it poses potential health risks to the pregnant woman. Some investigators have noted that the foetal brain is already awash in naturally occurring chemicals that keep it sedated and anaesthetized until birth.

Dr George Tiller

Anti-abortion violence

'Anti-abortion violence' is violence committed against individuals and organizations that provide abortion. Incidents of violence have included destruction of property, in the form of vandalism; crimes against people, including kidnapping, stalking, assault, attempted murder, and murder; and crimes affecting both people and property, including arson and bombings.

Anti-abortion violence is specifically directed towards people who, or places which provide abortion. It is known as "**single issue terrorism**". Extreme forms are recognized as terrorism. Incidents include vandalism, arson, and bombings of abortion clinics. At least eleven murders occurred in the United States since 1990, as well as 41 bombings and 173 arsons at clinics since 1977. At least one murder occurred in Australia, as well as several attempted murders in Canada.



Front Cover of Insomnia by Stephen King

On May 31, 2009, **Dr George Tiller** was shot and killed by Scott Roeder as Tiller served as an usher at a church in Wichita, Kansas, USA. This was not Tiller's first time being a victim to anti-abortion violence. Dr.Tiller was shot once before in 1993 by Shelley Shannon, who was sentenced 10 years in prison for the shooting. The Department of Justice and Department of Homeland Security's joint Terrorism Knowledge Base, identify the **Army of God** as an underground terrorist organization active in the United States. It was formed in 1982, and is responsible for a substantial amount of anti-abortion violence. The group has committed property crimes, acts of kidnapping, attempted murder, and murder. In August 1982, three men identifying as the Army of God kidnapped Hector Zevallos (a doctor and clinic owner) and his wife, Rosalee Jean, holding them for eight days and released them unharmed. In 1993, Shelly Shannon, an Army of God member, admitted to the attempted murder of Dr George Tiller, a prominent pro-choice activist.

Insomnia (1994), a popular novel by Stephen King, has much of the plot focusing around violent anti-abortion campaigners and their opposition to a pro-choice speech due to be held in their town. The group murders several women they believe to be seeking abortions and attempts to assassinate the speaker.

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- **Gastro-intestinal tract irritants** such as tartar emetic, which can cause reflex contractions of uterine muscle fibres.
- **Plant irritants** such as seeds or unripe fruit of papaya and methi seeds (fenugreek). Calotropis is also used.
- **Systemic poisons** such as the salts of arsenic, lead, copper, antimony and mercury.

- **Mechanical Trauma**: When drugs fail to bring about abortion, mechanical trauma is resorted to.
  - This may take the form of primitive, and often barbaric, methods of **rupturing the membranes** with the help of knitting needle, hairpin, stick, metal wire, coat hanger, screwdriver, etc. Once the membranes are ruptured, the products of conception get expelled.
  - Sometimes hot water, Savlon, or Dettol is injected under pressure, using a Higginson's syringe. Lysol, cresol, formalin or potassium permanganate may also be used. This process of injecting a fluid under pressure is called **syringing**. At times, instillation of hot water has resulted in death due to vagal inhibition, or due to embolism. A visit to the scene of the crime may reveal the presence of a syringe or remnants of the fluid used.
  - Some abortionists insert foreign bodies such as a stick, in order to dilate the cervix. More commonly, a **laminaria tent** is inserted into the cervix. Laminaria or Sea-tangle tent is a type of seaweed. Each "tent" is a cylinder about 5–10 cm long made from the dried stalk of the marine plant *Laminaria digitata* (Fig. 19.7). It is inserted into the cervical canal when it is dry, and slowly expands as it absorbs water, dilating the cervix. This results in expulsion of the foetus. Other substances that have been used include sola pith, compressed sponge, bark of the slippery elm, etc.

i. **Abortion stick**: This is a method favoured by untrained midwives (*dais*) in the rural areas. A thin stick about 12 inches long is wrapped in gauze or cotton wool. It is then dipped in an irritant solution like the juice of marking nut, or calotropis, or the paste of some metallic salt. The stick is then inserted into the cervix or vagina. It causes ulceration, bleeding from the os and expulsion of the foetus. At times, death of the woman takes place due to systemic absorption of the irritant or due to septicaemia. The application of potassium permanganate crystals can be extremely dangerous, causing ulceration, haemorrhage and toxic effects due to systemic absorption.

| Fig. 19.7 Box of Laminaria (Sea Tangle) Tents |

- **Cupping**: A lighted wick is placed over the hypogastrium and a cup is inverted over it. This creates a negative pressure, and when the cup is pulled suddenly, partial separation of placenta can result.
- Other methods resorted to by criminal abortionists include introduction of pastes, curetting, application of electrical current locally, or insufflation of air.

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Complications of Criminal Abortion

- **Immediate Complications**:
  - Haemorrhage due to perforation of vessels.
  - Shock due to vagal inhibition resulting from instrumentation, or insertion of objects into the genital tract.
  - Fat embolism may occur while syringing with soapy liquid.
  - Air embolism due to insufflating air inadvertently into the uterine cavity during amateur procedures.
- **Delayed complications**:
  - Septicaemia
  - Tetanus
  - Endotoxic shock
  - Renal failure
  - Meningitis, hepatitis, etc.

Duties of a Medical Practitioner in Criminal Abortion

- When a lady comes to a doctor with history of incomplete abortion attempted by an abortionist or by herself, the medical practitioner must make a detailed note of the circumstances and the method employed to procure abortion.
- If death is imminent, he must record a dying declaration.
- If the patient dies, he must not issue a death certificate, but report to the police and arrange for an autopsy to be done.

Medical Evidence of Abortion

In a Living Victim

- The breasts show pigmentation.
- Secretion of milk or colostrum from the nipple.
- Linea nigra and/or albicans may be present.
- In advanced pregnancy, the uterus may be palpable even after abortion.
- Congestion of the labia majora and minora is often present.
- Tags of membrane may be found in the uterus.
- Ulceration or erosion of the vagina or cervix may be noted.
- A swab taken from the cervical canal may help in detecting the chemical used for syringing.
- Blood or urine should be tested for HCG. Urine examination will reveal high levels of HCG up to 7 days.
- An ultrasound scan should be taken to study the uterus and appendages.
- Aborted material, if available, should be subjected to visual and histological examination (Fig 19.8).

| **Fig. 19.8** Fragmented Parts - Aborted Foetus *(Pic : Dr Dharmaraya Ingale)* |

In a Dead Victim (Autopsy Findings)

In addition to the above findings, the following may be observed:

- The face may appear pale or bluish.
- Undergarments may show blood clots and fragments of products of conception.
- Examination of the genitalia often reveals congestion of the labia, and injury to the posterior commissure.
- The abdominal cavity may contain clotted blood.
- Perforation of pelvic organs may have occurred. There may be evidence of peritonitis.
- Uterus may show the presence of paste, or marks of instrumentation.
- In the case of intrauterine infection, the uterus will be swollen, spongy, and discoloured. Serosal surface may be brownish, especially in clostridial infections. The endometrium may exhibit foul-smelling purulent discharge.

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- Vaginal fluid should be collected for chemical analysis. Swabs should be taken for microbiological examination. If air embolism is suspected, X-rays or CT scans must be taken.
- Uterus and ovaries may also be sent for chemical analysis to detect the presence of abortifacients.

Spontaneous (natural) abortion should be differentiated from criminal abortion. Histological examination of the expelled products of conception may be helpful. Blighted embryo, degenerative changes in the chrorionic villi, hydatidiform mole, attenuated trophoblastic layer and myxomatous avascular stroma indicate spontaneous abortion. Macerated foetus and macerated placenta are also indicative of natural abortion. Foetal abnormalities are often associated with natural abortion.

Sections of the Indian Penal Code (IPC) Dealing with Criminal Abortion

- **312**: (*Causing miscarriage*) – Whoever voluntarily causes criminal abortion is liable for imprisonment up to 3 years and/or fine. The imprisonment may extend up to 7 years if the woman is quick with child. It is necessary that the woman should be pregnant and abortion carried out with her consent.
  - Here the term 'with child' means pregnant, and 'quick' means the woman should have felt the child move within her.
- **313**: (*Causing miscarriage without consent*) – If miscarriage is carried out without the consent of the woman, the imprisonment may be extended up to 10 years.
- **314**: (*Death caused by act done with intent to cause miscarriage*) – If death of the woman takes place as a result of miscarriage, the minimum punishment would be 10 years.
- **315**: (*Act done with intent to prevent the child being born alive, or to cause it to die after birth*) – A person doing an act to prevent a child from being born alive, or causing it to die soon after its birth is liable for punishment up to 10 years imprisonment.
- **316**: (*Causing death of a quick, unborn child*) – Causing death of a quick, unborn child amounts to culpable homicide, and the punishment may extend up to 10 years imprisonment.

PRENATAL SEX DETERMINATION TEST (PNDT) ACT

- Referred to more correctly as the Prenatal Techniques (Regulation and Prevention of Misuse) Act 1994.
- In India, methods for diagnosing the sex of the unborn child have been in practice since the 1970s. These include:
  - Amniocentesis (performed during 15-17 weeks of pregnancy)
  - Chorionic villus sampling (very expensive and performed in the 10th week)
  - Ultrasound (least expensive and performed around the 12th week). This is in fact today the most sought after of all available tests. Gross misuse has resulted in a skewed male: female ratio across the country.
  - Based on evidence from National Family Health Surveys, studies estimate that more than 100,000 sex-selective abortions have been performed annually in India in recent years **(Box 19.4)**.
- In 1994, the Central Government passed the Prenatal Techniques (Regulation and Prevention of Misuse) Act covering the entire country. The law came into operation on January 1, 1996.
  - Under the Act, pre-natal diagnostic scans are permitted solely to detect genetic abnormalities. The Act forbids sex determination tests.
  - The Supreme Court in 2001 directed the State Governments to enforce the PNDT Act and file an affidavit indicating the status of action taken under the Act.
  - In early 2003, the PNDT Act was amended to include pre-conception techniques as well.
  - No genetic counselling centre, laboratory or clinic unless registered under this Act shall conduct prenatal diagnostic techniques.

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- No genetic counselling centre, laboratory or clinic shall employ any person who does not possess the prescribed qualification.
- No medical geneticist, gynaecologist, paediatrician or any other person shall conduct any prenatal diagnostic techniques at a place other than a place registered under the Act.
- No person shall sell any equipment capable of detecting sex of the foetus to any genetic counselling centre, laboratory or clinic not registered under the Act.
- No prenatal diagnostic techniques shall be conducted except for the purposes of detection of any of the following abnormalities:
  - Chromosomal abnormalities
  - Genetic metabolic diseases
  - Haemoglobinopathies
  - Sex-linked genetic diseases
  - Congenital anomalies
- No prenatal diagnostic technique shall be conducted unless the person qualified to do so is satisfied that any of the following conditions are fulfilled:
- Age of the pregnant woman is above 35 years
- The pregnant woman has undergone two or more spontaneous abortions or foetal losses.
- The pregnant woman has been exposed to potentially teratogenic agents such as drugs, radiation, infection or chemicals.
- The pregnant woman or her spouse has a family history of mental retardation or physical deformities such as spasticity or any other genetic disease.
- No person shall conduct the prenatal diagnostic procedures unless he has obtained in the prescribed form her written consent to undergo such procedure.
- No person conducting prenatal diagnostic procedure shall communicate to the pregnant woman concerned or her relative the sex of the foetus by words, signs or in any other manner.

- Advertisement in any manner including internet, regarding facilities of prenatal determination of sex available at any genetic centre, clinic or laboratory, shall be punishable with imprisonment for a term, which may extend up to three years, and fine which may extend up to Rs.10,000/-.
- If any geneticist, gynaecologist, paediatrician or any other person contravenes any of the provisions of this Act shall be punishable with imprisonment for a term which may extend to three years and fine of Rs.10,000/-. On any subsequent conviction, imprisonment may extend to five years and fine may extend to Rs.50,000/-.
- Not withstanding anything contained in the Indian Evidence Act, the court shall presume unless the contrary is proved that her husband or any other relative compelled the pregnant woman, to undergo prenatal diagnostic technique. Such a person shall be liable for abetment of offence with imprisonment up to 3 years and fine of Rs.10000/-.
- The PNDT Act 1994 was **amended** in **2003** to The **Pre-Conception and Pre-Natal Diagnostic Techniques (Prohibition of Sex Selection) Act (PCPNDT Act)** to improve the regulation of the technology used in sex selection.
  - Implications of the amendment include the following:
    - Amendment of the act mainly attempts to bring the technique of pre-conception sex selection within the ambit of the act.
    - Bringing ultrasound within its ambit.
    - Empowering the central supervisory board constitution of state level supervisory board.
    - Provision for more stringent punishments
      i. Persons seeking to know the sex of the foetus: 3 years imprisonment and/or fine of Rs 50,000 for the first offence. For subsequent offence, 5 years imprisonment and/or fine of Rs 1,00,000. The pregnant woman herself is considered innocent under the Act, unless and until proved otherwise. It is presumed that she has been compelled to undergo sex determination tests by her husband and relatives.

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ii. Persons connected with advertising of sex selection/sex determination services: 3 years imprisonment and/or a fine of Rs 10,000 with additional fine for continuing contravention at the rate of Rs 500 per day.

- Empowering appropriate authorities with the power of civil court for search, seizure and sealing the machines and equipments of the violators.
- Regulating the sale of the ultrasound machines only to registered bodies.

Box 19.4 Female Foeticide in India

India's 2001 census revealed a national 0-6 age child sex ratio of 108, which increased to 109 according to 2011 census (927 girls per 1000 boys and 919 girls per 1000 boys respectively, compared to expected normal ratio of 943 girls per 1000 boys). The child sex ratio in India shows a regional pattern. India's 2011 census found that all eastern and southern states of India had a child sex ratio between 103 and 107, typically considered as the "natural ratio." The highest sex ratios were observed in India's northern and northwestern states - Haryana (120), Punjab (118) and Jammu & Kashmir (116).

The Indian census data suggests there is a positive correlation between abnormal sex ratio and better socio-economic status and literacy. Urban India has higher child sex ratio than rural India according to 1991, 2001 and 2011 Census data, implying higher prevalence of sex selective abortion in urban India. Similarly, child sex ratio greater than 115 boys per 100 girls is found in regions where the predominant majority is either Hindu, Muslim, Sikh or Christian; furthermore "normal" child sex ratio of 104 to 106 boys per 100 girls are also found in regions where the predominant majority is any of these religions. These data contradict any hypotheses that may suggest that sex selection is an archaic practice which takes place among uneducated, poor sections, or particular religion of the Indian society.

Techniques for determining sex prenatally that were pioneered in the 1970s, gained popularity in India, and became broadly available in most of the Indian states by the early 2000s. Such prenatal sex determination techniques, where available, favoured male births. Modern foetal sex screening techniques have further skewed child sex ratios. It is estimated that 1/6 of reported abortions follow a sex determination test

The Indian government and various advocacy groups have been trying to find ways to prevent sex selection. India passed its first abortion-related law, the Medical Termination of Pregnancy Act of 1971, making abortion legal in most states, but specified legally acceptable reasons for abortion such as medical risk to mother, and rape. The law also established physicians who can legally provide the procedure and the facilities where abortions can be performed, but did not anticipate sex selective abortion based on technology advances. With increasing availability of sex screening technologies through the 1980s in urban India, and claims of its misuse, the Govt of India passed the Pre-natal Diagnostic Techniques Act (PNDT) in 1994. This law was further amended as the Pre-Conception and Pre-natal Diagnostic Techniques (Regulation and Prevention of Misuse) (PCPNDT) Act in 2003 to deter and punish prenatal sex screening and sex selective abortion.

The impact of the law and its enforcement is unclear. The Public Health Foundation of India, an activist NGO in its 2010 report, claimed a lack of awareness about the Act in parts of India, inactive role of the Appropriate Authorities, ambiguity among some clinics that offer prenatal care services, and the role of a few medical practitioners in disregarding the law.

The Ministry of Health and Family Welfare of India has targeted education and media advertisements to reach clinics and medical professionals to increase awareness. The Indian Medical Association has undertaken efforts to prevent prenatal sex selection by giving its members 'Beti Bachao' (save the daughter) badges during its meetings and conferences.

In spite of all this however, it is estimated that 100,000 abortions every year continue to be performed in India solely because the foetus is female.

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CHAPTER 20

Infanticide

It is as natural to die as to be born; and to a little infant, perhaps, the one is as painful as the other.
—**Francis Bacon** (1561–1626; English lawyer and philosopher)

DEFINITIONS

- **Infanticide**: Though the legal definition and implications of infanticide vary from country to country, the medical concept is more or less universally accepted. **Infanticide refers to the deliberate killing of a child below the age of one year**.
  - In England, Germany, and the UK, there is a clear-cut distinction between homicide and infanticide, and a charge of infanticide is less serious than a charge of murder, if committed by the mother due to stress factors surrounding birth and lactation.
  - In India, no such distinction exists, and the mother is punished under section 302 (IPC), the same as for murder.
- **Foeticide**: **Killing of a foetus prior to birth**.
  - Prenatal sex determination followed by selective abortion of female foetuses is the main cause for the declining sex ratio at birth in India. Women most clearly at risk are those who already have one or two female children. Based on conservative assumptions, the practice accounts for more than a million missing female births yearly, translating over the past 2 decades into the abortion of several million female foetuses, and the skewed male-to-female ratio.
  - The natural ratio is assumed to be between 103 to 107, and any number above it is considered as suggestive of female foeticide. According to the decennial Indian census, the sex ratio in the 0 to 6 age group in India has risen from 102 males per 100 females in 1961, to 104 in 1981, to 108 in 2001, to 109 in 2011. The child sex ratio is within the normal natural range in all eastern and southern states of India, but significantly higher in certain western and particularly northwestern states such as Punjab, Haryana and Jammu & Kashmir (118, 120 and 116, as of 2011, respectively).
  - However, high birth sex ratio and implied female foeticide is an issue that is not unique to India. Even higher sex ratios than in India have been reported for the last 20 years in China, Pakistan, Vietnam, Azerbaijan, Armenia, Georgia and some Southeast European countries.
- **Neonaticide**: **Killing of a newborn infant**.
  - The perpetrator is usually the mother, and the cause of death is either asphyxia or abandonment.
- **Still Birth**: Refers to the **birth of a baby born after 28 weeks of gestation, which did not at any time after being completely expelled from its mother, breathe or show any other signs of life**.
- **Dead Birth**: A dead born child is one **which has died in utero, and shows any one of the following signs after it is completely born**:
  - ***Maceration*** – This is a process of aseptic autolysis **(Fig 20.1)**. Unlike putrefaction which is due to bacteria, there is no bacterial action in maceration.
    - The cells break down due to autolysis, and the body becomes soft and flaccid.
    - Skin appears purplish brown & peels easily.
    - After the foetus dies in utero, the cerebral hemispheres shrink in size. As a result, the bones of the cranial vault loosen and begin

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| Fig. 20.1 Macerated Foetus
(Pic : Dr Shashidhar C Mestri) |

to override each other. This overriding of the cranial bones seen on X-ray is called **Spalding's* sign** (Fig. 20.2).

| Fig. 20.2 Spalding Sign on Ultrasound |

- Signs of maceration become evident only about 24 hours after the death of the foetus. However, skin slippage can occur as early as 6 to 12 hours, and constitutes the earliest sign of maceration.
- ***Putrefaction*** – If there is rupture of membranes, air entry occurs and putrefaction sets in.
- ***Mummification*** – When liquor amnii is scanty, the foetus becomes dry and shriveled.
- ***Rigor mortis*** – In the early stages after intrauterine death, if the foetus has developed to nearly full term, rigor mortis may set in. The delivery of such a foetus may be difficult.

- **Viability: The physical ability of a foetus to lead a separate existence after birth, by virtue of a certain degree of development, is called viability****.
  - Although in some cases, infants have reportedly survived even though the gestation period was only 180 days, for practical purposes, the **minimum duration required to make a foetus viable is taken as 210 days** (seven 30-day months).
  - Some factors which help in assessing the viability include *weight*, *crown-heel length*, and appearance of *ossification centres*. At seven months, the average weight is 1.3 kg, and the crown-heel length is 35 cm.
  - **Rule of Haase** – It is a rough method of determining the gestational age of a foetus after delivery. The square root of the crown-heel length (cm) gives the gestational age (months), up to 5 months intrauterine life. For example, a length of 16 cm indicates the age of the foetus to be 4 months. Beyond the 5th month, the length of the foetus (cm) when divided by 5, provides its age in months. For example, a length of 30 cm divided by 5 shows the age to be 6 months.
  - **Ossification centres** – By the 28th week, the centre for the proximal end of the tibia, as well as the centres for cuneate, capitate, and cuboid bones appear. The centre for the proximal end of the tibia is the most reliable, that of the cuneate and capitate least reliable, and that of the cuboid is of intermediate value.
- **Live Birth**: The term **live birth** is used **when a child has showed signs of life (however slight**

20

*Alfred Baker Spalding, an American gynaecologist, first pointed this out (in 1922).
**A student was asked by an examiner during the practical examination while pointing at a particular specimen of a foetus in a museum jar, "Is that foetus viable?" The student guffawed loudly and responded, "Ha! Ha! Ha! Sir, how can that foetus be viable? It is in formalin!" (narrated by Dr G Pradeep Kumar).

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it might have been), even if only a part of the child was out of the womb, though the child may not have breathed or been born completely. Causing the death of such a child is treated in the same manner as homicide.

SIGNS OF LIVE BIRTH

In India, the law presumes that every child that was discovered in a dead condition was born dead, unless the contrary can be proved. In civil cases, any sign of life such as a cry, movement of the body, or hand or foot, after birth is likely to be accepted as proof of live birth. Sometimes a child may cry even while it is still in the uterus or vagina (after the membranes have ruptured). This is called ***vagitus uterinus*** and ***vagitus vaginalis***, respectively. And yet when the child is actually born, i.e., has come to the exterior, it may be found to be without signs of life.

Hence, in criminal cases, the cry of the child alone is not proof enough of live birth. Such proof that is acceptable to the court can only be furnished after postmortem examination:

- **Umbilical cord**: If the cord has separated, it indicates that birth took place several days earlier.
  - Generally, in the first 12–24 hours after birth, the umbilical cord becomes dry and shriveled.
  - On the second day, a zone of redness is seen at the attachment of the cord to the umbilicus.
  - It is also important to consider as to whether the cord was cut or torn. In the case of a torn cord, the edges appear ragged and ripped.
- **Presence of vernix**: This merely indicates that the child was not washed. It does not indicate live birth.
  - **Vernix** (also known as **vernix caseosa**), is the waxy or cheese-like white substance found coating the skin of newborn humans. It is secreted by the foetus's sebaceous glands *in utero*, and is hypothesized to have antibacterial properties.
- **Food in the stomach**: Presence of milk or food in the stomach is a conclusive sign of live birth.
- **Proof of breathing**: The following points are relevant:
  - The shape of the chest is flat before respiration, after which it becomes drum shaped.
  - The diaphragm is at the level of the 6th or 7th rib after respiration has taken place. Otherwise it is at the level of the 3rd or 4th rib.
  - The lungs are voluminous, with the medial edges overlapping the mediastinum. The margins become rounded after respiration is established. Before respiration the lungs are firm in consistency, but respired lungs are spongy, elastic, and crepitant, due to being distended with air.
  - ***Hydrostatic test***: The hydrostatic test is based on the principle that if the infant has breathed, the lungs will float in water. Each lung is cut into pieces and tested for floatation in water. A piece of liver can serve as control. If the liver bit floats, the test has no meaning, because it is clear that putrefaction has set in. If all the pieces of lung float, they are crushed under a weight and tested again.
    - *Inference*: Floatation is positive when the baby has respired. But if the pieces sink after pressure, no respiration has taken place. If some pieces float while others sink, it means feeble respiration has taken place.
    - *Drawbacks*: Expanded lungs may sink due to oedema, pneumonia, atelectasis, and obstruction by alveolar duct membrane. On the other hand, unexpanded lungs may float due to putrefaction or artificial respiration.
    - The hydrostatic test is superfluous (i.e., not necessary) if the foetus is:
      i. below 180 days of gestation
      ii. macerated
      iii. grossly deformed
      iv. showing milk in the stomach.

    The hydrostatic test is of limited value. It can only be used as a suggestive pointer to live birth, but it is not conclusive.
  - **Other indicators**
    - The lungs of a stillborn are dark, small and heavy (like liver).
    - Before respiration, the lungs are smaller, constituting about 1/70th of the body

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weight. After respiration, due to increased vascular volume it becomes 1/35th of the body weight (this is also sometimes called the **Ploucquet's test**).

- The texture of the unrespired lung is rubbery and firm with sharp margins. On slicing, the interior is uniform in colour and texture. On rubbing a small piece between the fingers, close to the ears, no sound is heard. In the case of a respired lung, crepitation can be made out.
- Histological appearance: In a respired lung, alveoli appear expanded with flattened epithelium.
- Presence of air in the stomach and intestine (which float in water if double-ligated). This is referred to as **Breslau's second life test** or **Stomach-bowel test**.
- The disappearance of gelatinous tissue from the middle ear after respiration is established, may point to maturity of the infant (**Wredin's test**).
- Foetal haemoglobin, which is 80% at birth, decreases to 7–8% in 3 months.

CAUSES OF INFANT DEATH

- Death of a foetus may be due to **natural** or **unnatural** causes.
  - **Natural causes** include immaturity, foetal malformations, and birth trauma.
  - **Unnatural causes** may be accidental or criminal.
- ***Accidental causes*** may be due to delayed labour, cord twisting around the neck, or cord prolapse. Sometimes, a foetus is born with the membranes covering the head (caul) which if not incised soon after birth, leads to asphyxia (Fig 20.3).
  - **Precipitate labour**
    - Precipitate labour is said to occur when all the stages of labour merge with each other, and the birth takes place in an abnormally short time.
    - The mother may experience mild pain which she may attribute to a distended rectum, and therefore she may attempt to defaecate, as a result of which the child may be born into the lavatory pan. The child may sustain skull fractures or bleed from the torn end of the umbilicus. It may inhale faecal matter which may be demonstrable in the lungs.
    - Precipitate labour occurs when the pelvis is very roomy and the foetus is very small. In such cases, ***caput succedaneum*** or ***cephalhaematoma*** which are pointers to obstructed labour, are absent. The former is a soft swelling on the presenting part of the scalp formed during delivery and contains blood and serous fluid. The swelling does not cross over the midline as it is limited by the attachment of pericranium to the bones of the vault. In breech delivery it may be seen on the buttocks. Caput resolves in 1–7 days.
    - Cephalhaematoma is due to accumulation of blood deep to the scalp. It is limited to suture lines. It takes about one to three months to resolve and shows colour changes similar to a bruise.
- ***Criminal causes*** of infant death constitute the offence of **infanticide**. These may be the result of acts of omission or acts of commission.
  - **Acts of omission** (or neglect): Failure to
    - protect the child from heat or cold
    - provide assistance during labour
    - clear the air passages of mucus

| Fig. 20.3 Caul Birth
(Pic : Dr Shashidhar C Mestri) |

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- cut the umbilical cord
- feed the child.

- **Acts of commission**: The following constitute some common examples:
  - Smothering, e.g., by blocking the air passage by a pillow or soft cloth.
  - Strangulation, e.g., by ligature, sash of the baby's frock, or even the umbilical cord.
  - Manual strangulation or throttling.
  - Banging the head of the child against a wall.
  - Burning.
  - Drowning.
  - ***Concealed puncture wounds***, e.g., in the axilla, inner canthus of the eye, vagina, rectum, through a fontanelle, etc., usually accomplished by the insertion of a stout needle or fine-bladed knife.
  - Poisoning.

CONCEALMENT OF BIRTH

Section 318 of the **Indian Penal Code** recognizes intentional concealment of birth and/or secret burial or disposal of a dead child as a crime punishable with fine or imprisonment up to 2 years, irrespective of whether the child dies during, before, or after birth.

ABANDONING OF INFANTS

If the parent or guardian of a child below 12 years, or anyone entrusted with the care of such a child, leaves it in any place with the intention of abandonment, he /she is punishable up to 7 years imprisonment (**317 IPC**).

SUDDEN INFANT DEATH SYNDROME

Synonyms

Cot death, Crib death, SIDS

Definition

SIDS is defined as the sudden death of an infant which remains unexplained, even after a thorough case investigation, including performance of a complete autopsy, examination of the death scene, and review of the clinical history.

Possible Causes

The incidence of SIDS is 2–3/1000 live births, with a slight male preponderance. Most cases involve infants between the ages of 2 weeks to 2 years, with maximum incidence between 3 and 7 months (**Fig. 20.4**). Crib deaths occur commonly at night or in the wee hours of the morning. Twins are at greater risk. In many cases, there is a prior history of running nose or coryza.

The hypotheses for Sudden Infant Death Syndrome include:

- Overlaying of the infant by drunken parents.
- Prone sleeping position.
- Inadvertent smothering by soft cloth or pillow.
- Sleep apnoea, which causes hypoxia and respiratory depression.
- Hypotonic babies, whose neck posture reduces the airway lumen.
- Dust mite allergy.
- Cow's milk allergy.
- Calcium or selenium deficiency.
- Viraemia.
- Hyperthermia or hypothermia.
- Anaphylactic shock.

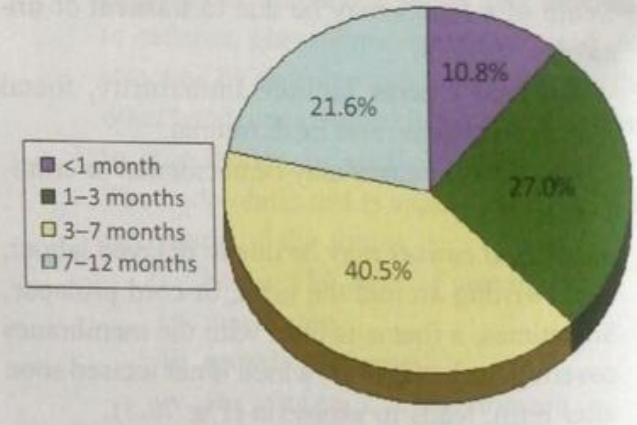

Fig. 20.4 SIDS–Commonly Affected Age Groups

Autopsy Findings

- Blood-stained froth in the mouth.
- Evidence of laryngitis, tracheitis, tracheobronchitis, or congenital heart disease may be seen in some cases.

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- Multiple petechial haemorrhages are often noticed in the heart, lungs, and thymus.

Preventing SIDS

- The parent/caregiver of an infant must not sleep along with the baby, as far as possible. A separate, properly designed crib must be used for the baby (Fig. 20.5).
- Ensure that the infant always sleeps on its back. Never allow it to sleep prone (face down).
- Use only a firm mattress and avoid soft bedding.
- Ensure that the room in which the baby is sleeping is well ventilated at all times.
- The baby must be breast fed as far as possible. Discourage bottle feeding in the early months after delivery.
- Do not allow anyone to smoke in the vicinity of a sleeping baby.
- Do not medicate an infant without consulting a paediatrician.

| Fig. 20.5 Prevention of SIDS |

NON-ACCIDENTAL INJURIES IN CHILDREN (CHILD ABUSE)

Introduction

India is home to almost 19 percent of the world's children. More than one-third of the country's population, around 440 million, is below 18 years. It is young children, in the 5–12 year group, who are most at risk of abuse and exploitation. Two out of every three children are physically abused. Child maltreatment can take the following forms:

- Physical abuse
- Neglect
- Sexual abuse
- Emotional abuse

Physical Abuse & Neglect

Battered Baby Syndrome

Synonyms

Non-accidental Injury of Childhood, Caffey's Syndrome, Child Abuse Syndrome, Maltreatment Syndrome

Definition

- **A battered child is one that suffers repetitive physical injuries inflicted by a parent or guardian, which are non-accidental in nature.**
- Such children usually belong to broken families, low socio-economic strata and may be illegitimate or unwanted.
- The physical findings will not corroborate the history (of accident) given by the parents/foster parents.

Manifestations

The signs to look for in a suspected victim of battering:

- The body language of the child may reflect fear and despair.
- Bruises around the wrist, forearm, thighs, and ankles, which form 'handles' for adults to grip and swing the child (Fig. 20.6).
- The buttocks may show burns, or whip marks.
- The face and lips may be bruised. There may be bruising or laceration inside the oral cavity (Fig. 20.7).
- Circular bruises of 1–2 cm size, called 'six-penny bruises,' which occur due to the poking of adult fingers on chest, abdomen and thighs.
- Bruises of different periodicity on the same child with a history inconsistent with the findings.
- Crack fractures of the skull bones associated with intracranial haemorrhages.

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- Multiple rib fractures may be seen.
- Limb fractures are mostly in the region of the metaphysis and epiphysis of growing bones. Periosteal elevations may be seen.

| Fig. 20.6 Battered Baby–Multiple Bruises |

| Fig. 20.7 Battered Baby–Oral Injuries from Violent Slapping |

Cinderella Syndrome

Sometimes in a family, a single child is chosen to receive the battering. The child (commonly the youngest or eldest) is repeatedly thrashed, while the other children of the same family are spared. Occasionally, it may take the form of deliberate neglect, wherein the child is ignored, while all attention is showered on the siblings.

Shaken Baby Syndrome

Definition

- Shaken baby syndrome is a serious and clearly definable form of child abuse.
- **It results from extreme rotational cranial acceleration induced by violent shaking or shaking/impact.**
- It most often involves children younger than 2 years, but may be seen in children up to 5 years.
- It occurs commonly, yet may be misdiagnosed in its most subtle form, and under-diagnosed in its most serious form **(Box 20.1)**.

Clinical Features

- In 1972, paediatric radiologist **John Caffey** popularized the term "**whiplash shaken baby syndrome**" to describe a constellation of clinical findings in infants, which included retinal haemorrhages, subdural and/or subarachnoid haemorrhages, and little or no evidence of external cranial trauma.
- Shaken baby injuries usually occur in children younger than 2 years old but may be seen in children up to the age of 5.
- A victim of sub-lethal shaking may have a history of poor feeding, vomiting, lethargy, and/or irritability occurring for days or weeks.
- The constellation of these injuries does not occur with short falls, seizures, or as a result of vaccination (as often alleged by the guilty parent).
- Shaking by itself may cause serious or fatal injuries **(Fig. 20.8)**. In many instances, there may be other forms of head trauma, including impact injuries. Thus, the term **shaken/slam syndrome** (or **shaken-impact syndrome**) may more accurately reflect the age range of the victims (who are not always babies) and the mechanisms of injury seen.
- Injuries are most likely to happen when there is both acceleration (from shaking) and deceleration (from the head hitting something). Even hitting a soft object, such as a mattress or pillow, may be enough to injure newborns and small infants. The result is a type of whiplash, similar to that seen in some automobile accidents. A number of factors make infants highly vulnerable to such forces. For example, children's brains are softer.

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Box 20.1 The Matthew Eappen Case (Massachusetts, USA)

On Feb. 4, 1997, Louise Woodward called the police and said that **Matthew Eappen**, son of Dr Sunil Eappen, an Indian expatriate, was having difficulty breathing. 19-year-old Woodward had been hired by Sunil and Deborah Eappen to baby-sit their sons Brendan (2 years) and Matthew (8½ months), in November 1996.

When paramedics arrived at the Eappen household, they found that the baby had a two-and-a-half-inch skull fracture. Matthew's eyes were also bulging, a possible sign of "shaken baby syndrome."

The baby spent four days on life support before dying on Feb. 9. The autopsy revealed that in addition to his fractured skull, young Matthew was also suffering from a month-old wrist fracture.

Prosecutors said that Woodward admitted to shaking Matthew and to dropping him on the floor and tossing him on a bed. They alleged that Woodward became so frustrated with Matthew's uncontrollable crying that she began shaking him violently to stop the crying. In addition, State Medical Examiners said Matthew hit the floor with the "force equivalent to a fall from a second-storey window." The injuries from the fall and the shaking allegedly caused Matthew Eappen's death.

Woodward was convicted, but on a lesser charge of involuntary manslaughter. On June 16, 1998, the Massachusetts Supreme Judicial Court upheld Louise Woodward's reduced conviction, and declared that the sentence was the 'time served', in this case 279 days. Woodward, who had been living in the United States pending the appeal decision, returned home to England.

their neck muscles and ligaments are weak and not fully developed, and their heads are large and heavy in proportion to their bodies.

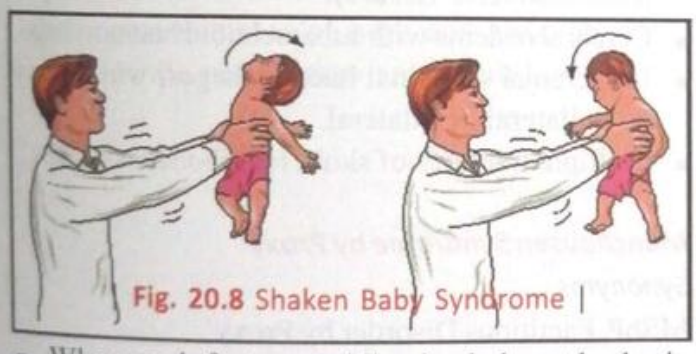

Fig. 20.8 Shaken Baby Syndrome

- When an infant or toddler is shaken, the brain bounces back and forth against the skull. This can cause cerebral contusion, oedema, and intracerebral haemorrhage. The large veins along the outside of the brain may tear, leading to further bleeding, swelling, and increased pressure (sub dural haematoma) **(Fig. 20.9)**. This can cause permanent brain damage or death.
- Shaking an infant or small child may cause other injuries, such as damage to the neck, spine, and eyes. Eye damage is very common and may result in loss of vision (retinal haemorrhage) **(Fig. 20.10)**.
- Such shaking often results from tension and frustration generated by a baby's incessant crying or irritability, though crying is of course not a legal justification for such violence.
- Caretakers at risk for abusive behaviour generally have unrealistic expectations of their children, and may exhibit a role reversal whereby caretakers expect their needs to be met by the child.

Investigations

- CT scan is generally the method of choice for demonstrating subarachnoid haemorrhage, or other kinds of intracranial bleeding. The scan should be repeated after a time interval, or if the neurologic picture changes rapidly.

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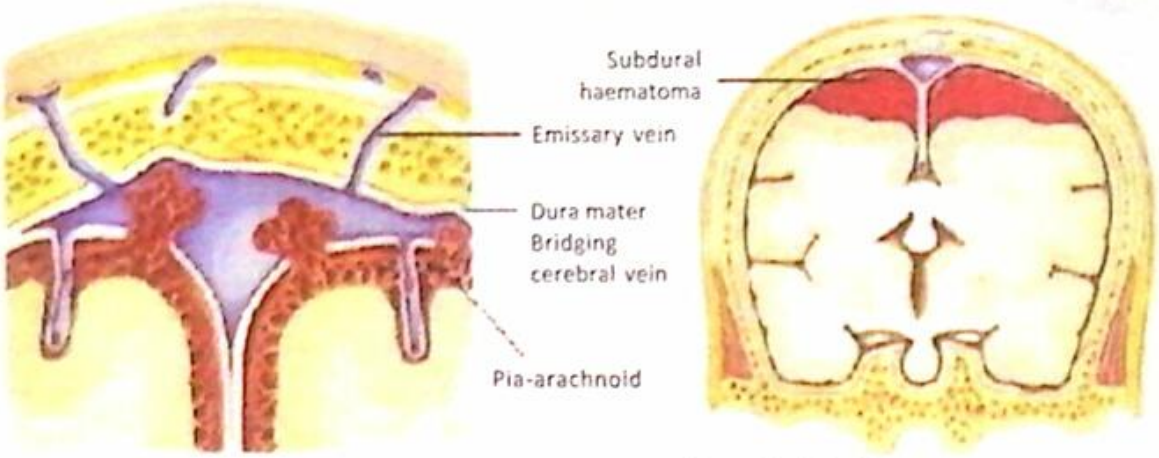
HEAD INJURIES



In children, bridging cerebral veins are poorly supported as they pass through subdural space. Violent shaking may cause vulnerable veins to tear, creating subdural haematoma.

Bilateral subdural haematomas with or without evidence of skull fracture can occur from head injuries. Seizures or coma may be first clinical sign

| Fig. 20.9 Mechanics of Head Injury – Shaken Baby Syndrome |

| Fig. 20.10 Ophthalmoscopy–Retinal Haemorrhage–Shaken Baby |

- MRI is of great value as an adjunct to CT in the evaluation of brain injuries in infants.
- At times, the clinical signs suggest meningitis, and a spinal tap yields bloody cerebrospinal fluid. Centrifuged spinal fluid that is xanthochromic should raise the suspicion of cerebral trauma that is at least several hours old, and not the result of a traumatic spinal tap.
- Because of confusing respiratory symptoms, chest X-rays may be obtained, which may appear normal, or show unexplained rib fractures. A skeletal survey of the hands, feet, long bones, skull, spine, and ribs should be obtained as soon as the infant's medical condition permits. Skull films complement CT bone windows in detection of skull fractures.

Autopsy Features

- Subdural haemorrhage (most prominent in the interhemispheric fissure).
- Cerebral oedema with subarachnoid haemorrhage.
- Intracranial or retinal haemorrhages, which may be unilateral or bilateral.
- Multiple fractures of skull, long bones, and ribs.

Münchausen Syndrome by Proxy

Synonyms

MSbP, Factitious Disorder by Proxy

Introduction

In 1977, paediatrician Roy Meadow at the University of Leeds, England, described the extraordinary behaviour of two mothers: According to Meadow, one had poisoned her toddler with excessive quantities of salt. The other had introduced her own blood into her baby's urine sample. He referred to this behaviour as Münchausen syndrome by proxy (MSbP).

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The medical community was initially skeptical of MSbP's existence, but it has gradually gained acceptance as a recognized condition.

Description

- An individual – usually a mother – deliberately makes another person (most often his or her own preschool child) sick or convinces others that the person is sick.
- The parent or caregiver misleads others into thinking that the child has medical problems by lying and reporting fictitious episodes. He or she may exaggerate, fabricate, or induce symptoms.
- As a result, doctors usually order tests, try different types of medications, and may even hospitalize the child, or perform surgery to determine the cause.
- Because the parent or caregiver appears to be so caring and attentive, often no one suspects any wrongdoing. It is not unusual for medical personnel to overlook the possibility of MSbP because it goes against the belief that a parent or caregiver would never deliberately hurt his or her child.
- Children who are subject to MSbP are typically of preschool age, although there have been reported cases in children up to 16 years old. There are equal numbers of boys and girls; however, 98% of the perpetrators are female.
- Diagnosis of MSbP is very difficult, but would involve some of the following:
  - a child who has multiple medical problems that do not respond to treatment
  - physical or laboratory findings that are highly unusual, do not correspond with the child's medical history, or are physically or clinically impossible
  - short-term symptoms that tend to stop when the perpetrator is not around
  - a parent who is not reassured by "good news" when test results find no medical problems, but continues to believe that the child is ill
  - a parent/caregiver who appears to be medically knowledgeable or fascinated with medical details or appears to enjoy hospital environment
  - a parent or caregiver who is unusually calm in the face of serious difficulties with the child's health

A recent case that caused an international sensation is described in **Box 20.2**.

Child Sexual Abuse

This is intricately related to paedophilia, and is discussed in detail in the chapter on "**Sexual Offences and Paraphilias**."

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Box 20.2 The Garnett Spears Case

The murder of 5 year old **Garnett Spears** occurred on January 23, 2014 at a hospital in suburban Valhalla, New York. The cause of death was deemed to be high levels of sodium leading to swelling in his brain. After his death, Garnett's mother, Lacey Spears, was charged with second-degree murder and first-degree manslaughter of her child. On March 2, 2015, a jury found Spears guilty of killing Garnett by poisoning him with table salt (sodium chloride), which she had administered to him from infancy through his feeding tube. On April 8, the judge sentenced Spears to 20 years to life in prison for the death of her son. The judge said that Lacey Spears suffered from Munchausen syndrome by proxy, and therefore did not sentence her to 25 years in prison, the maximum possible sentence.

Originally born and raised in Scottsville, Kentucky, Lacey Spears moved with her son to the town of Chestnut Ridge, New York, 14 months prior to Garnett's death. During her son's short life, Lacey Spears documented what she said was her son's struggle with numerous illnesses on her blog and on Facebook. Prosecutors said she enjoyed the "attention and sympathy" she received from having a sick child. Police who searched the mother's house after her son's death said they found two feeding bags that tested positive for sodium, as well as an open container of sea salt. A neighbour testified that Spears asked her to hide the bags in question. Spears' online history allegedly showed that she had been researching the dangers of sodium. And before his death in January 2014, Garnett had previously been treated for salt poisoning as an infant.

Lacey Spears at the time of her trial

But Spears maintained her innocence throughout the trial, saying her son may have been responsible for his own death. According to court documents, she told authorities "the victim would once in a while play with his feeding tube and could have put something into it."

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CHAPTER 21

Sexual Offences and Paraphilias

Rape is the only crime in which the victim becomes the accused.

—**Freda Adler** (Born: 1934; American Criminologist)

INTRODUCTION AND CLASSIFICATION

- The law in India (as of now) permits only hetero-sexual natural sexual intercourse (i.e., penile-vaginal sexual intercourse) between man and wife. **A sexual offence is therefore defined as any form of sexual intercourse which departs from this norm, and is consequently contrary to law.**
- A landmark decision of the Delhi High Court (02 July 2009) permitting also consensual homo-sexual acts in private between adults (over the age of 18 years) had been passed, which could have led to revision of the definition. However, the Court's decision was challenged, and the relevant section of the Indian Penal Code (377) could not be modified, **so the same definition is still operative.**
- On 2 July 2009, in Naz Foundation v. Govt. of NCT of Delhi, the Delhi High Court held that the provision making homosexuality a criminal act was unconstitutional with respect to sex between consenting adults, but the Supreme Court of India overturned that ruling on 11 December 2013.
- Because of such judicial contradictions the issue of decriminalizing homosexuality in India appears to be forever mired in controversy and there is little hope that the situation will become clear in the near future.
- Sexual offences are classified as:
  1. **Natural sexual offences**
     a. Rape
     b. Adultery
     c. Incest
  2. **Unnatural sexual offences**
     a. Homosexuality
     b. Buccal coitus
     c. Bestiality
  3. **Sexual deviations/perversions/ paraphilias***
     a. Fetishism/Transvestism
     b. Sadism/Masochism
     c. Voyeurism/Exhibitionism
     d. Paedophilia
     e. Miscellaneous disorders: necrophilia, necrophagia, etc.

NATURAL SEXUAL OFFENCES

RAPE

Definition

- As per **Sec. 375 IPC**, rape is defined as **unlawful sexual intercourse by a man with a woman**
  - **Against her will**
  - **Without her consent**
  - **With her consent, when her consent is obtained by**
    - **Force**
    - **Fear**
    - **Fraud**

Today, terms such as "perversion" and "deviation" are no more used. The correct term for these acts is "paraphilias"

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- **With or without her consent**
  - **When she is of unsound mind or intoxicated**
  - **When she is under 18 years of age. The Criminal Law (Amendment) Act, 2013** has increased the previous recommended age of consent from 16 to 18 years, which means any sexual activity irrespective of presence of consent with a woman below the age of 18 will constitute **statutory rape**.

- **Sec. 375 IPC** also explains that **mere penetration** is sufficient to constitute the offence of rape, and provides an **exception** to the age of consent to sexual intercourse by a female, i.e., *sexual intercourse by a man with his own wife, the wife being not less than 15 years of age, is* ***not*** *rape.*
  - Further, a **Manipur state amendment** to rape law has reduced the ages of valid consent to sexual intercourse by unmarried and married females to 14 and 13 years respectively.
- It must be emphasized here that **rape is not a medical term, but a legal concept**.
- Before proceeding any further, it would be pertinent to critically analyse from a medical viewpoint the provisions of **Sec. 375, IPC**:
  - **Firstly**, to constitute rape, sexual intercourse must be **unlawful**, i.e., between two persons who are not lawfully married. It must be noted that coitus between a man and a woman who are not lawfully married (either to each other or to anybody else), is not "unlawful" as long as such coitus takes place by mutual consent. Such sexual intercourse is, however, considered by orthodox societies as **illicit**, i.e., not permitted, and is called "**fornication**".
    - However, coitus between man and wife also amounts to rape if the wife is less than 15 years of age, because Indian law considers that, in view of her tender age and consequent immaturity of mind, the act may affect her body and mind adversely; hence the husband has no absolute right to coitus with her. (It may be mentioned here that the age of valid consent to sexual intercourse by a married woman as per Sec.375 IPC is itself a contradiction, as both the **Child Marriage Restraint Act** and the **Hindu Marriage Act** clearly specify that the minimum age at which a female can validly enter into a contract of marriage is eighteen years!)
  - **Secondly**, a **man** is defined in the Indian Penal Code as *a male human being of any age*. Therefore, there is, as per Indian law, no age below which a "man" cannot be charged with the offence of rape, unless Sec. 82 and 83 IPC can be applied, the latter stating that "*Nothing is an offence which is done by a child above seven years of age and under twelve, who has not attained sufficient maturity of understanding to judge the nature and consequences of his conduct.*"
    - The question of *minimum age* of the woman does not arise, because victims of rape have ranged from infants to the old and infirm.
  - **Thirdly**, there is bound to be some confusion between "will" and "consent" because in the minds of most people, the two words are synonymous. The two, however, differ considerably in that "will," in this context, is most simply explained as *desire, wish, or choice*, whereas "consent" is defined as *compliance or approval of what is done or proposed by another*. Therefore, a person may be willing to do something, but may not agree to do it. On the other hand, one may not be willing to do something, yet may comply, for whatever reason, with what is demanded.
    - It is important to note that legally valid consent by a woman to sexual intercourse, whether implied or expressed, **must be given before the act – that obtained subsequent to the act is not acceptable to a court of law**.
    - Till recently, Indian law also required that unwillingness or lack of consent by the woman must be proven by signs of resistance on her person, such as damage to her clothing or injuries on her body. However, this is possible only if the victim was in a position to put up a fight; it would be futile to search for such evidence if the victim had

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changed her clothing after the incident, or was unable to resist because of fear, fraud, impersonation, unsoundness of mind, etc. Today, most courts go by the oral evidence of the victim together with scientific evidence of sexual intercourse.

- The acclaimed Hindi film '**Pink**' reinforced the importance of a woman's explicit consent for any sexual act to make it legitimate, and also the importance of respecting a woman's unwillingness to have sex (Fig 21.1). The film clarifies that all that a woman needs to convey with regard to unwillingness is just to say "No". The most powerful dialogue in the film comes in the form of lead actor **Amitabh Bachchan's** baritone voice intoning towards the end of the film: "No is not just a word ... it's a sentence by itself ... it doesn't need any explanation or interpretation ... ***no*** *simply means* ***no***."

| Fig. 21.1 Film Poster of Pink |

- **Fourthly,** Sec. 375 explains that **mere penetration** (even up to the vulva) is sufficient to constitute the offence of rape – neither injury to the external genitalia, nor rupture of the hymen, nor penetration into the vagina, nor seminal emission is essential. Similarly, the inability to achieve or sustain erection does not preclude the inability to commit rape, and the presence of abrasions, and absence of a uniform layer of smegma over the glans penis indicate only complete sexual intercourse, not rape. **The Criminal Law (Amendment) Act, 2013** has extended the term 'rape' to include acts in addition to vaginal penetration. The definition is broadly worded with acts like penetration of penis, or any object or any part of body to any extent, into the vagina, mouth, urethra or anus of another person or making another person do so, constitutes the offence of sexual assault. The section has also clarified that penetration means "penetration to any extent", and lack of physical resistance is immaterial for constituting an offence.

- The **punishment** for **rape** is prescribed in **Sec. 376 IPC**:
  - **Subsection 1**: For rape as described in **Sec. 375**, imprisonment for at least seven years (which may extend to ten) and liability to fine, unless the victim is his own wife and is not less than twelve years of age, in which case the maximum sentence is two years of imprisonment, or fine, or both. **The Criminal Law (Amendment) Act, 2013** however states that except in certain aggravated situations, the punishment will be imprisonment of not less than seven years, but which may extend to imprisonment for life, and shall also be liable to fine. In aggravated situations, punishment will be rigorous imprisonment for a term which shall not be less than ten years, but which may extend to imprisonment for life, and shall also be liable to fine.
  - **Subsection 2**: Deals with **custodial rape** (that committed by a police officer or a public servant on a woman in prescribed situations), **institutional rape** (by a person on the management or staff of places such as remand homes, jails, hospitals, etc.), rape of a **pregnant woman** or a **woman less than twelve years of age**, or **a victim of gang rape** (that perpetrated by "one or more of a group of persons acting in furtherance of a common intention"). All of these being considered by both law and society as more heinous offences than rape under **Sec. 375 IPC**, the minimum duration of the penalty is enhanced to ten years. **The Criminal Law (Amendment) Act, 2013** however states that in case of "**gang rape**", persons

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Box 21.1 The Mathura Case (1972) (Tukaram Vs State of Maharashtra)

Mathura, a 15-year-old Harijan orphan girl was called to the Desaigunj police station of Chandrapur district of Maharashtra, on an abduction report filed by her brother, Gama. Mathura had attempted to elope with a neighbourhood boy, Ashok, since she had fallen in love with him. During the course of investigation of the case, Mathura, along with others, was detained in police custody. When it was time for them to leave however, Mathura was asked to stay back at the police station by two constables on duty at that time: Ganpat and Tukaram. It was late at night, and there was nobody else at the police station. Ganpat forced Mathura into a toilet and raped her. Tukaram followed suit, but owing to intoxicated state did not actually accomplish the act, though he fondled and molested the helpless girl.

The next morning, Mathura narrated her harrowing tale to her brother who reported the matter to senior police officials. The two constables were arrested and a case of rape was filed against them. On trial, the Sessions Judge of Chandrapur exonerated the culprits. He held that the constable Ganpat was not guilty of rape, though he accepted the probability of sexual intercourse between Ganpat and Mathura at the police station. According to him, there was a world of difference between *sexual intercourse* and *rape*. In the present case, he was of the opinion that the offence of rape had not been proved.

Activist Seema Sakhare who took up Mathura's battle with the courts

On appeal, the Bombay High Court (Nagpur Branch) reversed the finding of the Sessions Judge, and found Ganpat guilty of rape and sentenced him to 5 years rigorous imprisonment. Tukaram was sentenced to 1 year imprisonment for molesting the girl.

Against the judgement of the Bombay High Court, the accused appealed to the Supreme Court which, on September 15, 1978, shockingly reversed the finding of the High Court. It held among other reasons, that only "fear of death or hurt" can vitiate consent for sexual intercourse, and no such finding was recorded. The court further observed that Mathura was not subjected to any fear, and that she had in all probability voluntarily consented to the act. The two constables were acquitted of all charges.

Seema Sakhare with Mathura after the Supreme Court verdict

The judgement of the Supreme Court led to vociferous debate among sections of the general public. Women's Rights Groups widely criticised the judgement, and stated that it involved sacrificing human rights of women under the law and the Constitution. Mathura was after all a young, illiterate, orphan girl from a backward community, and she was all alone in the dead of night in a police station, with two burly

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men who were supposed to uphold the law, and protect her. How could anyone expect her to put up stiff resistance in such circumstances? Public outcry led to a review petition being filed by the Maharashtra Government, but the Supreme Court dismissed it on an unrelated technical point, without going into the merits of the case.

The controversy generated by the Mathura case however served to change the existing rape law, and led to the enactment of a more stringent law (**Criminal Law Amendment Act, 1983**), which introduced the provision of a new offence (*custodial rape*), and enhanced the minimum punishment for all categories of rape.

involved regardless of their gender shall be punished with rigorous imprisonment for a term which shall not be less than twenty years, but which may extend to life, and shall pay compensation to the victim which shall be reasonable to meet the medical expenses and rehabilitation of the victim.

- Box 21.1 highlights the earlier landmark case which led to **The Criminal Law (Amendment) Act, 1983**, which in turn led to the inclusion of the specific offence of custodial rape, as well as enhancement of minimum punishment for the offence of rape in general.

- **Further, under**
  - **Sec. 376-A**, *a husband who "has sexual intercourse with his own wife, who is living separately"* while divorce proceedings are pending in court, can be punished with a maximum of two years of imprisonment, and
  - **Sec. 376-B, C & D**, *a public servant, superintendent or member of the management or staff* of any of the institutions previously listed, who has sexual intercourse with any inmate of such an institution, such sexual intercourse not amounting to *rape*, can be punished with imprisonment for a maximum duration of five years.
  - **The Criminal Law (Amendment) Act, 2013** has modified the section **376A**, which now states that if a person committing the offence of sexual assault, "inflicts an injury which causes the death of the person or causes the person to be in a persistent vegetative state, shall be punished with rigorous imprisonment for a term which shall not be less than twenty years, but which may extend to imprisonment for life, which shall mean the remainder of that person's natural life, or with death."

Recent Amendments to Laws Relating to Sexual Offences

- **The Criminal Law (Amendment) Act, 2013** provides for amendment of Indian Penal Code, Indian Evidence Act, and Code of Criminal Procedure on laws related to sexual offences. It was originally an Ordinance promulgated by the President of India on 3 February 2013, in light of the protests in the **2012 Delhi gang rape case** (Box 21.2). This new Act has expressly recognised certain acts as offences which were dealt under related laws. These new offences including **acid attack**, **sexual harassment**, **voyeurism**, and **stalking** have been incorporated into the Indian Penal Code.
  - **326A**: Whoever causes permanent or partial damage or deformity to, or burns or maims or disfigures or disables any part of the body of a person, or causes grievous hurt by **throwing acid** on that person, or by using any other means with the intention of causing such injury or hurt, shall be punished with imprisonment of not less than 10 years, but which may extend to life imprisonment, and with fine. For the purpose of this section, "acid" includes any substance which has corrosive character or burning nature.
  - **354A**: Any man who is guilty of any of the following:
    - physical contact and advances involving unwelcome and explicit sexual overtures

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Box 21.2 Delhi Gang Rape Case (2012)

The 2012 Delhi gang rape case involved a rape and fatal assault that occurred on 16 December 2012 in Munirka, a neighbourhood in South Delhi. The incident happened when a 23-year-old female physiotherapy intern (named '**Nirbhaya**' by the media which wanted to protect her identity) was beaten and gang raped in a private bus in which she was travelling with a male friend. There were six others in the bus, including the driver, all of whom raped the young girl and beat her friend. When the latter tried to intervene, he was beaten, gagged and knocked unconscious with an iron rod. The men then dragged 'Nirbhaya' to the rear of the bus, beating her with the rod and raping her while the bus driver continued to drive. Medical reports later said that she suffered serious injuries to her abdomen, intestines and genitals due to the assault, and doctors said that the damage indicated that a blunt object (suspected to be the iron rod) may have been used for penetration. That rod was later described by police as being a rusted, L-shaped implement of the type used as a wheel jack handle.

The bus route during the incident

According to police reports, the victim attempted to fight off her assailants, biting three of the attackers and leaving bite marks on the accused men. After the beatings and rape ended, the attackers threw both victims from the moving bus. Then the bus driver allegedly tried to drive the bus over the badly injured girl, but she was pulled aside by her male friend. One of the perpetrators later cleaned the vehicle to remove evidence. Police impounded it the next day.

The partially clothed victims were found on the road by a passerby at around 11 pm. The passerby called the Delhi Police, who took the couple to Safdarjung Hospital, where the girl was given emergency treatment and placed on mechanical ventilation. She was found with injury marks, including numerous bite marks, all over her body. Thirteen days after the assault, she was transferred to a hospital in Singapore for advanced treatment, but two days later she died from her injuries. The boy suffered broken limbs as a result of the vicious attack, but survived.

The bus in which the crime took place

The incident generated widespread national and international coverage and was widely condemned,

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both in India and abroad. Subsequently, public protests against the state and central governments for failing to provide adequate security for women took place in New Delhi, where thousands of protesters clashed with security forces. Similar protests took place in major cities throughout the country. Because India does not allow the press to publicize a rape victim's name, the victim has become widely known as Nirbhaya, meaning "fearless", and her life and death have come to symbolize women's struggle to end rape and the long-held practice of blaming the victim rather than the perpetrator.

Massive public protests against the crime

All the accused were arrested and charged with sexual assault and murder. One of the accused, Ram Singh, died in police custody on 11 March 2013 in the Tihar Jail. According to some published reports, the police say Ram Singh hanged himself, but defence lawyers and his family suspect he was murdered. The rest of the accused went on trial in a fast-track court; the prosecution finished presenting its evidence on 8 July 2013. A juvenile among them was convicted of rape and murder and given the maximum sentence of three years' imprisonment in a reform facility. On 10 September 2013, the four remaining adult defendants were found guilty of rape and murder and three days later were sentenced to death by hanging. On 13 March 2014, the Delhi High Court upheld the guilty verdict and the death sentences.

Clashes during the protests

As a result of the protests, in December 2012, a judicial committee was set up to study and take public suggestions for the best ways to amend laws to provide quicker investigation and prosecution of sex offenders. After considering about 80,000 suggestions, the committee submitted a report which indicated that failures on the part of the government and police were the root cause behind crimes against women. In 2013, the **Criminal Law (Amendment) Ordinance, 2013** was promulgated by President Pranab Mukherjee, several new laws were passed, and six new fast-track courts were created to hear rape cases. Critics argue that the legal system remains slow to hear and prosecute rape cases, but most agree that the case has resulted in a tremendous increase in the public discussion of crimes against women and statistics show that there has been

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an improvement in the number of women willing to file a crime report.

However, in December 2014, the two-year anniversary of the attack, the girl's father called the promises of reform unmet and said that he felt regret in that he had not been able to bring justice for his daughter and other women like her.

A BBC documentary titled **'India's Daughter'** based on the attack was telecast in the UK on 4 March 2015, but was banned from being telecast in India. A political decision that received wide condemnation around the world. On 9 March, the documentary film was screened during an event at Baruch College, New York City, which was attended by the Hollywood actress Meryl Streep and some other notable celebrities.

Main perpetrators - of the remaining two, one committed suicide in custody, while the 6th was a juvenile

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- a demand or request for sexual favours
- making sexually coloured remarks
- forcibly showing pornography
- any other unwelcome physical, verbal or non-verbal conduct of sexual nature to a woman, is guilty of the offence of '**sexual harassment**' and is punishable with imprisonment of 1-3 years, or with fine, or with both.

- 354C: Any man who watches, or captures the image of a woman engaging in a private act in circumstances where she is not expecting to be observed,or disseminates such image, shall be punished on first conviction with imprisonment of 1-3 years, and on a second or subsequent conviction, with imprisonment of 3-7 years. - **voyeurism**.
- 354D:Any man who-
  - follows a woman and contacts, or attempts to contact such woman to foster personal interaction repeatedly despite a clear indication of disinterest by such woman
  - monitors the use by a woman of the internet, email or any other form of electronic communication, commits the offence of **stalking**, and shall be punished on first conviction with imprisonment up to 3 years; and on a second or subsequent conviction, with imprisonment up to 5 years. Box 21.3 outlines a disturbing case that emphasizes the fact that a stalker can be a very dangerous person and must never be taken lightly.

- **Section 370** of **Indian Penal Code (IPC)** has been substituted with new sections, 370 and 370A which deals with trafficking of person for exploitation. If a person (a) recruits, (b) transports, (c) harbours, (d) transfers, or (e) receives a person by using threats, or force, or coercion, or abduction, or fraud, or deception, or by abuse of power, or inducement for exploitation including prostitution, slavery, forced organ removal, etc. will be punished with imprisonment ranging from at least 7 years to imprisonment for the remainder of that person's natural life depending on the number or category of persons trafficked. Employment of a trafficked person will attract penal provision as well.
- The most important change that has been made is the change in definition of rape under IPC. Although the Ordinance sought to change the word rape to sexual assault, in the Act the word 'rape' has been retained in **Section 375**, and was extended to include acts in addition to vaginal penetration. The definition is broadly worded with acts like penetration of penis, or any object or any part of body to any extent, into the vagina, urethra or anus of another person or making another person do so, while application of mouth or touching private parts constitutes the offence of sexual assault. The section has also clarified that penetration means "penetration to any extent", and lack of physical resistance is immaterial for constituting an offence. Except in certain aggravated situations the punishment will be imprisonment not less than seven years but which may extend to imprisonment for life, and shall also be liable to fine. In aggravated situations, punishment will be rigorous imprisonment for a term which shall not be less than ten years but which may extend to imprisonment for life, and shall also be liable to fine.
- A new section, **376A** has been added which states that if a person committing the offence of sexual assault, "inflicts an injury which causes the death of the person or causes the person to be in a persistent vegetative state, shall be punished with rigorous imprisonment for a term which shall not be less than twenty years, but which may extend to imprisonment for life, which shall mean the remainder of that person's natural life, or with death." In case of "gang rape", persons involved regardless of their gender shall be punished with rigorous imprisonment for a term which shall not be less than twenty years, but which may extend to life and shall pay compensation to the victim which shall be reasonable to meet the medical expenses and rehabilitation of the victim. The age of consent in India has been increased to 18 years, which means any sexual activity irrespective of

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Box 21.3 Swathi Murder Case (2016)

Swathi was a 24-year-old Indian Infosys employee who was murdered on June 24, 2016, at the Nungambakkam railway station in Chennai, Tamil Nadu, while on her way to her office. She was murdered in front of several people, with passengers remaining mute spectators. The assailant, suspected to be Ramkumar, escaped, and Swathi's body lay unattended before the police arrived and started their investigation process.

The suspect, P. Ramkumar was born in Meenakshipuram, a small village in the Tirunelveli district of Tamil Nadu. He dropped out of a government school in 2011, and received technical training in mechanical engineering in 2015, though he found difficulty receiving employment. Ramkumar and Swathi were Facebook friends, and they had previously exchanged phone numbers. A police officer stated that Ramkumar had stalked Swathi on Facebook, and monitored her movements offline. Seeking employment in the film industry and an opportunity to be closer to Swathi, he took residence in Choolaimedu, a locality of Chennai. Acquaintances characterized Ramkumar as largely solitary; some residents of Meenakshipuram said he was "friendless".

Ramkumar

On July 1, 2016, Ramkumar was arrested in Tirunelveli for the murder of Swathi. He allegedly attempted to commit suicide by slitting his throat when he was on the point of being apprehended, and was transferred to the government hospital of Tirunelveli.

During the tenure of the investigation, Ramkumar attempted suicide again on 18 September, while lodged in the Central prison. He was taken to hospital after he bit a live electrical wire, where he was declared brought dead.

presence of consent with a woman below the age of 18 will constitute **statutory rape**. The age of consent varies from country to country. For instance, it is just 14 years in some states of the USA. The **Roman Polanski** Case that created (and continues to create) international sensation concerned statutory rape which the highly acclaimed film director was alleged to have committed on a 13 year old girl in 1977 (**Box 21.4**).

- Certain changes have been introduced in the **Criminal Procedure Code (CrPC)** and **Indian Evidence Act (IEA)**; for instance, the process of recording the statement of the victim has been made more victim friendly and easy. But the two critical changes are:
  - The 'character of the victim' is now rendered totally irrelevant.
  - There is now a presumption of 'no consent' in a case where sexual intercourse is proved and the victim states in the court that she did not consent.

Medicolegal Examination of an Alleged Victim of Rape

- In the past, rape survivor examination was recommended to be done only after receiving police requisition. Today, police requisition is not mandatory for a rape survivor to seek medical examination and care. The doctor should examine such cases if the survivor reports to the hospital first without FIR. He can then inform the police accordingly as per the request of the patient.
- A survivor may come to the hospital only for treatment of the effects of assault. Under section 39 CrPC the doctor is not bound to inform such

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Box 21.4 The Never Ending Case of Roman Polanski

Roman Polanski (born 18 Aug 1933) is a renowned French-Polish film director, producer, writer, and actor. Having made films in Poland, UK, France, and USA, he is considered one of the few "truly international filmmakers". Born in Paris to Polish parents, he moved with his family back to Poland in 1937, shortly before the outbreak of World War II. He survived the Holocaust although his father was Jewish and mother of Jewish descent, and subsequently became a highly acclaimed director of both art house and commercial films.

Roman Polanski at Cannes Film Festival 2013

Polanski's first feature-length film, "Knife in the Water" (1962), made in Poland, was nominated for a United States Academy Award for Best Foreign Language Film. He has since received 5 more Oscar nominations, along with 2 BAFTAs, 4 Césars, a Golden Globe Award and the Palme d'Or of the Cannes Film Festival in France. In the United Kingdom he directed 3 films, beginning with "Repulsion" (1965). In 1968 he moved to the United States and cemented his status by directing the classic horror film "Rosemary's Baby" (1968).

In 1969, Polanski's pregnant wife, Sharon Tate, was murdered by members of a notorious gang (Manson Family) while staying at Polanski's California home. Following Tate's death, Polanski returned to Europe and spent much of his time in Paris, but did not direct another film until "Macbeth" (1971) in England. He travelled to Hollywood to direct "Chinatown" in 1974. The film was nominated for 11 Academy Awards, and was a huge critical and box-office success.

In 1977, after a photo shoot in Los Angeles, Polanski was arrested for the rape of 13-year-old Samantha Geimer and pleaded guilty to the charge of statutory rape. He was released from prison after serving 42 days and was told that the prosecutors had agreed to ask for him to be put on probation. When he learned that the judge planned to reject the plea bargain, he fled to Paris before sentencing. He publicly offered his apology to Geimer, telling her that he regretted the episode. He never returned to the U.S. In Sept 2009, he was arrested by Swiss police and later released after Swiss authorities denied a U.S. request for his extradition. In Oct 2015, after another request for extradition, a judge in Poland refused the request. Geimer herself supported the Polish decision, adding, "He said he did it, he pled guilty, he went to jail. I don't know what people want from him."

Film Poster of Chinatown

Polanski continued to make films, including "The Pianist" (2002), a World War II true story drama about a Jewish-Polish musician. The film won 3 Academy Awards including Best Director, along with numerous international awards. In 2009 he received a lifetime-achievement award from the Zurich Film Festival, and in 2011 won Best Director at the 60th Berlin International Film Festival for "Carnage". He was also awarded Best Director for "The Ghost Writer" (2010) at the 23rd European Film Awards.

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Polanski's French-language adaptation of the award-winning play "Venus in Fur" (2013), stars his wife Emmanuelle Seigner. The film is in French and is Polanski's first non-English language feature film in 40 years. The film premiered in competition at the 2013 Cannes Film Festival on 25 May 2013.

Polanski is currently preparing to direct "D", a film about the notorious Dreyfus affair in the 19th century, in which one of the few Jewish members of the French Army's general staff was wrongly convicted of passing military secrets to the German Empire and sent to Devil's Island, only to be acquitted 12 years later.

In Jan 2014, newly uncovered emails by a Los Angeles County Superior Court judge from 2008, indicated that if Polanski returned to the United States for a hearing, the conduct of the judge who had originally presided over the case might require that Polanski be freed. These emails were related to a 2008 documentary film by Marina Zenovich. In late October 2014, Polanski was questioned by prosecutors in Kraków.

On 30 Oct 2015, Polish judge Dariusz Mazur denied a request by the United States to extradite Polanski for a full trial, claiming that it would be "obviously unlawful." The Krakow prosecutor's office declined to challenge the court's ruling, agreeing that Polanski had served his punishment and did not need to face a U.S. court again. However, Poland's national justice ministry took up the appeal, arguing that sexual abuse of minors should be prosecuted regardless of the suspect's accomplishments or the length of time since the suspected crime took place. In a December 2016 decision, the Supreme Court of Poland dismissed the government's appeal, holding that the prosecutor general had failed to prove misconduct or legal error on the part of the lower court.

Poster of the Documentary Film on Polanski

In 2008, the documentary film by Marina Zenovich, "Roman Polanski: Wanted and Desired", was released in Europe and the United States where it won numerous awards. The film focuses on the judge in the case and the possible reasons why he changed his mind. It includes interviews with people involved in the case, including the victim, Geimer, and the prosecutor, Roger Gunson. Geimer said that the judge "didn't care what happened" to her or Polanski, but "was orchestrating some little show," while Gunson added, "I'm not surprised that Polanski left under those circumstances, ... it was going to be a real circus."

On 24 Jan 2017, after protests from French feminist groups, the now 83 year-old Roman Polanski decided not to preside over the Feb 2017 César awards ceremony, the French equivalent of the Academy Awards.

It appears that 40 years on after the incident, Polanski is still not free of the unsavoury case that has had a stranglehold on most part of his adult life.

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cases to the police. Informed refusal for not informing the police should however be documented. Neither the court nor the police can force a rape survivor to undergo medical examination. It has to be with her/ parental/ guardian's informed consent (depending on age).

- A physician's responsibilities in the medicolegal examination of the victim of an alleged sexual assault are both *therapeutic*, in ameliorating the physical and emotional consequences of the incident, as well as *evidentiary*, in order to facilitate the scientific investigation of the crime.
- **Written informed consent** of the victim to examination and treatment, as well as for the collection of material evidence, duly **witnessed**, must be obtained if she is over the age of **12 years**. If the victim is less than 12 years of age, or is mentally unsound, the consent of the parent or guardian must be obtained. In case an invasive procedure needs to be performed, age of consent is **18 years**. Invasive procedures include pervaginal, per speculum, per-rectal examinations. Noninvasive procedures include physical examination and evidence collection from exposed parts of the body.
- A **support person** (e.g., family member or rape counsellor) and/or a **female nurse** must be present throughout, not only to assist the examining physician (who must preferably be a female), but also to prevent allegations of sexual assault against the physician (if this happens to be a male), and to provide emotional support to the victim.
- The medicolegal examination should include complete **history, physical examination,** and **collection of material evidence** for laboratory examination, to establish the following crucial points:
  - Did sexual intercourse occur?
  - If yes, was this sexual intercourse forced on the alleged victim?
  - Was the alleged victim a virgin prior to the commission of the alleged offence?
  - If the validity of consent is the question
    - how old is the victim?
    - was she of sound or unsound mind (whether due to mental disease or intoxication) at the time of commission of the alleged offence?
  - How many assailants were there?
  - Is it possible to identify the assailant from material evidence gathered?
  - Are there any sequelae of the alleged offence (e.g., sexually transmitted disease, pregnancy or psychological trauma)?
  - How much time has elapsed between commission of the alleged offence and medicolegal examination?

The History

- The purpose of the history (which includes a general medical history, a sexual history, and a history of the incident) is to gather information that will help the medical and legal management of the case.

General Medical History

- Past medical history of injury or illness (particularly disorders which may have an adverse effect on the alleged victim, e.g., bleeding disorders).
- Is the victim on any medication?

Sexual History

- Has the victim attained menarche?
- If yes, what is the frequency and regularity of menstruation?
- Has the victim been sterilized, or does she use any contraceptives?
- Marital and obstetric history (where applicable):
  - Number of pregnancies, and the result of each.
  - Most recent consensual sexual intercourse.
  - Existence and onset of any symptoms or signs of pregnancy.
  - Patient's attitude to pregnancy and its prevention or termination by therapeutic measures.
  - Past history of venereal disease:
    - Whether treated or not, and if yes, where and when, and whether blood titres returned to normal.

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History of the Incident

- Time and location of the alleged assault
- Specific nature of the alleged assault
- Whether penetration was vaginal, oral, or anal
- Whether penetration was accomplished/attempted with penis, finger, any other object
- Whether she experienced pain at the time of the incident or subsequently
- Whether or not body fluids were left in/on the victim
- Whether or not instruments and/or restraints were used
- Number of assailants, and their physical description if she is able to recall such information
- Whether she resisted–in which manner?
- Was there use of condom and/or foam or jelly or lubricant?
- Whether or not there were any activities which could possibly interfere with the collection of material evidence (change of clothing, bathing, douching, urinating, defaecating, etc).

The Examination

- It must be conducted gently, but firmly, in the presence of a female nurse, explained step by step after ensuring total privacy, and thorough enough to note any abnormalities resulting from the sexual assault.

General Examination **(Fig. 21.2)**

- Take the victim's (or that of the parent/guardian) written informed consent.
- Assess and record the victim's general appearance (disarrangement or damage to, or any stains on clothing; demeanour of the victim, signs of emotional distress, gait, etc).
- Record vital parameters (blood pressure, pulse, temperature, and respiration).
- Record at least two marks of identification.
- Request the victim to stand on a large clean white sheet of paper, and to undress herself, and collect any material that falls onto the paper in the process.
- Examine the fingernails for any damage, and for any material which may have accumulated under them **(Fig. 21.3)**, which must be scraped off into cellophane packets (to be sealed, labeled and forwarded to the Forensic Science Laboratory for examination).
- Record the presence of fresh/dried stains of blood, semen, dirt, mud, grass, etc., on the surface of the body; these too, must be swabbed/scraped off into appropriate containers, sealed, labeled, and despatched to the Forensic Science Laboratory.
- Carefully examine and meticulously record external injuries (signs of restraint, bite marks, scratches, contusions, etc.).
- Follow-up examination for injuries: If there are deep bruises or contusions, signs of injury will usually show only after 48 hours. Therefore it is mandatory to repeat the examination of the survivor for recording the appearance of bruises. Bite marks may not be obvious immediately following an assault, but may become more apparent with time.

Local (Genital) Examination **(Fig. 21.4)**

Must be performed in total privacy with the victim in the lithotomy position **(Fig. 21.5)**.

- The external genitalia and its surroundings:
  - Pubic hair:
    - Matted with blood/semen?
    - Combings for specimens of foreign hair
    - Clippings for comparison.
  - Bruising of the inner aspects of the thighs and labia.
- Internal examination – Disposable vaginal speculum may be used **(Figs. 21.6 & 21.7)**. Per vaginal or per speculum examination is not a must in the case of a child, when there is no history of penetration and no visible injuries.

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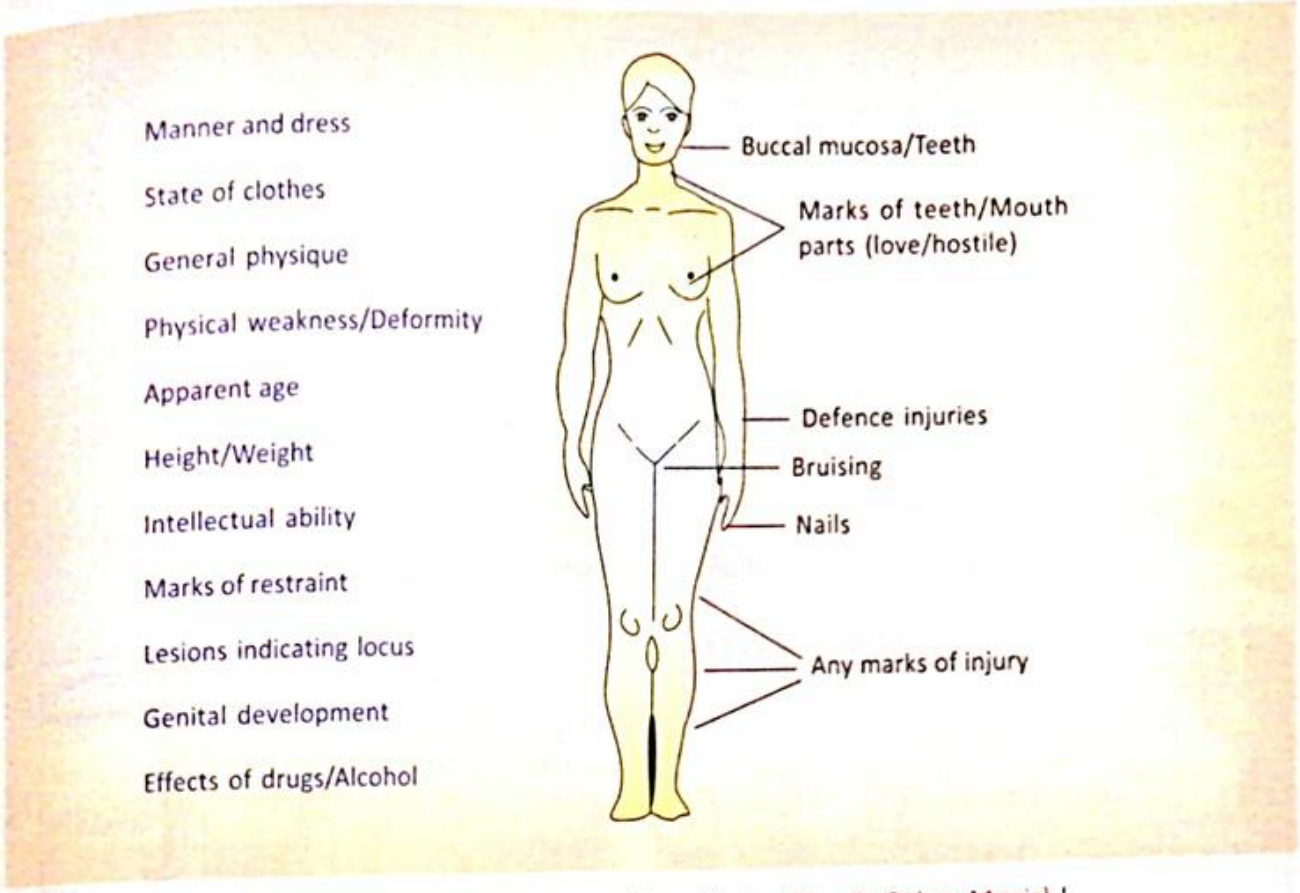

| **Fig. 21.2** General Examination of Rape Victim *(Fig : Dr Rohan Manis)* |

| **Fig. 21.3** Collecting Debris from Under Fingernails |

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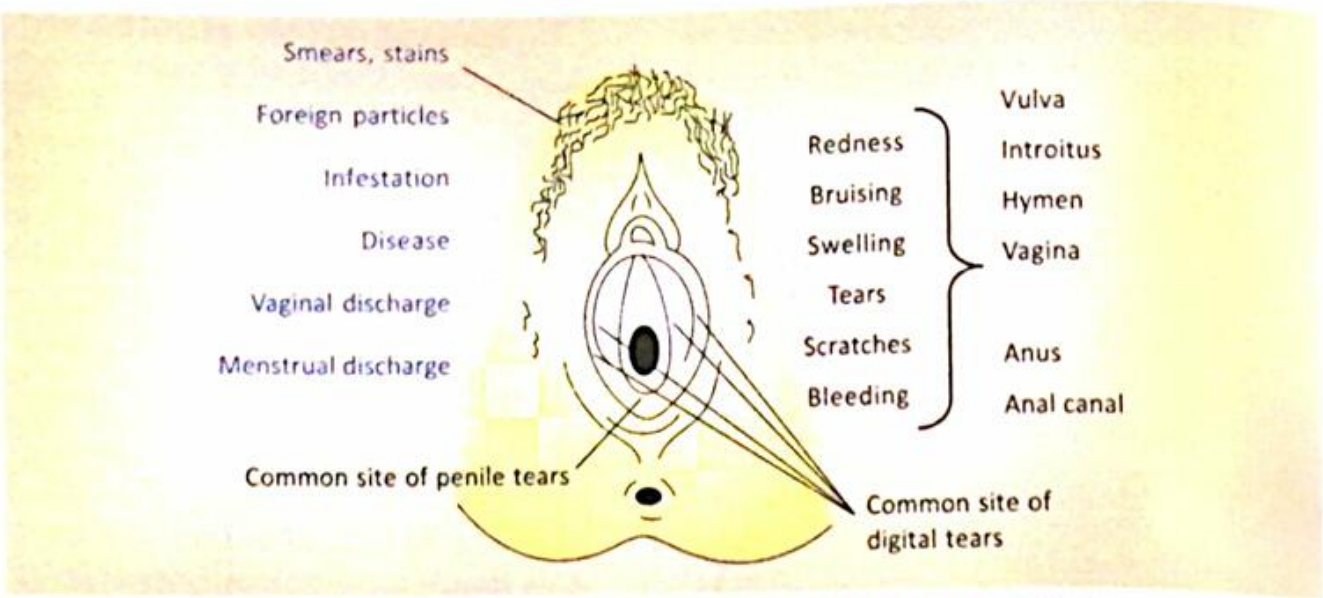
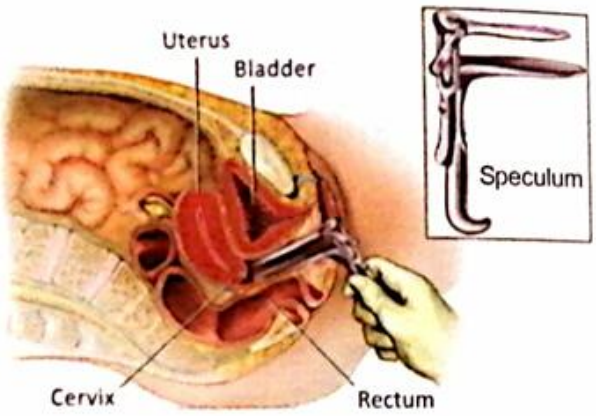


| Fig. 21.4 Local Examination of Rape Victim *(Fig : Dr Rohan Monis)* |

| Fig. 21.5 Lithotomy Position |



| Fig. 21.7 Speculum Examination |

| Fig. 21.6 Disposable Vaginal Speculum |

- In case injuries are not visible but suspected, 1 **toluidine blue dye test** may be done (*vide infra*) there is vaginal discharge, comment on the ty i.e., texture, colour, odour, etc.
  - Inspection of the introitus:
    - Is the hymen intact or ruptured (Fig. 21.
    - If ruptured, what is the site, nature and tent of damage?
    - Presence of intact hymen should be do mented but does not rule out vaginal p etration.
  - Collection of material evidence:
    - Washings from the posterior fornix, vagi swabs.

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| Fig. 21.8 Torn Hymen |

- Bimanual examination to assess the size and consistency of the uterus, signs of pre-existing pregnancy, and tenderness resulting from trauma sustained during the assault.
- **Anoscopic examination** need only be used in cases of anal bleeding, or severe anal pain, or if the presence of a foreign body in the rectum is suspected.
- **Colposcopic examination** (only when facility available) is required to be done when injuries are not appreciated by naked eye examination and when collection of photographic evidence is required.
- **Toluidine blue dye test**: Toluidine blue dye is used to assist in the identification of recent genital and perianal injuries. After the initial examination of the posterior fourchette and fossa navicularis and the collection of swabs, apply 1% aqueous solution of toluidine blue dye to the posterior fourchette and fossa navicularis. After allowing a minute for the dye uptake, remove the excess with lubricant, such as K-Y jelly or 10% acetic acid. Dye uptake is considered positive and affirms injury when there is residual blue colouring of the laceration or its border after the excess dye has been removed. Abrasions from forced cunnilingus can result in a diffuse pattern of dye uptake.
- The previously recommended **'two-finger test'** should **not** be performed in cases of sexual assault as information about past sexual conduct has been considered irrelevant to the case in several judgments (Section 146 of the **Indian Evidence Act** & deletion of Sub-section (4) of Section 155). The test itself has no scientific validity and is subjective. On the basis of such a test no doctor can conclude that a victim is habituated to sexual intercourse.

Laboratory Investigations

- All material evidence collected during the general and local examinations must enter a chain of evidence by proper sealing and labeling, with the name, case number, date and time of collection, and the name and designation of the examining physician, and despatched to the nearest Forensic Science Laboratory through the police constable concerned.
- **A checklist** of the said material evidence, for ready reference, is as follows:
  - Clothing that is torn, blood stained, or soiled.
  - Foreign debris: Hair, fibres, and fresh/ dried secretions on the surface of the body.
  - Fingernail scrapings.
  - Combings from pubic hair, and clippings of the victim's pubic hair for comparison.
- Washings from the posterior fornix and vagina, for histochemical and histological examination for the detection of the constituents of seminal fluid.
- Vaginal swabs (Fig. 21.9) for the detection of the above (Fig 21.10), and of *Mycobacterium smegmatis*, and for the presence of sexually transmitted disease (by Gram's staining and culture of secretions).

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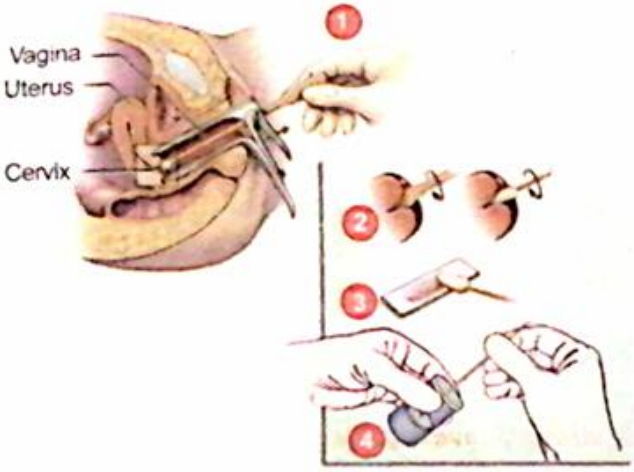

| **Fig. 21.9** Vaginal Swab from Victim |

| **Fig. 21.10** Vaginal Smear from Rape Victim - Positive for Sperms *(Pic : Dr EJ Rodrigues)* |

- Inspection of a **wet mount** slide of vaginal swabs under light microscope (for sperms): The presence of motile sperm in the vaginal pool is the best indication of recent ejaculation. The absence of motile sperm, however, does not negate the possibility of recent ejaculation as sperm may become non-motile within hours of entering the vaginal environment. Place a drop of normal saline or buffered nutrient medium on the slide to preserve the motility of the sperm. A glucose fortified solution of balanced salts, such as Ringer's, Tyrode's, or Dulbecco's at normal osmolality, pH 7.2-7.4 is recommended. Prepared solutions of media designed to enhance sperm survival during microscopic examinations are commercially available. Select one of the swabs collected from the vaginal pool and roll the swab back and forth in the drop to transfer cellular debris to the medium. Place a cover slip on the slide. Examine the wet mount slide within 5-10 min using a biological microscope at 400 power, or by using a phase contrast or other "optically staining" microscope to determine whether or not motile or non-motile sperms are present.
- Blood for grouping, baseline serology for sexually transmitted disease, and presence and levels of ethanol and/or other intoxicating agents.
- Urine for the presence and levels of ethanol and/or other intoxicating agents, and pregnancy tests.
- In addition to clinical implications, presence of ethanol and/or drugs in the patient's blood or urine or vomitus may have legal significance. The assailant may have used drugs to subdue the victim **(drug-facilitated sexual assault)**. The victim may have lost the ability to make rational decisions, or to offer resistance, or she may have lost consciousness, or may have no recollection of events. There may not be any physical or genital injuries in such cases. Drugs such as marijuana (cannabis), cocaine, methamphetamine, benzodiazepines, and gammahydroxybutyrate (GHB) can be detected through testing blood and urine samples.

The Opinion

Following opinions may be drawn as per the available findings:

a. If there are recent genital and/or physical injuries (fresh injuries) with wet vaginal/anal smear detecting spermatozoa, the opinion could be stated as 'There is evidence suggestive of recent forceful vaginal/anal intercourse."
b. If there are genital/physical injuries but no evidence of spermatozoa in the wet smear, it does

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not rule out forced penetrative sex. So the opinion should be stated as "There are signs of use of force/forceful penetration of vagina/anus, however the opinion regarding penetrative intercourse is reserved pending availability of FSL reports."

c. If there are only physical injuries and no genital injuries, and no evidence of spermatozoa in the wet smear, it does not rule out forced penetrative sex. So the opinion should be stated as "There are signs of use of force, however the opinion regarding penetrative intercourse is reserved pending availability of FSL reports."

d. If there are only genital injuries but no physical injuries, and no evidence of spermatozoa in the wet smear, it does not rule out forced penetrative sex. So the opinion should be stated as "There are signs of use of force/forceful penetration of vagina and/ or anus; however the opinion regarding penetrative intercourse is reserved pending availability of FSL reports".

e. If there is evidence of spermatozoa in the wet smear of vagina, but no physical and genital injuries then the opinion could be stated as, "There are signs of recent sexual intercourse. However opinion regarding forceful sexual intercourse will be given after the follow-up examination".

f. If there are normal exam findings, i.e., there are no physical and genital injuries, no evidence of spermatozoa in the wet smear, the opinion could be stated as "On examination, the findings are within normal limits which neither refute nor confirm forceful sexual intercourse. However, final opinion regarding penetrating intercourse is reserved pending till availability of FSL reports and opinion regarding application of force will be given after follow up examination".

Medicolegal Examination of Accused in a Case of Alleged Rape

- If the accused in a particular case of rape is produced for medicolegal examination (conducted under **Secs 53** and **54** of the **Code of Criminal Procedure**), it is preferable that the same physician who examined the victim also examines the accused, for better correlation.
- The objectives of the medicolegal examination do not differ significantly from that of the examination of the victim, except that such sequelae of the incident as signs of pregnancy must not obviously be looked for! **(Figs 21.11 and 21.12)**.
- Answers to the following questions must be sought:
  - **Did the accused take part in sexual intercourse?** This can be determined by:
    - Examination of the clothing and undergarments for recent seminal stains
    - Absence of smegma under the prepuce: smegma is a thick, cheesy secretion with a disagreeable odour, consisting of desquamated epithelial cells and smegma bacilli (*Mycobacterium smegmatis*), which is generally wiped off during sexual intercourse. However, its absence is not conclusive evidence of sexual intercourse, since during the customary daily bath, the prepuce is expected to be retracted and any accumulated smegma washed away. On the other hand, the actual presence of smegma can be taken as evidence that the person did not participate in sexual intercourse.
    - Examination of the surface of the shaft of the penis for the presence of vaginal epithelial cells: Since these have a high glycogen content, whether or not they have been transferred to the penile shaft (as per Locard's principle of exchange), can be assessed by wiping the shaft with a clean moist filter paper, which is then exposed to vapours of Lugol's iodine. A brown colour indicates a positive test (**Lugol's iodine test**).
    - Fresh/dried bloodstains, which may be from the victim, or of the accused himself from injuries sustained, such as tearing of the frenulum.
    - It must be noted that the defence often raises the plea that the accused was impotent, and, therefore, could not have committed the offence. However, since potency is the usual and normal state in man, it will

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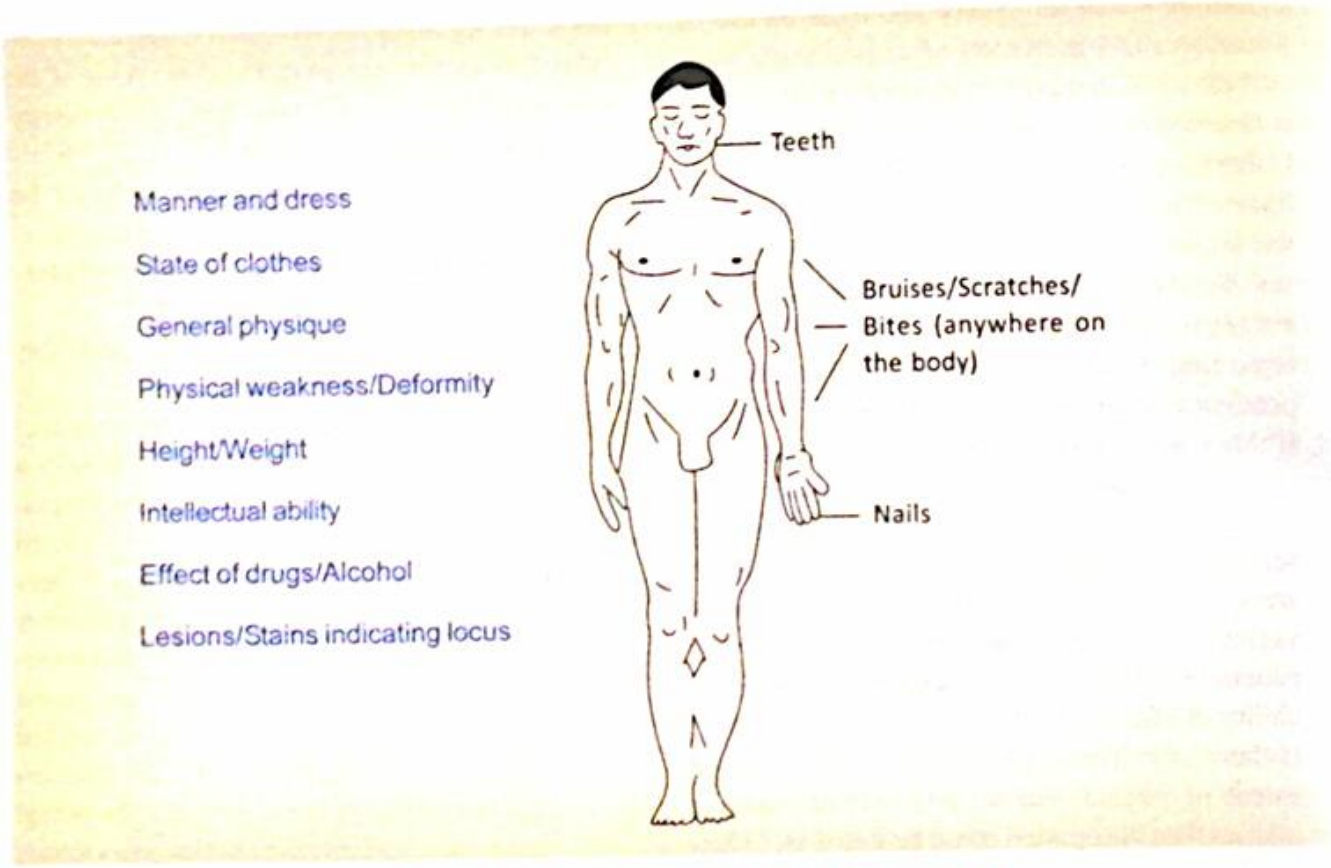
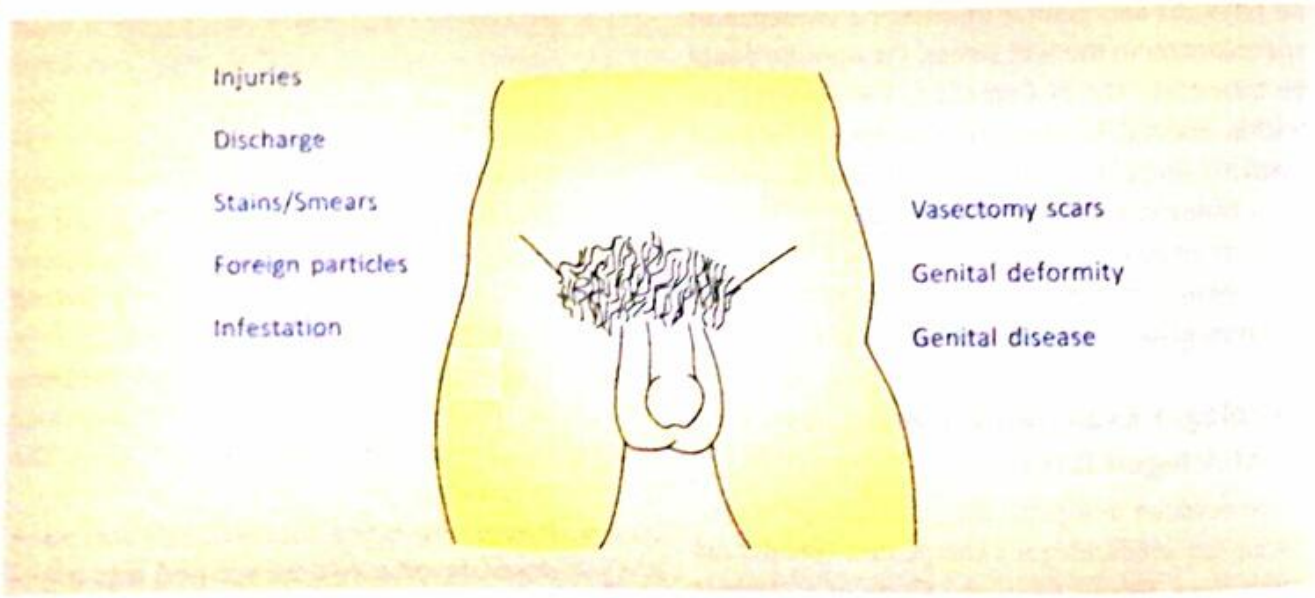


| **Fig. 21.11** General Examination of Rape Accused |



| **Fig. 21.12** Local Examination of Rape Accused *(Fig 21.11, 21.12 : Dr Rohan Monis)* |

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always be presumed to be so, unless the contrary is proved by the accused.

- **If yes, was this sexual intercourse forcible?**
  - If the victim offered resistance to the assault, or if there was considerable disproportion between the size of the genitalia of the assailant and victim, the assailant may have sustained injuries such as
  - Scratches on the face
  - Bite marks on his upper limbs or elsewhere
  - Frenular tears or grazed abrasions on the shaft of the penis, etc.
- **What was the mental status of the accused at the time of commission of the alleged offence?**
  - The answer to this question is relevant to the criminal responsibility of the accused, as determined by **Secs 84 & 85, IPC,** which do not hold a person responsible for an act if, at the time of committing it he was, by reason of unsoundness of mind or intoxication, unable to understand the nature or consequences of what he was doing, or that he was doing what was either wrong or contrary to law.
- **Was the accused suffering from any sexually transmitted disease which he may have communicated to the victim?** This can be determined by
  - Serological examination of the blood
  - Bacteriological examination of a urethral swab
- **How much time has elapsed between commission of the alleged offence and medicolegal examination?**
  - This is probably the most difficult question to answer, unless the age of injuries proven to be sustained by him during the alleged offence can be estimated with any degree of accuracy.

In conclusion, it can be stated that courts of law consider rape as "*the easiest charge to make and the most difficult to refute.*"

ADULTERY

- **Adultery** is defined as **voluntary (natural) sexual intercourse between a married man and someone other than his wife, or between a married woman and someone other than her husband**. In simpler terms, it is voluntary natural sexual intercourse between a married person and another who is not one's legally wedded spouse.
- **Fornication** (sometimes confused with adultery) refers to consensual sexual intercourse between two people not married to each other.
- **Sec. 497 IPC** states that, "*Whoever has sexual intercourse with a person whom he knows or has reason to believe to be the wife of another man, without the consent or connivance of that man, such sexual intercourse not amounting to rape, is guilty of the offence of adultery.*"
  - **Sec. 498** describes the offence of enticing, or taking away, or detaining with criminal intent, a married woman.
- Thus, as per the Indian Penal Code:
  - **Adultery** can be committed **only by a man** and not by a woman. The man is prosecutable and can be sentenced for up to five years (even if he himself was unmarried) whereas the married woman cannot be jailed.
  - The person committing adultery must know or have reason to believe that the woman with whom he has had sexual intercourse is the wife of another man.
  - The sexual intercourse should not amount to rape, i.e., intercourse must be accomplished with the consent of the woman.
  - A criminal suit of adultery can be filed only against the male adulterer, but not against the adulterous wife. The latter is not guilty of the offence; not even as an abettor! But under matrimonial law, the aggrieved husband can file for divorce.
- In Islamic countries that follow Sharia law, adultery often incurs severe punishment, usually for the woman and sometimes for the man. The punishment may include stoning to death ('*lapidation*'). There are 15 countries where stoning is

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authorized as lawful punishment, although in practice legal stoning does not occur; however instances have occurred outside the legal system (extrajudicially).

INCEST

- **Incest** is defined as **natural sexual intercourse between two persons so closely related that they are forbidden by law to marry**.
- The meaning of the expression "closely related" does, of course, differ from country to country, so that incest is punishable by legislation and constitutes a valid ground for divorce, and is prohibited by religious laws (by annulment of marriage) in many developed countries.
- However, in India and in many other Asian countries, incest is **not** a criminal offence (unless it also amounts to rape or adultery or child sexual abuse) because of the social acceptability of intracaste marriage.
- In some Western countries, incestuous relationships between consenting adults (with the age varying by location) are permitted, including in the Netherlands, France, and Spain. In Sweden, the only type of incestuous relationship allowed by law is that between half-siblings and they must seek government counseling before marriage.
- Incest most frequently occurs between members of a nuclear family, and the victims are most often children. Notable examples include:
  - Between father and daughter (e.g., the ***Electra complex***, derived from the Greek myth of Electra, who wanted her brother to avenge the death of their father by killing their mother) (Box 21.5).
  - Between mother and son (e.g., the ***Oedipus complex***, named after the Greek mythical character Oedipus, who unknowingly kills his father, and marries his mother) (Box 21.5).
  - Between brother and sister (e.g., "***Pharaonic incest***," derived from the practice in ancient Egypt in which royal brothers and sisters married each other).
- Factors promoting the perpetration of incest:
  - Marital discord leading to frequent quarrels between husband and wife, and lack of a healthy sexual relationship.
  - Overcrowding by close relatives within the same house.
  - Lack of parental supervision over children.
  - Low morality and delinquency in a family.
  - In a 1999 news story, BBC reported, "Close-knit family life in India masks an alarming amount of sexual abuse of children and teenage girls by family members, a new report suggests. Delhi organisation RAHI states that 76% of respondents to its survey had been abused when they were children - 40% of those by a family member".

UNNATURAL SEXUAL OFFENCES

- As previously mentioned, the law in India to date permits only natural sexual intercourse between a legally married man and wife.
- **Sec. 377 IPC** states that *"Whoever voluntarily has carnal intercourse against the order of nature with any man, woman, or animal shall be punished with imprisonment for life, or with imprisonment of either description for a term which may extend to ten years, and shall also be liable to fine."* This section covers all offences which have come to be clubbed under the term "Unnatural Sexual Offences."
- As with rape, penetration is sufficient to constitute the carnal intercourse necessary to prove the offence.
- A person who has both heterosexual and homosexual urges is called a **'bisexual'**.*

* *Bisexuality doubles your chances for a date on Saturday night!* – **Woody Allen** *(Hollywood comic actor, director)*

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Box 21.5 The Origins of "Oedipus" and "Electra" Complexes

Oedipus is a tragic hero in Greek mythology, accidentally fulfilling a terrible prophecy, despite his efforts not to, that he would end up killing his father and marrying his mother, thereby bringing disaster to his city and family. The story of Oedipus is the subject of Sophocles's tragedy 'Oedipus the King', which was followed by 'Oedipus at Colonus' and then 'Antigone'. Together, these plays make up Sophocles's three Theban plays. Oedipus represents two enduring themes of Greek myth and drama: the flawed nature of humanity, and an individual's role in the course of destiny in a harsh universe.

The legend of Oedipus has been retold in many versions, and was used by Sigmund Freud to name and give mythic precedent to the 'Oedipus complex'. So let us look at the travesty of the legend first, exemplified by the following 'poem', and then the actual tragic story that has been so terribly distorted.

'There once lived a man called Oedipus Rex
You must have heard about his odd complex
His name appears in Freud's index
He loved his mother, and with her had sex'

The Actual Story

By Sophocles

- Laius, ruler of Thebes is told by an oracle that his son will kill him and sleep with his wife.
- When his son Oedipus is born, Laius disables his feet and asks a slave to abandon him to wolves.
- But the slave takes pity on the boy and gives him to a shepherd from Corinth, who presents him to Polybus, the ruler of Corinth, who brings up the boy as his own.
- As Oedipus grows up he comes to know of the prophecy, and fearing that it may come true, leaves Corinth and heads for Thebes.
- On the way he gets into an argument with a charioteer and kills him and his slaves (an ancient example of road rage!).
- When Oedipus reaches Thebes he learns that the place is terrorised by a monster (Sphinx) who destroys all who cannot solve her riddle: which animal has 1 voice, but 4, 2, and 3 feet, being slowest on 3?
- Oedipus gives the correct answer: Man.
- Thebes welcomes him as a saviour, makes him ruler, gives him the hand of the wife of Laius (Jocasta). Laius had been killed earlier by some "robber" during his travels.
- Oedipus marries Jocasta, has 4 children, before he realises that actually he had killed his own father and married his own mother! The prophecy had come true.

Oedipus and the Sphinx

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- When Jocasta learns this terrible truth, she hangs herself, while Oedipus in a fit of remorse blinds himself with pins, and relinquishes his throne.

Electra is the main character in two Greek tragedies, 'Electra' by Sophocles and 'Electra' by Euripides. In Neo-Freudian psychology, the 'Electra complex', as proposed by Carl Gustav Jung, is a girl's psychosexual competition with her mother for possession of her father. In classical psychoanalytic theory, the child's identification with the same-sex parent is the successful resolution of the Electra complex and of the Oedipus complex; his and her key psychological experience to developing a mature sexual role and identity. Sigmund Freud instead proposed that girls and boys resolved their complexes differently - she via 'penis envy', he via 'castration anxiety'; and that unsuccessful resolutions might lead to neurosis and homosexuality. Hence, women and men who are fixated in the Electra and Oedipal stages of their psychosexual development might be considered "father-fixated" and "mother-fixated" as revealed when the mate (sexual partner) resembles the father or the mother.

The Actual Story

By Sophocles

- In Greek mythology, Electra was the daughter of King Agamemnon and Queen Clytemnestra.
- She was sent to Athens as a child.
- In her absence, Agamemnon was murdered by Clytemnestra's lover when he returned from the Trojan war.
- When Electra returns from Athens 8 years later, she learns of the crime and asks her brother (Orestes) to avenge their father's death.
- Orestes kills his mother and then goes mad.
- Electra marries Pylades, son of Orestes' close friend and son of king Strophius and lives happily ever after!

Electra at the Tomb of Agamemnon

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MALE HOMOSEXUALITY (SODOMY)

- **Sodomy** is a type of unnatural sexual offence which derives its name from a historical city (Sodom) mentioned in the Bible, where it was supposed to have been practiced; it denotes **homosexual penile-anal intercourse**.
  - **Heterosexual penile-anal intercourse** is called **buggery**.
- The offender in sodomy is called the ***active agent***, while the other partner (who may or may not have consented to the act) is termed the ***passive agent***.
  - If the passive agent is a child, the practice is known as **paederasty** (and is one form of paedophilia).
  - Habitual passive agents are called ***catamites*** (also *fairies*, *gays*, or *queens*, in the West); in our country, ***hijras*** (castrated males), and ***zenanas*** (male transvestites) prostitute themselves as passive agents.

Psychological Aspects and Circumstances of Commission

- Penile-anal sexual intercourse in general is viewed by psychologists as a sexual deviation (and not as an offence) that is widely prevalent because it is closest to heterosexuality in offering sexual gratification with a usually willing human subject.
- Most people are said to have subconscious or unconscious homosexual desires.
- Isolation of males from females (or vice versa), as in boarding schools, prisons, defence establishments, ships on long voyages, etc., frequently leads to temporary homosexuality.
- History reveals that sodomy enjoyed social acceptability:
  - In ancient Greece, where it was quite popular, and from where it spread to Rome, Persia and Arabia
  - In India, China and Japan, where it was alternately accepted and condemned
  - In the top echelons of Nazi society (Germany).
- Even though '**homophobia**' is today prevalent in India, and public discussion of homosexuality in India is inhibited by the fact that sexuality in any form is rarely discussed openly, attitudes towards homosexuality have shifted slightly. In particular, there have been more depictions and discussions of homosexuality in the Indian news media, and in Bollywood. While several Indian films have been made recently on the theme of homosexuality, two films that were praised for their sensitive handling of the theme were "**Aligarh**" and "**Margarita with a Straw**" (Figs 21.13 and 21.14).

| Fig. 21.13 Film Poster of Aligarh |

| Fig. 21.14 Film Poster of Margarita with a Straw |

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- Lesbian, gay, bisexual and transgender (**LGBT**) rights in India have historically and culturally been accepted under the 'Hijra' concept. India is one of the few countries in the world to legally recognize a **third gender**. Tamil Nadu was the first state to introduce a transgender (hijra/ aravani) welfare policy. According to the transgender welfare policy transgender people can access free Sex Reassignment Surgery (SRS) in the Government Hospital; free housing program; various citizenship documents; admission in government colleges with full scholarship for higher studies; alternative sources of livelihood through formation of self-help groups (for savings) and initiating income-generation programmes.
- Hijras have been legally granted voting rights as a **'third sex'** since 1994. On 15 April 2014, the Supreme Court of India declared transgender people as a socially and economically backward class entitled to reservations in education and jobs, and also directed union and state governments to frame welfare schemes for them.

Medicolegal Examination of an Alleged Victim of Sodomy/Buggery

Preliminary Particulars

- Written requisition for the examination from the police or magistrate.
- General information (name, age, sex, occupation, address of normal residence, marital status).
- Express written informed consent, duly witnessed.
- History as per that taken from a victim of alleged rape, modified according to the sex and age of the victim.
- Gait: Normal, or broadbased and painful.
- Examination of clothing for
  - Damage
  - Loose pubic hairs
  - Stains of blood/semen/lubricant/faeces.
- General physical examination, including
  - At least two marks of identification, and
  - Any injuries indicating resistance.

Local Examination (in knee-elbow position)

Victim Not Used To Sodomy/Buggery (Fig 21.15a & b)

- Pain/tenderness during examination.
- Smears of lubricant and loose foreign pubic hairs around/in the anus.
- Perianal abrasions (whose severity is dependent on the relative proportion between the size of the penis of the assailant and the anal sphincter of the victim, and are therefore most marked in children).
- Perianal bruising, and extension of injuries into the anal canal.
- Anal lacerations – Usually triangular and based at the external sphincter, with the sides extending horizontally inward, but rarely more than 2 to 3 cm, because penile penetration would have been limited by a strong contraction of the sphincter ani. These lacerations will result in bleeding onto the thighs and clothing.
- Fresh/dried semen around/in the anus, if present, should be swabbed/scraped off, appropriately packed, sealed, labeled, and sent through the accompanying police officer, to the Forensic Science Laboratory for serological and microscopic examination.
- Digital examination per anum is extremely painful.

Habitual Passive Agent

- Bloodstains are usually not observed.
- Loose foreign pubic hairs and smears of lubricant may or may not be present.
- Perianal hair is usually shaved.
- The person does not experience any pain or tenderness during examination, and the external sphincter relaxes reflexly when bimanual traction is applied to the buttocks (*lateral traction test*).
- Funnel-shaped depression of the buttocks towards the anus.
- Perianal skin may be thickened and keratinised from constant friction.

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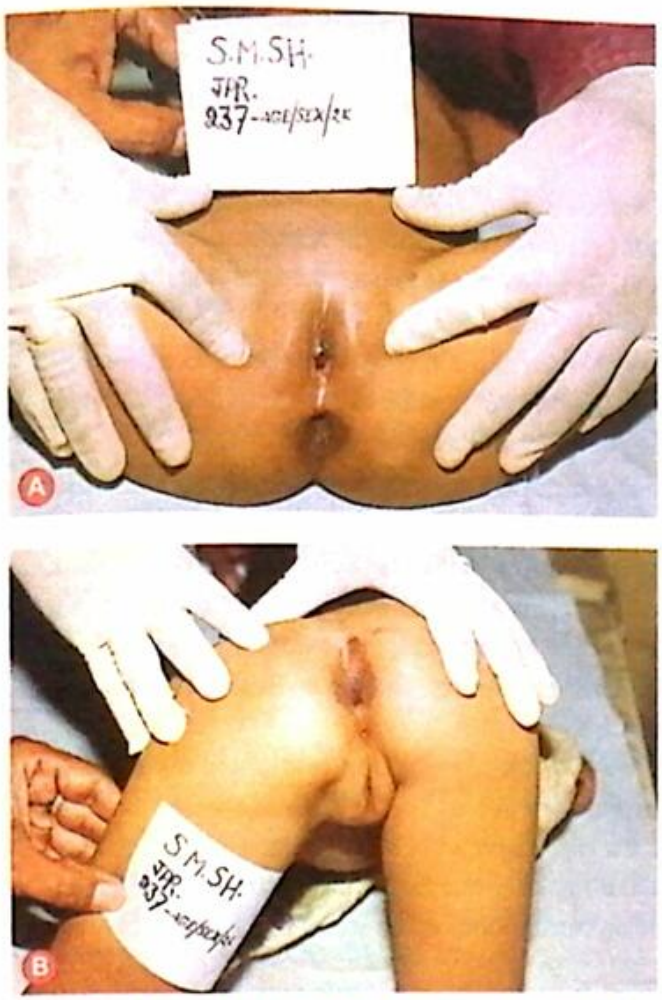

| **Fig. 21.15 a & b** A Case of Attempted Rape and Sodomy of Child *(Pics : Dr Shiv Ratan Kochar)* |

- Anus
  - Dilated and patulous
  - Loss of rugosity of mucous membrane
  - Fresh or old fissures/sinuses (tunneling)
- Rectum – Prolapse of mucosa, which is usually thickened, with disappearance of radial folds
  - Evidence of sexually transmitted disease (e.g., condylomata acuminata, chancre/chancroid, gonorrhoeal discharge, etc) may or may not be present.
  - Digital examination per rectum: Relatively painless.

Medicolegal Examination of an Alleged Assailant of Sodomy/Buggery

Examination of the alleged assailant/active agent proceeds in exactly the same manner as that of the medicolegal examination of the accused in a case of alleged rape, except that the shaft of the penis may reveal traces of faecal matter and/or lubricant instead of vaginal epithelial cells.

Medicolegal Aspects

- Penile-anal intercourse between consenting adults over 21 years of age is now legally permissible in many countries abroad, provided it is practiced in private. Such licence is still not allowed in our country *(though in July 2009, the Delhi High Court passed a judgement in a public interest litigation case that criminalizing homosexuality is against human rights and the Indian Constitution)* (Box 21.6). However, until such time that Sec. 377 is repealed or amended, the following points are still valid:
  - The consent of the passive agent is neither valid nor a defence, and the passive agent will then also be prosecuted along with the active agent.
  - The marriage contract gives implied consent only for sexual intercourse per vaginum, not per anum.
  - Under Sec. 13 of the **Hindu Marriage Act**, conviction for natural or unnatural sexual offences is valid grounds for divorce.
  - Homosexual jealousy often leads to intense emotional upheaval, and can result in suicide or homicide.

21

FEMALE HOMOSEXUALITY (LESBIANISM, SAPPHISM, TRIBADISM)

- The counterpart of sodomy as the physical manifestation of male homosexuality, **lesbianism** is the physical expression of female homosexuality.
- Typically, it involves mutual masturbation, and occasionally an active-passive relationship, by bielitoral/digital/lingual-vaginal stimulation, or the use of vibrators or artificial phalluses (*dildoes*).
- The terms '*sapphism*' and '*lesbian*' are derived respectively from **Sappho**, who was born in the Greek island **Lesbos** in the Aegean sea, and who wrote poems with powerful emotional content

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Box 21.6 Repeal of Section 377 IPC

The movement to repeal Section 377 was led by the Naz Foundation (India) Trust, an activist group, which filed a public interest litigation in the Delhi High Court in 2001, seeking legalisation of homosexual intercourse between consenting adults. In 2003, the Delhi High Court refused to consider a petition regarding the legality of the law, saying that the petitioners had no locus standi in the matter.

Naz Foundation appealed to the Supreme Court against the decision of the High Court to dismiss the petition on technical grounds. The Supreme Court decided that Naz Foundation had the standing to file a PIL in this case and sent the case back to the Delhi High Court to reconsider it on merit.

In September 2006, Nobel Laureate Amartya Sen and acclaimed writer Vikram Seth, along with other prominent Indians publicly demanded the repeal of section 377 of the IPC.

In May 2008, the Naz Foundation case came up for hearing in the Delhi High Court, but the Government was undecided on its position, with The Ministry of Home Affairs maintaining a contradictory position to that of The Ministry of Health on the issue of enforcement of Section 377 with respect to homosexuality.

On 7 November 2008, the seven-year-old petition finished hearings. The Indian Health Ministry supported this petition, while the Home Ministry opposed such a move.

Eventually, in a historic judgement delivered on 2 Jul 2009, Delhi High Court overturned the 150-year old section, legalising consensual homosexual activities between adults. The essence of the section goes against the fundamental right of human citizens, stated the High Court while striking it down. In a 105-page judgement, a bench of Chief Justice Ajit Prakash Shah and Justice S Muralidhar said that if not amended, section 377 of the IPC would violate Article 14 of the Indian constitution, which states that every citizen has equal opportunity of life and is equal before law.

However, on 11 December 2013, while responding to an appeal, the Supreme Court of India overturned that ruling and upheld the constitutionality of Section 377 of the IPC, stating that the Court was instead deferring to Indian legislators to provide the 'sought-after clarity'. In its judgment the Supreme Court stated, "We declare that Section 377 IPC, in so far as it criminalises consensual sexual acts of adults in private, is violative of Articles 21, 14 and 15 of the Constitution. The provisions of Section 377 IPC will continue to govern non-consensual penile non-vaginal sex and penile nonvaginal sex involving minors... Secondly, we clarify that our judgment will not result in the re-opening of criminal cases involving Section 377 IPC that have already attained finality." On 28 January 2014, the Supreme Court dismissed the review petition filed by Central Government, Naz Foundation and several others, against its December 11 verdict on Section 377 of IPC.

Of late, several organisations, aside from the Naz Foundation have been expressing support for decriminalizing homosexuality in India, including the National AIDS Control Organisation, Law Commission of India, Union Health Ministry, National Human Rights Commission of India, and the Planning Commission of India. There is increasing support for tolerance and social equality for the lesbian, gay, bisexual, and transgender (LGBT) community. Today, India is among only a few countries with a social element of a 'third gender'. But mental, physical, emotional and economic violence against LGBT community in India still prevails. Lacking support from family, society or police, many 'gay rape' victims do not even report such crimes.

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directed toward other women. Due to this association, Lesbos and especially the town of Eresos her birthplace, are visited frequently by lesbian tourists even today. Sappho was born sometime between 630 and 612 BC, and it is said that she died around 570 BC, but little is known for certain about her life. The bulk of her poetry, which was well-known and greatly admired through much of antiquity, has been lost; however, her immense reputation has endured through surviving fragments.

- The term *tribadism* derives from the Greek word "tribas", a "woman who practises unnatural vice with herself or with other women". In ancient Greek and Roman sexuality, a "tribas", or "tribade" was a woman or intersex individual who actively penetrated another person (male or female) through use of the clitoris or a dildo. The Greeks and Romans recognized same-sex attraction, but as any sexual act was believed to require that one of the partners be "phallic", and that therefore sexual activity between women was impossible without this feature, mythology popularly associated lesbians with either having enlarged clitorises or as incapable of enjoying sexual activity without the substitution of a phallus.
- A preferentially active lesbian, who is most often a transvestite or transsexual, is known as a *butch* or *dyke*, while the usually passive agent is called a *femme*.

Medicolegal Aspects

- In the same way as sodomy/buggery between consenting adults over 21 years of age, lesbianism is legalised under the Sexual Offences Act of England.
- However, under **Sec. 377 IPC**, it is still a criminal offence in India, although publicity and trials are rare, because
  - Consent is usually mutual.
  - Such relationships, not being socially acceptable, are carefully concealed, and
  - Physical or psychological trauma, if any, is relatively minor.
- Lesbianism is extremely difficult, if not impossible to prove, unless
  - Traces of fresh/dried saliva or buccal mucosal cells can be detected on/around the external genitalia, or
  - Injuries result from the use, or forcible introduction into the vagina, of an artificial phallus.
- Because habitually active lesbians are strongly averse to normal sexual relationships (passive agents are usually less so and, in fact, frequently bisexual), continued lesbianism is a valid ground for divorce or annulment of marriage under the Hindu Marriage Act.
- Morbid jealousies, as frequent in lesbianism as in male homosexuality, may lead to homicide, suicide, or suicide pacts.

BUCCAL COITUS (ORAL SEX)

- Also called the "sin of Gomorrah" because of the alleged prevalence of the practice in Gomorrah, the Biblical twin city of Sodom, the term denotes penile/vaginal buccal sexual intercourse, and can therefore be performed by both males and females.
  - Buccal-penile intercourse is called **fellatio**. The partner who performs the act is known as the "fellator"; the one on whom it is performed is the "fellatee."
  - Buccal-vaginal stimulation is referred to as **cunnilingus**.
- Although formerly considered as a sexual deviation/perversion, psychiatrists and psychologists now view buccal coitus as a part of normal sexual foreplay.

Medicolegal Aspects

- Provided the act is performed by mutual consent of two adults over 21 years of age, buccal coitus is also permitted by the Sexual Offences Act of England. It is however included as an unnatural sexual offence in India under **Sec. 377 IPC**.

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- Under the **Hindu Marriage Act**, insistence on buccal coitus, if it is non-consensual and repetitive, constitutes valid ground for divorce.
- The only material evidence of commission of the offence would be
  - Spermatozoa of the fellatee in the buccal cavity of the fellator
  - Fresh dried saliva or buccal mucosal cells on the penis of the fellatee, or on the external genitalia or the vulva of the subject of cunnilingus.
  - As any of these would be unobtainable under ordinary circumstances (unless the participants were caught in the act), it is generally practically impossible to prove a charge of buccal coitus in a criminal court of law.

BESTIALITY

- As the name itself suggests, this unnatural sexual offence involves sexual intercourse with a lower animal.
- The animals usually selected
  - **By males** include cows, mares, bitches, female sheep/goats/donkeys and large birds.
  - **By females** (although bestiality in this sex is far less common) include bulls, horses, dogs, and male sheep/goats/donkeys.
- Just as any animal may be used by a male, so also sexual intercourse may be effected through any of its natural orifices, i.e., the vagina or anus.
- In our country, bestiality has been depicted in erotic sculpture, and in the Kama Sutra. Abroad, Greek and Roman mythology, and the literature and rituals of Satanism and Voodoo abound with descriptions of, and references to, bestiality.

Psychological Aspects and Circumstances of Commission

- Of all the unnatural sexual offences, bestiality is the least common.
- It is characteristically the act of an isolated, simpleminded, aberrant farmworker, who is the object of ridicule and/or ill treatment by his fellow men, or by women (in which case he feels frightened and incapable of approaching the opposite sex). He then overcomes his rejection and humiliation by sexual intercourse with an available and usually compliant animal companion. An element of revenge, if present, is usually manifested as sadism (*vide infra*).
- Bestiality may also be the product of a superstition among some ignorant males that sexual intercourse with a female donkey cures gonorrhoea!

Medicolegal Aspects

- Bestiality is a criminal offence worldwide. It is a valid ground for annulment of marriage.
- The offence is difficult to prove (unless the accused is caught in the act), not the least because one of the parties is incapable of expression.
- The following general findings may be observed on medicolegal examination of the accused:
  - Young adult male, usually mentally challenged.
  - Injuries inflicted by the animal, if it resisted the act by kicking and/or biting.
  - Hair/feathers and/or bloodstains of the animal on the clothing or person of the accused.
- Human seminal stains may be present in or around the genitalia of the animal.

SEXUAL PARAPHILIAS (Formerly: SEXUAL DEVIATIONS, PERVERSIONS)

My own belief is that there is hardly anyone whose sexual life, if it were broadcast, would not fill the world at large with surprise and horror.

—W Somerset Maugham
(1874-1965; British author and playwright)

- These conditions together form one of the groups of psychosexual disorders, characterized **by the achievement of sexual gratification by means other than natural sexual intercourse**. The term "**paraphilia**" emphasizes the unusual quality or nature of the object of an individual's sexual interest.
- The latest edition of Diagnostic and Statistical Manual of Mental Disorders (DSM-V, 2013) states that "paraphilias are not ipso facto

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psychiatric disorders", and defines **paraphilic disorder** as a condition associated with unusual sexual desires that cause distress or impairment to the individual, or harm to others.

Main Categories

1. Fetishism
2. Transvestism
3. Sadism and masochism
4. Voyeurism
5. Exhibitionism
6. Paedophilia
7. Miscellaneous disorders (e.g., necrophilia, necrophagia, etc.)

FETISHISM (FETICHISM)

- The essential feature of this condition is the sexual focus on parts of the body not normally associated with sexual arousal (e.g., hair, foot, toes, etc), or on inanimate objects intimately associated with the human body (handbag, glove, underwear, shoe/slipper, etc).
- Sexual activity may be directed toward the fetish itself, or may be part of sexual intercourse, and the preferred fetish or class of fetishes is usually constant over a period of time.
- In one review of 48 cases of fetishism, fetishes included clothing (58.3%), rubber and rubber items (22.9%), footwear (14.6%), body parts (14.6%), leather (10.4%), and soft materials or fabrics (6.3%).
- Fetishism does not ordinarily contravene law, unless
  - The constant search for a particular fetish leads to theft or mischief.
  - Repeated insistence on the use of fetishes by a non-consenting spouse is cited by him/her as grounds for divorce.

TRANSVESTISM

- Also called "**cross-dressing**" or **Eonism**, after the **Chevalier d'Eon de Beaumont** (1728–1810), a noted practitioner who was a French diplomat; he lived the latter part of his life dressed constantly as a female) (Fig. 21.16).

| Fig. 21.16 Chevalier D'Eon de Beaumont |

- It is defined as fantasised or actual dressing in the clothing of the opposite sex, for the purposes of sexual arousal, and as an adjunct to masturbation or sexual intercourse.
- The following points must be noted:
  - Male preponderance.
  - Commencement of the transvestic syndrome at around puberty (but frank dressing in women's clothing does not begin until mobility and relative independence from parents is well established).
  - Transvestism is also seen in girls, but it seems to start later than in boys, is nowadays easily disguised because of unisex clothing, and has an uncertain outcome.
  - At first glance, **transvestism** and **transsexualism** appear to be quite similar. However, there are distinct differences between the two conditions. Until recently, transsexualism has been included as a part of transvestism but the difference lies mainly in the different degrees of desire held by the individual. Transsexualism involves a more permanent desire to be the other sex, whereas transvestism involves only the desire to dress in clothes typically worn by the other sex.
  - One of the most famous enactments as a transvestite in films is that of **Tim Curry** in the

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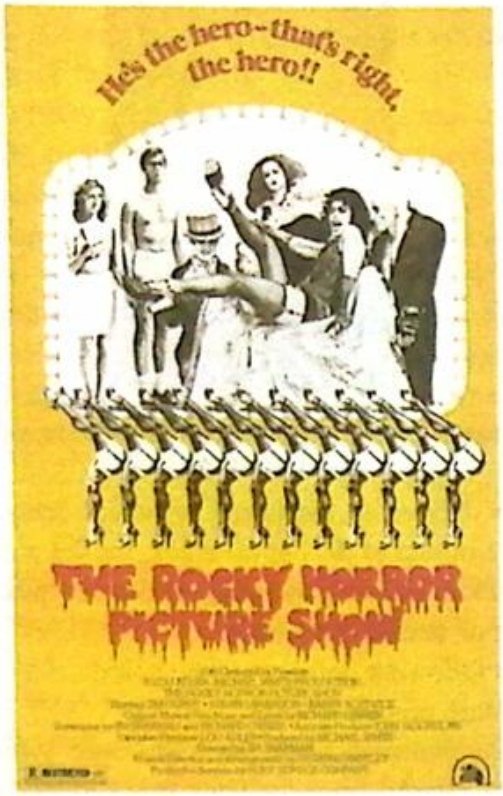
Hollywood cult classic, **'Rocky Horror Picture Show'** in which he introduces himself as a "sweet transvestite from Transsexual, Transylvania"! (Fig 21.17).



| **Fig. 21.17** Film Poster of 'The Rocky Horror Picture Show' |

- **Transgender** is the state of one's gender identity or gender expression not matching one's assigned sex. Transgender is independent of sexual orientation; transgender people may identify as heterosexual, homosexual, bisexual, etc.
- **Gender dysphoria** or **gender identity disorder (GID)** is the dysphoria (distress) a person experiences as a result of the sex and gender they were assigned at birth. In these cases, the assigned sex and gender do not match the person's gender identity, and the person is transgender. There is evidence suggesting that those who identify with a gender different from the one they were assigned at birth may do so not just due to psychological or behavioral causes, but also biological ones related to their genetics or exposure to hormones before birth.
- **'Drag'** is a term that is used to refer to the clothing associated with one gender when worn by a person of another gender. **'Drag queen'** refers to a gay man who dresses in drag, either as part of a performance or for personal fulfillment.* Though a good portion who wear women's clothing are straight men, the term 'drag queen' distinguishes them from transvestites, transsexuals or transgender people. Doing drag here often includes wearing dramatically heavy makeup, wigs and prosthetic devices as part of the costume. While some male music celebrities wear exaggerated feminine clothing as part of their show, they are not necessarily drag queens. A famous exception is **Freddie Mercury** of the legendary rock band **'Queen'** who sometimes dressed in drag for his stage performances and music videos (e.g., 'I Want to Break Free') (Fig 21.18), and was also a well known homosexual. Females who dress in drag are called **'drag kings'**.

| **Fig. 21.18** Freddie Mercury in the Music Video – 'I Want to Break Free' |

**If horse racing is the sport of kings, then drag racing must be the sport of queens!*
—**Bert R Sugar** (1937-2012; boxing writer and sports historian)

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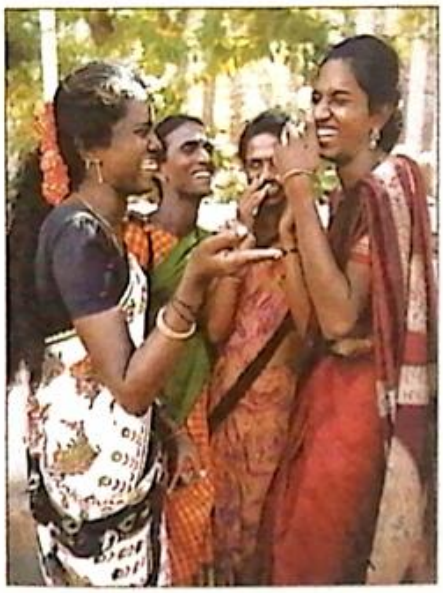
- **Medicolegal Aspects**
  - Transvestite behaviour (both by males and females) was until the 1960s seen as an expression of homosexuality or suppressed homosexual impulses. However, it is known today that most homosexuals are not tranvestites. Transvestites are generally heterosexual males who wear traditionally feminine clothing as a form of sexual arousal. They distance themselves strictly from both homosexuals and transsexuals, and usually also deny any fetishistic intentions.
  - Transvestism does not cause any problems if it is practiced privately. A male transvestite who flaunts himself in public may be considered to disturb the peace by so doing. In our country, long accustomed to male transvestism under such circumstances as religious festivals and Ramlila performances, and used to the presence of **hijras** and **zenanas** (Fig. 21.19), it is unlikely to deserve a second glance. It is important to note however that "hijras" are actually transsexuals and not really transvestites, while the term "zenana" refers to an effeminate male who takes on a female gender role in same-sex relationships. Today, hijras are officially recognized as **third gender** by the Govt of India after the landmark Supreme Court verdict in April 2014.



| Fig. 21.19 Hijras |

  - However, if a male spouse persistently indulges in transvestism, even in private, and refuses to participate in normal sexual intercourse, it would obviously constitute a ground for divorce, or even annulment of marriage.

SADISM AND MASOCHISM

- These represent two opposite and separate aspects of the self, i.e., the active and passive poles of a subjugation-humiliation axis.
- The term **sadism**, derived from **Marquis de Sade** (1740–1814) a French novelist (Fig. 21.20), is applied to **sexual arousal and orgasm linked to the active infliction, in fantasy or reality, of humiliation, subjugation, or torture of the sexual partner**. Many of Marquis de Sade's books, including *Justine* (1791) (Fig. 21.21), *Juliette* (1797) and *The 120 Days of Sodom* (published posthumously in 1905), are written from a cruelly sexual viewpoint.
- The term **masochism** is named after **Leopold von Sacher-Masoch** (1836–1895) (Fig. 21.22), an Austrian writer and journalist, who enjoyed being humiliated and subjugated by women. It is the direct reciprocal of sadism, and is defined as **sexual excitement linked with the passive experience of physical or emotional humiliation, subjugation, torture or danger**.

| Fig. 21.20 Marquis de Sade |

- Both are included under a broader entity often referred to as **BDSM**, which is a compound

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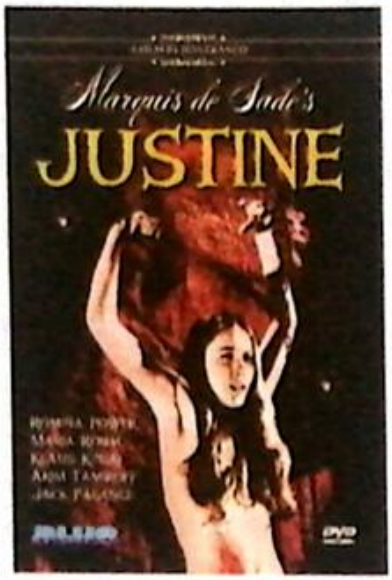
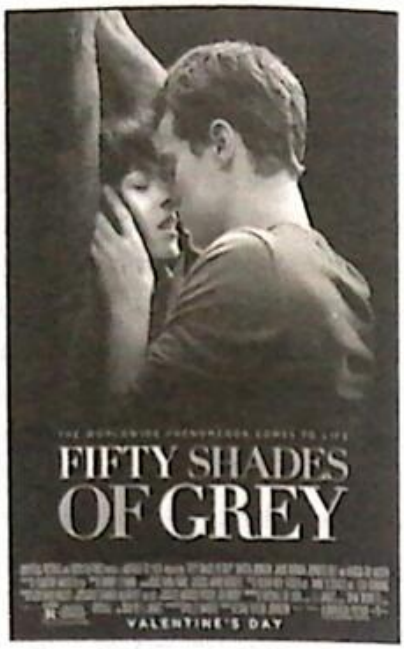
acronym derived from the terms **b**ondage and **d**iscipline; **d**ominance and **s**ubmission; **s**adism and **m**asochism. BDSM is not a form of sexual abuse – although some BDSM activities may appear to be violent or coercive, such activities are conducted with the consent of all partners involved. A recent novel that was later adapted as a film which created quite a sensation is "**Fifty Shades of Grey**" (it was of course never released in India!) (Fig 21.23).



| Fig. 21.21 Poster of a Film Adaptation of Justine by Marquis de Sade |

| Fig. 21.22 Leopold von Sacher-Masoch |



| Fig. 21.23 Film Poster of Fifty Shades of Grey |

- Neither sadism nor masochism is exclusively male or exclusively female, but sadistic practices are more common among men, and masochistic practices are more frequently observed in women.

Medicolegal Aspects

- Prevalence figures of both sadism and masochism are underestimated, because the acts are usually by mutual consent, and therefore are not reported.
- Masochism comes to medical and legal attention when the degree of tolerable suffering is unknowingly exceeded, with tragic results.
- A sadist may be sought by law enforcement personnel only in cases of brutality, marital cruelty, rape, or **lust murder** (i.e., homicide committed in the pursuit of sexual arousal and orgasm).
- Some serial killers are sexual sadists by nature.

VOYEURISM

- **Voyeurism** (which is almost exclusively seen in males) refers to the repetitive seeking out of situations in which unsuspecting women might be observed when they are grooming themselves, undressing, bathing, or copulating.

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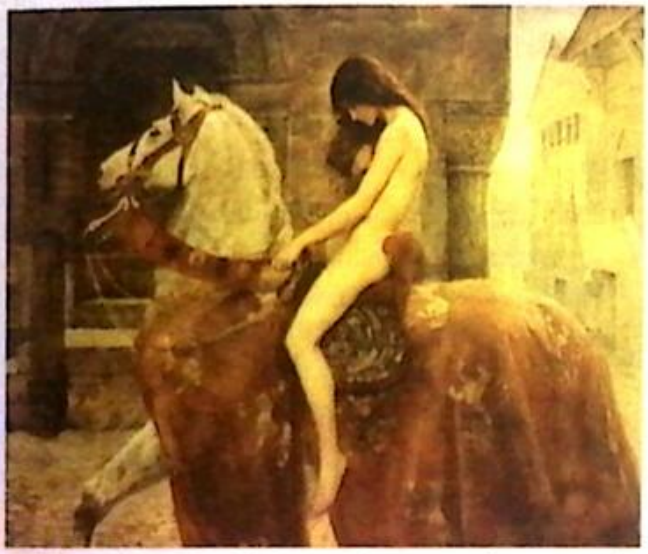
- A male voyeur is sometimes referred to as a **Peeping Tom** (named after a person who, in the legend of Lady Godiva* (Fig. 21.24), watched her during her naked ride on horseback, and was struck blind).
- **Voyeurism** can take several forms, but its principal characteristic is that the voyeur does not normally relate directly with the subject of his or her interest, who is often unaware of being observed. The voyeur may observe the subject from a distance, or use stealth to observe the subject with the use of two-way mirrors, camera, videos, etc. Today, mobile phones (which are invariably fitted with cameras) are commonly misused for this purpose. The diagnosis of "voyeurism" does not apply to people who experience sexual arousal simply by seeing nudity or sexual activity. The aspect of spying is central to paraphilic voyeurism.



- Voyeurism has high prevalence rates in most studied populations. Research shows that up to 65% of men engage in peeping, which suggests that this behaviour is widely spread throughout the population.
- Voyeurs usually do not come in conflict with the law, unless they are caught in the act of spying. They are more often considered to be a public nuisance than a social menace. However, some voyeurs gradually become bolder and may venture into exhibitionism.
- In 2013, Indian Parliament made amendments to the Indian Penal Code, introducing voyeurism as a criminal offence. As per **Section 354C**, a man committing the offence of voyeurism would be liable for imprisonment not less than one year, and which may extend up to three years for the first offence, and shall also be liable to fine, and for any subsequent conviction would be liable for imprisonment for not less than three years, and which may extend up to seven years and with fine.
- Some voyeurs become paedophiles.

21

EXHIBITIONISM

- **Exhibitionism** refers to sexual gratification obtained by repeated acts of exposing one's genitals to a stranger or unsuspecting person (usually of the opposite sex).
  - **Flashing** is the display of bare breasts by a woman with an up-and-down lifting of the shirt, blouse, or bra, or a man exposing his genitals.
  - **Mooning** is the display of one's bare buttocks by pulling down trousers and underwear.
    - In either case, there may not be any sexual connotation, but may be merely an attention-getting gambit. Mooning is sometimes resorted to as an offensive gesture.
  - **Streaking** is the act of taking off one's clothes and running naked through a public place. It is purely an attention-seeking gambit, and almost never has sexual connotations.
- **Telephone scatalogia (obscene phone call)** is a form of exhibitionism.

**Lady Godiva was an 11th century Anglo-Saxon noblewoman who, according to legend, rode naked through the streets of Coventry, in England, in order to force her husband to reduce the oppressive taxation imposed by him on his townspeople. All the people stayed indoors with their doors and windows shuttered as a mark of respect, except the tailor "Tom" who could not resist peeping from his window as Lady Godiva rode past.*

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- In psychiatry, exhibitionism is only considered a paraphilia once the practice begins to interfere with the quality of life or normal functioning capacity of the individual.
- Because of the tendency for repeated exposure, true exhibitionists (who do it for sexual gratification) sooner or later get arrested and charged with the offence of "indecent exposure" under **Sec 294 IPC**.
- Like voyeurism, exhibitionism can lead to paedophilia, as in many cases, the victim is a child.

PAEDOPHILIA (CHILD SEXUAL ABUSE)

- **Paedophilia** (or **pedophilia**) is generally defined as a psychological disorder in which an adult experiences a sexual preference for prepubescent children.
- In law enforcement, the term "paedophile" is generally used to describe those accused or convicted of the sexual abuse of a minor (including both prepubescent children and adolescent minors younger than the local age of consent). Most paedophiles are men, though there are also women who have paedophilic tendencies.
- Paedophilic crimes may be perpetrated within a family (amounting to **incest**), or among acquaintance groups, or by strangers. In all cases, the offence is punishable, under **Sec. 376, IPC**, if the victim is a female, or **Sec. 377, IPC**, if male.
- **Child sexual abuse** includes a variety of sexual offences, including:
  - **Sexual assault** – a term defining offences in which an adult touches a minor for the purpose of sexual gratification; for example, rape (including sodomy), and sexual penetration with an object.
  - **Sexual molestation** – a term defining offences in which an adult engages in non-penetrative activity with a minor for the purpose of sexual gratification; for example, exposing a minor to pornography or to the sexual acts of others.
  - **Sexual exploitation** – a term defining offences in which an adult victimizes a minor for sexual gratification or profit; for example, prostituting a child, and creating or trafficking in child pornography.
  - **Sexual grooming** – defines the social conduct of a potential child sex offender who seeks to make a minor more accepting of their advances, for example in an online chat room.
- Aggression and sadism are inherent components of paedophilia. These may be subconscious, under control, or open. Only a few paedophilic encounters result in injuries and/or death, but a victim may be badly beaten, or killed, if the assailant is a cold-blooded killer or a lust murderer, or panics after the act.
- The effects of child sexual abuse include depression, post-traumatic stress disorder, anxiety, and physical injury to the child, among other problems such as transmission of venereal disease.

Indian Scenario

- In 2007 the Ministry of Women and Child Development published the "Study on Child Abuse: India 2007." It sampled nearly 15000 children and minors across 13 states. The study looked at different forms of child abuse: physical abuse, sexual abuse and emotional abuse in five evidence groups, namely, children in a family environment, children in school, children at work, children on the street and children in institutions. The study's main findings included:
  - 53% of children reported having faced sexual abuse.
    - Among them 53% were boys & 47% girls.
  - Andhra Pradesh, Assam, Bihar and Delhi reported the highest percentage of sexual abuse among both boys and girls, as well as the highest incidence of sexual assaults.
  - 22% of child respondents faced severe forms of sexual abuse, 6% had been sexually assaulted and 51% reported other forms of sexual abuse.
  - Children on the street, at work and in institutional care reported the highest incidence of sexual assault.

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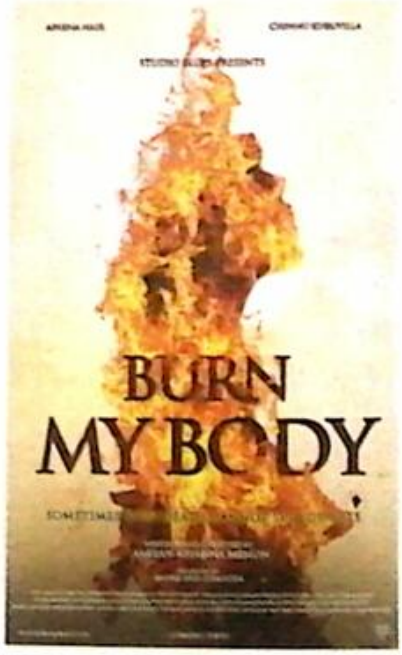
- The study also reported that 50% of abusers are known to the child, or are in a position of trust and responsibility, and most children had not reported the matter to anyone.

- The Parliament of India passed the **'Protection of Children Against Sexual Offences Act, 2012'** regarding child sexual abuse on May 22, 2012. The new Act provides for a variety of offences under which an accused can be punished.
  - It recognizes forms of penetration other than peno-vaginal penetration.
  - It criminalizes acts of immodesty against children.
  - With respect to pornography, the Act criminalizes even watching or collection of pornographic content involving children.
  - Makes abetment of child sexual abuse an offence.
  - Provides for various procedural reforms, making the tiring process of trial in India considerably easier for children.
  - The main criticism is that the Act has criminalized consensual sexual intercourse between two people below the age of 18, while previously (under the Indian Penal Code) it was 16 years.
- Goa was the first state in India that framed a law to deal with offences against children, including child trafficking: The **Goa Children's Act 2003**. This was the direct fall-out of the infamous **Freddy Peats case** (Box 21.7).

NECROPHILIA

- **Necrophilia** is a perversion in which sexual arousal and orgasm can be attained only by sexual intercourse with a corpse. A 30-minute documentary film in Malayalam was released online (on YouTube) in early 2015, dealing with a supposedly real-life series of necrophiliac offences that took place over a period of time in a hospital morgue, which caused quite a flutter among Indian netizens (Fig 21.25).
- While necrophilia is almost exclusively encountered in males, and is usually associated with psychiatric issues, an exceptional case of a female (**Jennifer Burrows**) indulging in necrophilia was reported in January 2017 from Kansas City Missouri, USA. It was subsequently proved to be **fake news** floated by the satirical news website "World News Daily".
  - **Necrophagia** is an extreme degree of necrophilia wherein the individual who is often a sadist, derives sexual gratification by mutilating the genitals or other body parts of a corpse, and eating them.
- Both acts are punishable under **Sec. 297, IPC**, (apart from other sections as applicable), which states that *"Whoever with the intention of...(offering) any indignity to any human corpse...shall be punished with imprisonment of either description for a term which may extend to one year, or with fine, or with both."*



| Fig. 21.25 Poster of Malayalam Documentary 'Burn My Body' |

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Box 21.7 The Freddy Peats Case

The issue of paedophilia gained prominence in India only after the arrest of Freddy Peats in 1991. He was charged with forcing boys into homosexual activities and for possessing drugs and pornographic material. Freddy Peats who claimed to be an Anglo-Indian, was a resident of Goa for over a decade.

Investigations, after his arrest, revealed that Peats had been operating a paedophile den where boys between 6-16 years were forced into prostitution catering mainly to German tourists. Freddy Peats, who was found in possession of 2,305 pornographic photographs, was arrested on April 3, 1991. He was granted bail within 45 days, after which he freely roamed the State till he was convicted five years later. The Sessions Court expedited the case only after Mumbai-based child rights activists filed a writ petition in the High Court in 1995 praying that the Sessions Court proceed with the trial on a daily basis. This resulted in Freddy Peats being sentenced to life imprisonment on March 21, 1996.

Of Peats' six alleged accomplices, two were extradited from France and Ireland, but only one was successfully prosecuted.

In April 2005, Freddy Peats aged 81, died due to multiple illnesses and old age at the Goa Medical College Hospital at Bambolim, Goa.

Freddy Peats at the time of his arrest

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Section IV

Forensic Science

Chapters

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CHAPTER 22

Crime Scene Investigation

Whenever man commits a crime, heaven finds a witness.
— **Edward Bulwer-Lytton** (1803–1873; English novelist and poet)

INTRODUCTION

One of the most important aspects of crime investigation, with which all doctors (especially forensic experts) must be familiar, is a detailed study of the **crime scene**.

Meaning of the Term "Crime Scene"

- In a broad sense, the crime scene includes more than the actual location where the crime was committed. It includes also other locations where evidence has been generated. For example, a person may have been murdered in one place, the body dumped in another place, and the car used to transport it may have been abandoned in yet another location. All of these are part of the crime scene and can contain important evidence.

Approach to Crime Scene Investigation

This chapter deals with the investigation of a homicide crime scene from a forensic expert's viewpoint.

- The analysis of a crime scene and subsequent collection of physical evidence requires skill, knowledge, and aptitude. The manner in which a crime scene was studied would have an important, sometimes crucial, bearing on the eventual success of the investigation. A systematic approach is necessary to ensure:
  - Harmonious coordination between crime scene officers and investigating officers.
  - Thorough and effective crime scene analysis.
  - Orderly collection of evidence.
  - Correct interpretation and deductions.

ASSESSMENT OF CRIME SCENE

- Every attempt must be made to answer the following questions during the course of crime scene investigation (Fig 22.1):

| **Fig. 22.1** Crime Scene Indicating Suicide by Poisoning *(Pic : A Nayak, FSL, Ujjain - Courtesy Dr Manish Nigam)* |

- **Who?**
  - Who is the victim?
  - Who reported the crime?
  - Who saw or heard anything?
- **What?**
  - What happened?
  - What is the nature of the crime?
  - What were the actions of the victim?

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- What do the witnesses say?
- What clothing and personal property are present on the deceased?
- What injuries or marks are present on the body?
- What is the time of death?
- What type of weapon was used?
- What could be the cause and manner of death?

- When?
  - When was the body discovered?
  - When was the victim last seen alive?
  - When was the crime reported?
- How?
  - How did the victim sustain the injuries?
  - How much time has passed between injury and death?
- Where?
  - Where is the body located?
  - Where did the death occur?
  - Where was the victim last seen?
  - Where did the injuries occur?
  - Where were the witnesses during the incident?
- Why?
  - Why was the victim at this location?
  - Why was the crime committed?
  - Why was this type of weapon used?
  - Why was the deceased found at this particular time?

Scene Security

- It is important to ensure proper security of the crime scene, and to keep curious onlookers at bay (Fig 22.2). Though this is mainly the responsibility of the investigating officer, the forensic expert must do his bit to see that no tampering or destruction of evidence occurs at the scene. The perimeter of the crime scene is taped off with **barricade tape** in order to keep only those necessary on site. Barricade tape is a brightly coloured tape (often incorporating a two-tone pattern of alternating yellow-black or red-white stripes or the words "Caution" or "Danger" in prominent lettering) (Fig 22.3). It is also known as barrier tape, caution tape, warning tape, or danger tape. The main objectives of securing a crime scene include:
  - Prevention of destruction or contamination of evidence.

| Fig. 22.2 Cordoning off a Crime Scene (Pic : Dr MB Rao) |

| Fig. 22.3 Barricade tape at a crime scene |

  - Prevention of leakage of vital information to the general public which could hinder investigation.
  - Ensuring chain of custody.
  - Ensuring proper recovery of evidence and recording of the same.
  - Removal of all unauthorized persons from the scene.

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Sequential Approach to Crime Scene Search

- It is important to conduct a search of the crime scene in a scientifically based sequential manner, so that best results are obtained and no evidence is lost or rendered useless. The following is an example of such a sequential approach:
  - Identifiable evidence should be collected from an area before it is dusted for fingerprints.
  - Bloodstains and other forensic evidence should be collected before dusting for fingerprints.
  - Polished floors need to be examined with oblique lighting to locate latent foot/shoe prints.
  - Visible hairs, fibres, etc., should be collected from an area before tape lifts, sweeping, or vacuuming.
  - Tape lift areas of interest before removing the dead body.

Specific Duties of Forensic Pathologist at the Crime Scene

- The main role of a forensic pathologist at the crime scene is to help find out the
  - *Fact that the victim is really dead:* Search for pulse, heartbeat, evidence of breathing, etc. Use stethoscope!
  - *Identity of the deceased:* Observe and record distinctive physical characteristics of the victim. Details can be recorded at the time of the autopsy.
  - *Time of death:* The following methods may help: study of livor mortis, rigor mortis, temperature of the body (use chemical thermometer and determine rectal or core body temperature), signs of decomposition, etc.
  - *Cause and manner of death:* An initial assessment can be attempted at the crime scene, which can be later verified at autopsy.
  - *Age of the victim:* A rough estimate suffices at the crime scene.
  - *Evidence of any sexual assault:* Look for disturbance or disarray of clothing, injuries around private parts, evidence of seminal emission, etc. Ensure that swabbing of stains is done.
  - *Nature of injuries:* At the crime scene, it is enough to deduce whether the injuries have resulted from the use of a blunt or sharp weapon, firearm, etc. Details can be worked out later at autopsy.
  - *Whether it is a case of poisoning:* Look for evidence of odour, frothing from the mouth, poison or drug containers lying around, etc.
  - *The best method of recording and preserving evidence relating to the death:* Careful instructions should be given to the photographer, police artist, etc., as to how best to record important findings on the body of the deceased.
- A check list of important points in relation to homicide crime scene investigation is laid out in Table 22.1.

COLLECTION, PACKING, AND DESPATCH OF EVIDENTIARY MATERIAL

Collection

- The principal methods of collection of trace material from a crime scene include
  - *Handpicking:* Gross and macroscopic items large enough to be seen visually should be recovered by hand or by the use of tweezers. As far as possible, gloves must be worn.
  - *Tape lifting:* This is an effective method of collecting material such as hairs and fibres from a variety of surfaces, especially garments and motor vehicle seats. Transparent adhesive tape of no more than 7.5 cm length is applied to the surface and then placed over a clean piece of glass or rigid plastic, which is then put inside a clean, labeled plastic bag. Care should be taken not to tape too much material on a single tape piece.

    Fingerprints can also be tape-lifted from surfaces (Fig. 22.4).
  - *Swabbing:* Dry swabs are used to collect minute particles, while swabs moistened with distilled or injection water can be used to collect body fluids.
  - *Sweeping:* This method is particularly useful for collecting material from inaccessible sites,

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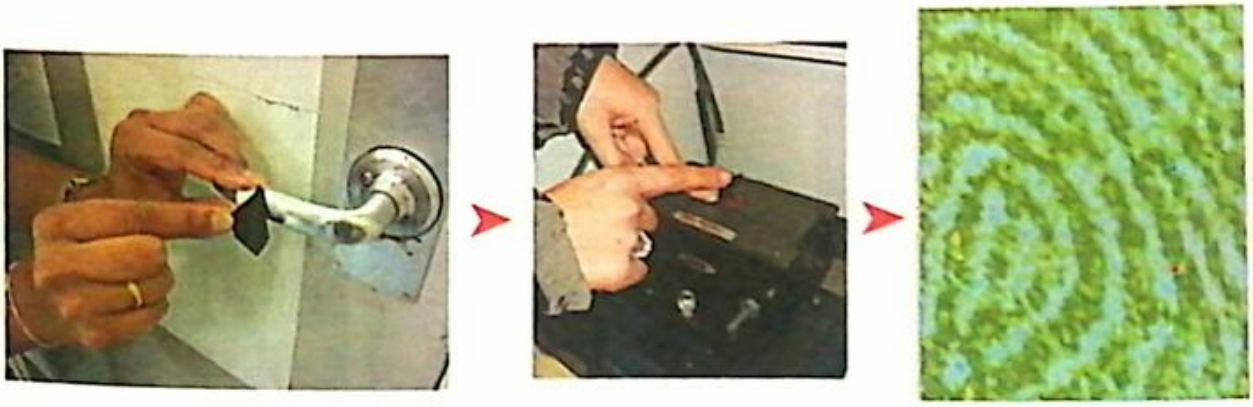
Table 22.1 Check List for Doctors at Homicide Crime Scene

- Is the victim dead or alive?
  - If alive, rush to hospital after rendering first-aid. Record dying declaration.
  - If the victim is dead, record the exact location, position of the body, signs of struggle, blood distribution pattern, etc.
- Is there any evidence of disturbance of scene?
- Record details of dress, ornaments, cash, visiting cards, letters, receipts, etc.
- Record sex, height, weight (if possible), build, approximate age, etc.
- Record distinctive features with reference to complexion, hair, eye colour, tattoo marks, etc.
- Look for discolouration of face or other body parts, peculiar odour, discharge from natural orifices, state of decomposition.
  - Collect maggots if present, for entomological study.
- Record rectal and environmental temperature.
- Observe status of livor mortis, rigor mortis.
  - Whether cadaveric spasm is present?
- Look for evidence of sexual assault. Take swabs if necessary.
- Look for evidence of poisoning:
  - Odour, frothing at the mouth, corrosion, vomitus, faecal soiling, injection marks.
  - Search for poison/drug container, tablet strips, tablets or capsules, powder, liquid, injection syringe or needle, etc.
- Look for suicide note.
- Look for evidence of gagging, binding, strangling, etc. Search for ligature material.
- Describe visible wounds on the body. Detailed description can wait till the time of autopsy.
  - Search for possible weapon.
- Collect and pack all evidentiary material as per standard procedures.

***Bapuly AK.** Reading material and check list for crime scene investigators. SVP National Police Academy, Hyderabad.*



| Fig. 22.4 Tape Lifting of a Fingerprint |

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or where there is a mass of material to be collected. The best implement for sweeping is a paintbrush approximately 2.5 cm wide. It is imperative that a clean brush is used each time.

- *Vacuuming:*
  - Collection of microscopic material from garments, motor vehicles, and other large objects is best facilitated by vacuuming.
  - Specialized nozzles (custom-made from stainless steel) must be employed.
  - Ordinary vacuum cleaners must not be used.
  - Material is collected on to a clean filter paper or cotton material resting on the perforated plate located in the central compartment.
  - When not in use, the nozzle should be cleaned and stored in a sealed plastic bag.

Packing and Despatching

Procedures for packing and despatching are the same as for any specimen in medicolegal cases. A summary is given below:

1. **Blood**
   - *On absorbent material*
     - Cut material, air dry, and pack separately.
     - Include control sample. Pack large items in paper, while small samples can be placed in plastic vials.
   - *On non-absorbent material*
     - Wet: Suck up with pipette, or soak small piece of cotton.
     - Dry: Use scalpel to scrape off the stain, or rub with moistened cotton. Include controls. Pack in plastic or glass vials.
2. **Saliva**
   - Wet: Collect on clean white gauze. Air dry and pack.
   - Dry: Use moistened swab. Pack in plastic container.
3. **Semen**
   - Stains can be photographed.
   - Items bearing seminal stains must be collected, air dried, and packed. Pack in paper bags.
4. **Paint**
   - If possible, collect the item (tool, clothing, or vehicle) containing the evidence.
   - Collect paint chips separately. Pack in folded paper inserted inside envelope, plastic bag, or plastic container.
5. **Hairs and Fibres**
   - If hairs or fibres are present on a movable item, collect the item.
   - If it is a fixed object, use plastic tweezers or adhesive tape to collect the hairs or fibres.
   - Pack in folded paper inserted inside envelope, plastic bag, or plastic container.
6. **Clothing** (Fig. 22.5 and 22.6)
   - Photograph, note, and describe.
   - Remove clothing from body over clean white paper, air dry, and pack.
   - Pack trace material from clothing separately.
   - Pack in paper bags. Each item must be placed in a separate bag.
7. **Ammunition**
   - Projectiles, cartridges, shot, or wads, must be wrapped in tissue paper or small plastic bags.

| Fig. 22.5 Protecting the Cut on the Shirt and Method of Packing *(Pic : Dr MB Rao)* |

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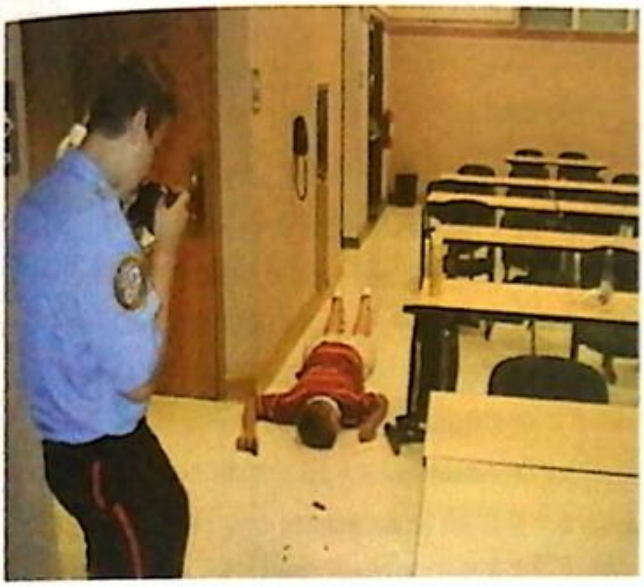
| Fig. 22.6 Packing and Sealing of Blood-Stained Cloths *(Pic : Dr MB Rao)* |



| Fig. 22.7 Crime Scene Photography – Indoors |

| Fig. 22.8 Crime Scene Photography – Outdoors |

Each item is placed in a separate plastic or cardboard container.

- It is advisable not to mark ammunition. Label the container instead.
- Wash projectiles and air dry if removed from the body. Pack each item separately in plastic or cardboard container.

8. **Cigarette butts**
   - Collect with plastic tweezers, air dry, and pack.
   - Look for trace evidence: lipstick, fingerprints, etc. Pack each butt separately in plastic or glass vials.

All packed evidentiary items must be labelled and sealed.

RECORDING EVIDENCE AT CRIME SCENE

- This can be done by
  - Photography: Must be done preferably by a police photographer. There are specialized techniques for effective indoor and outdoor photography (Figs 22.7 & 22.8).
  - Videography: Not always required.
  - Sketching: Must always be undertaken. The forensic expert at the scene can himself draw the scene, taking care to label the various components of the crime scene in relation to nearby landmarks (Fig. 22.9).

In spite of some significant advances in recent times, crime scene investigation in India is still in its infancy as compared to the meticulously professional manner in which it is conducted in most Western countries. This is illustrated well (though a little melodramatically) in the hugely popular, long running American TV series - **Crime Scene Investigation**, often abbreviated to just **CSI** (Fig 22.10). As of 2015, CSI has aired 15 seasons over 15 years. It is the seventh longest-running scripted US primetime TV series overall.

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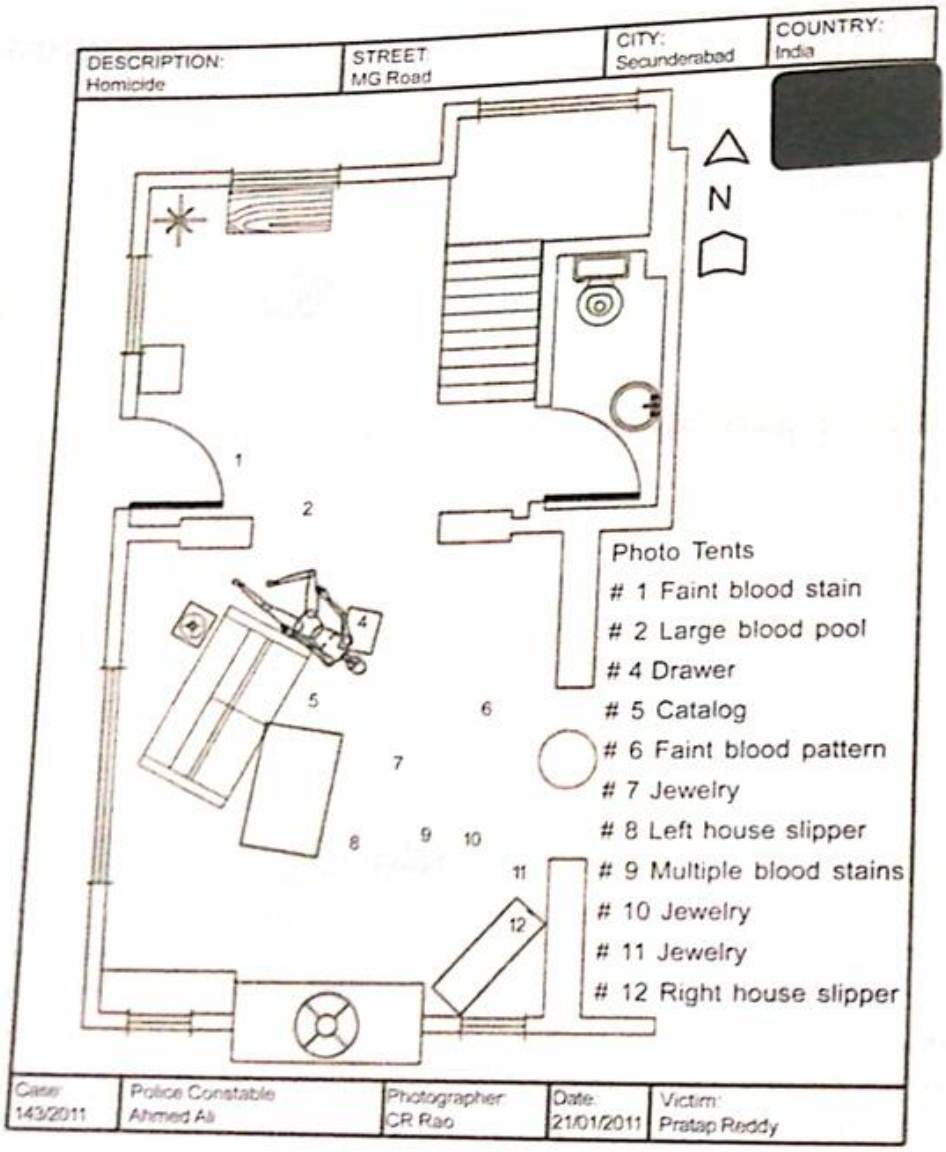
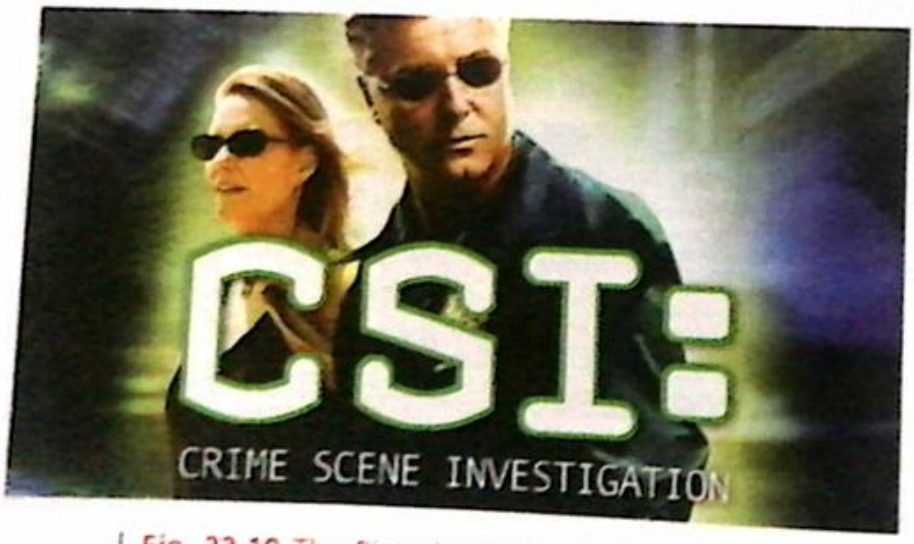


| Fig. 22.9 Example of a Crime Scene Sketch |



| Fig. 22.10 The Pictorial Ad for CSI TV Series |

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CHAPTER 23

Trace Evidence: Biological Materials

Whenever two objects come into contact with each other, there is a mutual transfer of material from one object to the other.

—**Edmond Locard** (1877–1966; French Forensic Scientist)

INTRODUCTION

- The above famous quote from an eminent expert underlines the main principle of Forensic Science, which constitutes the basis of all crime detection. It has come to be called the **Locard's Principle of Exchange**. Edmond Locard (Fig 23.1) studied medicine and law at Lyon, France, eventually becoming the assistant of Alexandre Lacassagne, a criminologist and professor. He held this post until 1910, when he began the foundation of his criminal laboratory. In 1910, Locard succeeded in persuading the Police Department of Lyon to give him two attic rooms and two assistants, to start what became the first police laboratory. He produced a monumental, seven-volume work, 'Traité de Criminalistique'.

| Fig. 23.1 Dr Edmond Locard |

- Since awareness among criminals has increased regarding scientific investigation of crime, the forensic scientist is left only with microtraces of evidence in many modern day offences. That is why in recent times, several technologically advanced instruments and methods have been developed, to detect such microtraces of evidence.
- Biological materials such as blood and other body fluids – semen, saliva, sweat, etc. – are well-known examples of trace evidence which are commonly encountered in scenes of violent crime. A clever criminal may try to clear the scene of crime in an attempt to obliterate such evidence, so much so that only microtraces may be left behind.
- The routine use of ultraviolet light can help in detecting stains of various origins such as blood, semen, saliva, pus, milk etc., as they all fluoresce under UV light. But confirmation requires the performance of sophisticated tests.

IDENTIFICATION OF BLOOD AND BLOODSTAINS

- Testing for the presence of blood is perhaps the most important step in the examination of a stain associated with a violent crime. Unless this issue is resolved, it may be futile to proceed with further analysis.
- Identification of blood is based upon the presence of blood cells or compounds characteristic of blood, such as
  - Erythrocytes (RBC) and leukocytes (WBC)

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- The same drawbacks of benzidine test also apply to this test.

5. Leucomalachite Green Test

- Same principle as the above mentioned tests.
  - The reagent is the dye leucomalachite green dissolved in water along with sodium perborate ($NaBO_3$).
  - A blue-green colour indicates a positive result.
  - The same drawbacks of benzidine test also apply to this test.

Confirmatory Tests

1. Crystal Tests (Fig. 23.5a & b)

- All the crystal tests are based upon the formation of haemoglobin-derived crystals such as haematin, haemin, haemochromogen, etc.
- **Teichmann Test (Haemin Crystal Test)**
  - When blood is heated with glacial acetic acid in the presence of a salt like NaCl, dark brown rhombic crystals are formed due to the combination of halogen with ferriprotoporphyrin.
  - Overheating, presence of rust, or any other substance which degrades haemoglobin or haematin to haematoporphyrin will interfere with crystal formation.
- **Takayama Test (Haemochromogen Crystal Test)**
  - When blood is heated with Takayama reagent (pyridine–5 mL, NaOH–5 mL, glucose–5 mL, & distilled water–16 mL), pink, rhomboidal, haemochromogen crystals are formed.
- Both these tests are highly specific for blood, and require as little as 0.001 mL of blood or 0.1 mg of haemoglobin.

2. Spectrophotometry

- Haemoglobin and its derivatives exhibit characteristic bands of absorption at specific wavelengths which can be observed by a spectrophotometer.
- Haemoglobin and its derivatives show a common absorption band at 400–425 nm (*Soret band*), apart from one or more bands at their characteristic wavelengths. Hence the presence of two or more absorption bands in the spectroscope confirms the presence of blood in the stain (Fig. 23.6).
  - Oxyhaemoglobin: Two bands between Fraunhofer lines D and E, the one nearer D being about half the width of the other.
  - Reduced haemoglobin: One broad band between D and E.
  - Carboxyhaemoglobin: Similar to oxyhaemoglobin, but remains unchanged after addition of ammonium sulfide, while the former becomes reduced haemoglobin.
  - Methaemoglobin: Similar to oxyhaemoglobin with a third band between C and D, and a fourth between E and F.

| Fig. 23.5a & b Crystal Tests for Blood (a) Haemin Crystal Test (b) Haemochromogen Crystal Test *(Pic : Dr MB Rao)* |

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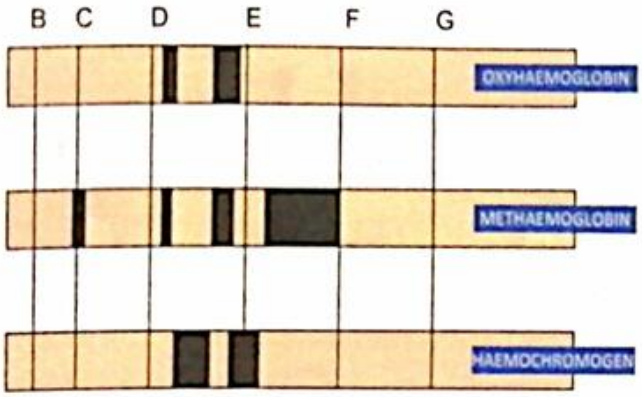
- Porphyrin compounds and their derivatives from other animal and vegetable sources may share a common band with haemoglobin and its derivatives. Hence, a single absorption spectrum should never be relied upon for confirming the presence of blood.



| Fig. 23.6 Spectroscopy of Blood: Absorption bands |

3. Electrophoresis

- Haemoglobin and its derivatives are made up of conjugated proteins and carry a specific charge, which at a particular pH, can be separated by induction of an electric field on a suitable medium like agarose gel.
- The distance travelled by each is characteristic for that particular substance, and can be detected on the gel medium by spraying any one of the common colour reagents (benzidine, leucomalachite green, etc).
- The false positives given by the colour tests are obviated in this procedure, since such substances either carry no charge, or possess a different charge other than haemoglobin and its derivatives, and hence would not be separated by electrophoresis. This makes the method a reliable confirmatory test for blood.

4. Immunoelectrophoresis

- Immunoelectrophoresis further enhances the reliability of the above method by combining immmunodiffusion with electrophoresis.
- In this procedure, the extract of the stain is subjected to electrophoresis and then the slide is placed in a well which contains antiserum.
- The antiserum diffuses into the gel, and there is migration of serum proteins towards the diffusing antiserum forming a white line of precipitation of Ag-Ab complex, whereas haemoglobin and its derivatives remain at the point of origin giving a pinkish ring around the sample well.
- The white precipitin line of Ag-Ab reaction, and the pink ring of haemoglobin or its derivatives, constitute double confirmation for the presence of blood.

5. Chromatography

- The principle of this method is the separation and migration of haemoglobin and its derivatives in a suitable stationary phase such as silica gel, alumina, etc. (or paper, in paper chromatography), with respect to a particular solvent system.
- The distance travelled by Hb and derivatives in relation to that particular solvent system (termed as the R_f value) is a highly characteristic feature aiding in their identification.
- The separated derivatives can be detected on the TLC (thin layer chromatography) plate by either UV radiation or the use of appropriate colour reagent.

Determination of Species Origin

- After identifying the stain as blood, the next step is to find out the species, as to whether it is human or animal. Many immunological tests are used to determine this. When the antigen derived from a particular species is injected into the body of another, the latter recognises it as a foreign body, and produces antibody (antiserum). This antiserum forms an antigen-antibody (Ag-Ab) complex with the antigen, both *in vivo* and *in vitro*. The white precipitin formed by the Ag-Ab complex *in vitro*, forms the basis for the following tests employed in the determination of species: Ring test, Gel diffusion, Immunoelectrophoresis, Crossed-over electrophoresis, Latex particle method. All these are grouped under the collective term **precipitin test**. Antihuman sera prepared from horses (H type), and rabbits (R type), are generally used to determine the blood of human origin. The

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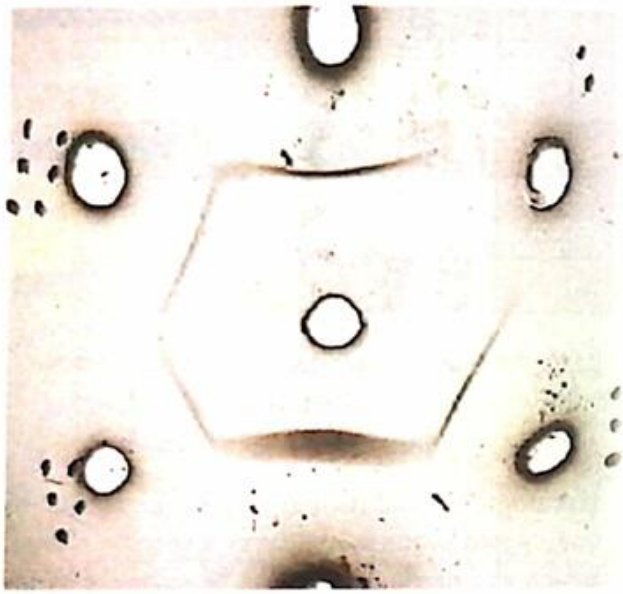
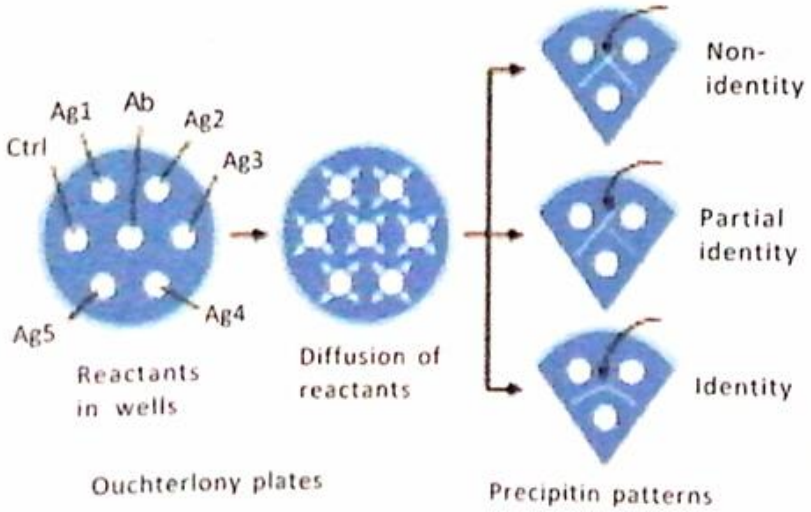
classical precipitin test is the **double gel diffusion technique of Ouchterlony** (Figs 23.7 & 23.8)

- Thomas G. Ouchterlony, a Swedish bacteriologist, developed the double immunodiffusion technique in 1948 that, when used in forensics, determines whether a bloodstain is human or animal.
- The technique involves cutting cylindrical wells into a purified preparation of agar gel in a Petri dish. The wells are filled with antibody or antigen and the dish is allowed to incubate.
- Homologous antigen and antibody diffuse toward each other from the individual wells to a point in the agar where optimum concentration of each is reached. Subsequently, a precipitin line will form within 18–24 hours somewhere between the two wells.
- If challenges are mixed together in a single well and allowed to diffuse out into the agar towards the serum test well, multiple precipitin bands are seen.
- Non-specific reactants diffuse past each other, forming no precipitate.
- However, the Ouchterlony method is rarely done today due to the time and expertise required, and the need for reagent sensitivity and selectivity validation. Today, **immunoassay tests** are used that rely on immunological principles similar to the Ouchterlony test. Results are accurate, more sensitive, and visible within ten minutes; the test apparatus is portable and simple to use, requiring no prior experience to conduct and interpret the results.



| Fig. 23.8 Double Diffusion – Positive Result |

OUCHTERLONY DOUBLE DIFFUSION



| Fig. 23.7 Ouchterlony Double Diffusion Test |

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Determination of Blood Group

- The common blood groups such as ABO, MNS and Rh systems are determined in a bloodstain by one of the following methods:
  - Latte's crust method
  - Absorption-elution technique
  - Absorption-inhibition
  - Latex method
- Whereas absorption-elution technique is suitable for small stains, the absorption-inhibition technique is less susceptible to interferences.
- The various **blood group systems** (ABO, Rh, MNS, Kell, Duffy, Lutheran, Kidd, etc.), polymorphisms exhibited by **serum proteins** (Hp, Gc, Ag, Gm^1, Gm^2, KM, etc.), and **red cell enzymes** (PGM, GPT, ADA, AK, GLO-I, etc) can help in individualising blood stains to great extent. **HLA typing** and **DNA fingerprinting** can accomplish this beyond any doubt.
- **Disputed maternity and paternity**: The blood group systems and the polymorphisms of serum proteins, red cell enzymes, and HLA and DNA typing mentioned above, are all inherited from the parents and follow Mendelian laws of inheritance. This fact enables the forensic scientist to determine the parentage of a child in disputed cases.
- Table 23.2 mentions salient principles with reference to inheritance of blood groups.

Determination of other Information from Blood or Bloodstains

Apart from being an identification marker, a bloodstain can also give information regarding the following:

Source of Blood

- Foetal blood can be distinguished from adult blood by electrophoretic determination of HbF or α-foetoprotein (AFP).
- Blood of pregnancy and abortion/parturition can be differentiated by the presence of chorionic gonadotropin (in the earlier stages), or heat-stable

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Table 23.2 Inheritance of Blood Groups

Phenotypes of Parents	Phenotypes of Children	
	Possible	Impossible
O x O	O	A, B, AB
O x A	O, A	B, AB
O x B	O, B	A, AB
O x AB	A, B	O, AB
A x A	O, A	B, AB
A x B	O, A, B, AB	None
A x AB	A, B, AB	O
B x B	O, B	A, AB
B x AB	A, B, AB	O
AB x AB	A, B, AB	O
M x M	M	N, MN
M x MN	M, MN	N
M x N	MN	M, N
MN x MN	M, N, MN	None
MN x N	N, MN	M
N x N	N	M, MN

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alkaline phosphatase (in the later stages). Detection of certain types of alkaline phosphatase and placental lactogen (from 15th week of pregnancy), would enable the identification of placental blood.

- Menstrual blood is detected on the basis of absence of fibrin content in it.
- Arterial and venous blood can be differentiated to some extent on the basis of amount of blood loss and spurting characteristics. Arterial blood loss is generally copious in nature, bright red in colour, and shows spurting due to high pressure and velocity, whereas venous blood is dark in colour, and oozes out gradually, as a result of which there is no evidence of spurting.
- Blood which has effused during life can be peeled off in scales upon drying, due to the presence of fibrin, whereas blood which has flowed after death tends to break up into a powder on drying.

Direction of Fall of Blood (Blood Spatter Analysis) (Fig. 23.9, 23.10 and 23.11)

- Modern origin of the study of blood spatter analysis began with the **Sam Sheppard case** in 1954 (Box 23.1).
- A trail of blood stains, or splashes of blood on walls or furniture may be encountered in a scene of crime. It is important to determine the height and direction of fall of blood in such cases.
  - If blood falls vertically from a relatively low height (not exceeding a few centimetres), the drops are round and sharply delineated .

| Fig. 23.9 Blood Spatter – Arterial Spurts |

| Fig. 23.10 Blood Spatter (From a Height) – Arterial Drops |

| Fig. 23.11 Blood Spatter (From a Height) – Venous Drops *(Figs 23.9 to 23.11 : Dr Manish Nigam)* |

  - If height is increased above 30 cm, the spots show prickly edges, the projections growing finer and larger in number with increase in height.
  - Splashes of blood striking a surface obliquely may appear like spears or exclamation marks, depending upon the velocity and angle of fall; the pointed end indicates the direction of motion. This is especially important in assessing the relative positions of victim and assailant.
  - A single spatter of blood is not enough to determine the '**Area of Origin**'* at a crime scene. The determination of the angles of impact and placement of the Area of Origin should be based

**The common point (area) in three-dimensional space to which the trajectories of several blood drops can be retraced.*

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Box 23.1 The Sam Sheppard Case

Sam Sheppard was an American osteopathic physician and, toward the end of his life, a professional wrestler. He was convicted in 1954 of the brutal murder of his pregnant wife, Marilyn Reese Sheppard, at their Bay Village, Ohio home (USA). He spent almost a decade in prison, mostly at the Ohio Penitentiary, before a retrial was ordered, where he was acquitted in 1966. To his death, he maintained his innocence in the murder.

On the night of July 3, 1954, Sheppard and Marilyn were entertaining neighbours at their lakefront home on Lake Erie in Bay Village, Ohio. While they were watching the movie 'Strange Holiday', Sheppard fell asleep on the daybed in the living room. Marilyn walked the neighbours out.

In the early morning hours of July 4, 1954, Marilyn Sheppard was bludgeoned to death in her bed with an unknown instrument. The bedroom was covered with blood spatter and drops of blood were found on floors throughout the house. Some items from the house, including Sam Sheppard's wristwatch, keychain and key, and fraternity ring, appeared to have been stolen. They were later found in a canvas bag in shrubbery behind the house. According to Sheppard, he was sleeping soundly on the daybed when he heard the cries from his wife. He ran upstairs where he saw a form in the bedroom and then he was knocked unconscious. When he awoke, he saw the person downstairs, chased the intruder out of the house down to the beach where they tussled and Sheppard was knocked unconscious again. He awoke with half his body in the lake.

At 5:40 AM, a neighbour received an urgent phone call from Sheppard who pleaded for him to come to his home. When the neighbour and his wife arrived, Sheppard was found shirtless and his pants were wet with a bloodstain on the knee. Authorities arrived shortly thereafter. Sheppard seemed disoriented and in shock. The family dog was not heard barking to indicate an intruder, and their son, Chip, was asleep in the adjacent bedroom during the whole ordeal.

Dr Sam Sheppard at the time of his arrest

A public inquest was held on July 22, 1954. Sheppard was declared the main suspect and his trial began in autumn 1954. Prosecutors learned during their investigation and revealed at trial that Sheppard had carried on a three-year-long extramarital affair with Susan Hayes, a nurse at the hospital where Sheppard was employed. The prosecution argued that the affair was Sheppard's motive for killing his wife.

Sheppard's attorney argued that Sheppard had severe injuries and that those injuries were inflicted by the intruder. He based his argument on the report made by a neurosurgeon who examined Sheppard and found that he had suffered a cervical concussion, nerve injury, many absent or weak reflexes (mainly on the left side of his body), and injury in the region of the second cervical vertebra in the back of the neck. The doctor stated that it was impossible to fake or simulate the missing reflex responses.

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The defense further argued that the crime scene was extremely bloody, and the only blood evidence on Sheppard was a bloodstain on his trousers. The defense attorney also argued that two of Marilyn's teeth had been broken and that the pieces had been pulled out of her mouth, suggesting she had bitten her assailant. He told the jury that Sheppard had no open wounds. Sheppard took the stand in his own defense. He testified that he had been sleeping downstairs on a daybed when he woke to his wife's screams.

Paul Kirk

But on December 21, 1954, the jury found Sheppard guilty of second-degree murder. He was sentenced to life in prison. On January 7, 1955, shortly after his conviction, Sheppard was told that his mother had committed suicide by gunshot. Eleven days later his father died of a bleeding gastric ulcer. He was permitted to attend both funerals but was required to wear handcuffs.

Sheppard served ten years of his sentence. At a new re-trial in October 1966, a "not guilty" verdict was returned. It was during this trial that Paul Kirk, a famous forensic scientist presented the blood spatter evidence he had collected in Sheppard's home in 1955 which proved crucial to his acquittal. On January 22, 1955 (one month after Sheppard's conviction) Kirk had visited the scene of the crime after which he wrote an extensive report primarily based on bloodstain pattern analysis. A motion for a retrial had been denied in 1955, but this decision was overturned in 1964, and in 1966, the Supreme Court upheld the decision for a retrial. Later that same year, Kirk testified at the retrial, which led to Sheppard's acquittal.

The 1993 film **The Fugitive** starring **Harrison Ford** is said to be loosely based on Sheppard's story.

Film Poster of 'The Fugitive'

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on the consideration of a number of stains and preferably stains from opposite sides of the pattern to create the means to triangulate.

- While blood spatter analysis has a solid foundation in science and can be a useful tool for investigators, the reliability of courtroom testimony by bloodstain pattern analysts has come under fire in recent years. Care needs to be taken to ensure that the bloodstain pattern analyst has appropriate credentials and training as well as uses appropriate methods. Even with proper training and methods, there are still many times where reputable analysts disagree on their findings, which calls into question the reliability of their conclusions and its value as evidence in court.

Age of Bloodstains

Several points can help in dating bloodstains:

- Progressive decrease in solubility of bloodstain in various aqueous solutions, with age.
- Change in colour from red to brown due to oxidation of haemoglobin to methaemoglobin.
- Measuring colour changes by colourimetry and spectrophotometry.
- Immunoelectrophoresis.
- Changes in enzyme activities of blood cells.

Sex of the Individual

The presence of Davidson body or Y chromosome in WBCs, can help in sexing blood stains.

IDENTIFICATION OF SEMEN AND SEMINAL STAINS

- Identification of semen is particularly useful in the investigation of sex crimes.
  - Semen is a suspension of spermatozoa in seminal plasma which is a pool of different secretions by different structures and glands such as vas deferens, seminal vesicles, prostate gland, and mucous glands. Seminal plasma consists of a very high concentration of citric acid, fructose, zinc, phosphoryl choline, spermine and spermidine, acid phosphatase, y-seminal protein, etc. Identification of seminal stain is based on the detection of any of these constituents.
- Invisible stains can be detected by examining the material in question under UV light. Seminal stains fluoresce bluish-white in colour on a dark background. This is true of other body fluids also such as blood, saliva, pus, milk, etc. Since certain fabric whiteners also fluoresce under UV light, it might not be reliable if the stain is present on cloth, and has to be subjected to other tests characteristic of semen.

Chemical Tests

The seminal stain is extracted by soaking a small bit of the stained material in sufficient quantity of sodium acetate buffer (pH 4.5). The extract is subjected to various tests:

1. Acid Phosphatase Test

- Acid phosphatase is a prostatic gland secretion found in very high concentration in semen when compared with other body fluids.
  - Semen recovered from vagina retains recognisable amounts of acid phosphatase up to 36 hours.
  - Dried stains which are not decomposed, retain acid phosphatase acitvity for weeks or months, whereas heating the specimen above 60°C destroys the activity.
- Acid phosphatase, on addition of p-nitrophenyl phosphate, releases paranitrophenol which can be detected by the following two methods:
  - Phenol and its derivatives give a yellow colouration in the presence of an alkaline solution (sodium carbonate is commonly used).
  - Phenol/derivatives couple with diazonium salts to give insoluble and brightly coloured azo dyes. Diazo-diortho-anisidine is one of the more stable diazonium salts, which on coupling with phenolic derivatives gives a purplish red colour at pH 5, the pH of the acid phosphatase.
  - However, many other organisms and materials such as bacteria, snake venom, almonds, cauliflower, etc., contain acid phosphatase which can interfere with the screening of seminal fluid

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or stain. Hence a qualitative acid test is insufficient to prove semen in the absence of other independent tests.

- It has recently been reported that acid phosphatase of semen can be separated and identified from other acid phosphatases by poly acrylamide gel electrophoresis (PAGE) which can be used to confirm the presence of semen in the stains.

2. Zinc Test

- The concentration of zinc in semen is unusually high (140 mg/mL in contrast to 1.2 mg/mL for normal blood serum). Zinc, a secretion of prostatic gland, is supposed to maintain microbiological sterility.
- Reagents which give brightly coloured products in the presence of zinc are used to distinguish semen from other body fluids. Laboratory-based methods use atomic absorption spectrometer for quantitative detection of zinc in semen.
- Acid phosphatase degrades slowly in moist samples, whereas zinc does not, making it a more useful parameter in the case of older specimens.

3. Florence Iodine Crystal Test

- Semen contains phosphoryl choline, a secretion of seminal vesicles, which on standing liberates free choline. Choline reacts with Lugol's iodine solution (*Florence iodine*)* to form rhomboidal brownish crystals of choline iodide.

4. Barberio's Test

- Semen contains spermine, a prostatic gland secretion, which reacts with picric acid to form needle-shaped yellowish crystals of spermine picrate.

Microscopy

- The presence of semen in a stain can be considered a certainty only if spermatozoa or sperm heads are detected microscopically (Fig. 23.12).
- A smear of the seminal extract on a microscope slide is stained with haemotoxylin or Ziehl-Neelsen's stain, and viewed through an oil immersion microscope.
- Phase contrast microscopy gives better results (Fig. 23.13).
- The most reliable confirmation for the presence of semen is said to be the positive visual identification of spermatozoa using the Christmas tree stain.

| Fig. 23.12 Seminal Fluid – Microscopy |

- Microscopic visualisation of spermatozoa is still considered to be confirmatory of semen, but can show false-negative results for a variety of reasons such as azoospermia, vasectomy, or old age. In such cases, the stain can be reported to be semen if it gives positive results with a combination of Florence test, human precipitin test, and acid-phosphatase test.

*Lugol's iodine solution: 2 g of potassium iodide and 1 g of iodine are ground well in a mortar, and made up to 30 mL with distilled water.

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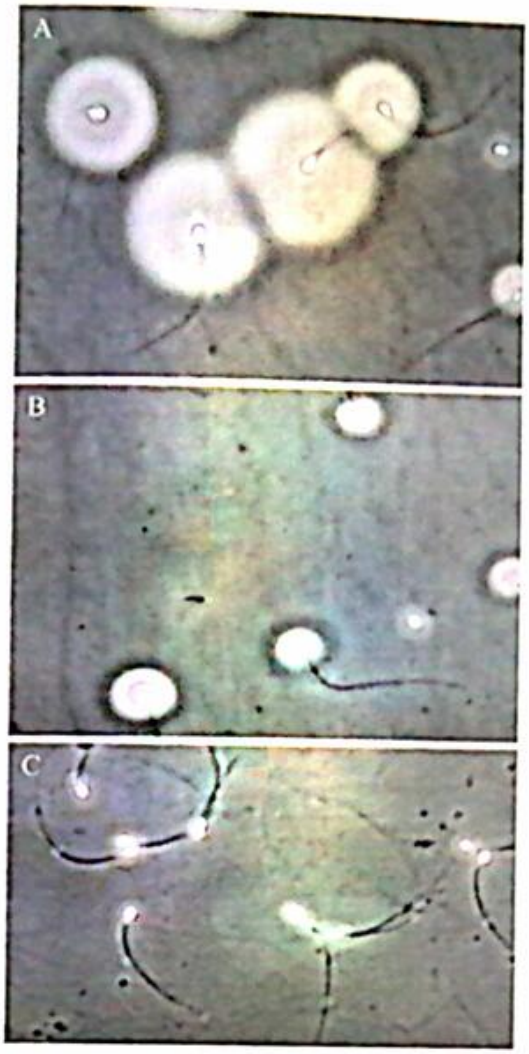

| Fig. 23.13 Seminal Fluid, Phase Contrast Microscopy |

Immunological Method

- Human seminal plasma (HSP) contains specific antigens which are absorbed to the spermatozoal surface and are called as sperm-coating antigens. They can be detected both on the sperm cells and in the ejaculated fluid.
- The following antigens have been identified: the specific antigen **P-30** (also called ***prostate specific antigen***) produced by the epithelial cells of the prostatic gland, **MHS-5**, originating from the epithelial cells of seminal vesicles, and an antigen corresponding to **Mab 4E6**. Antibodies specific to these antigens can be detected by various immunological tests such as immunodiffusion, ELISA, etc.
- These HSP antigens have been reported to be present in the semen of aspermic persons as well, making them a very reliable confirmatory test for semen.
- **RSID-Semen Strip Test**: The RSID-Semen test provides sensitivity as well as specificity to human semen. It deals with identification of human **semenogelin** in a membrane strip for the detection of semen. Similar in format to a pregnancy test strip, the RSID-semen test identifies the presence of the seminal vesicle-specific antigen, or semenogelin. This antigen is unique to semen, and therefore, there is no cross reactivity with other bodily fluids in males and females or with semen from other mammals. This test can also identify semen even if the stain was stored under less favourable conditions which have been shown to affect other tests such as the Acid Phosphatase test.

Determination of Species

- Semen originating from various animal species as well as humans, can be differentiated by a number of immunological methods based on the precipitin reaction (same as for blood, *vide supra*).
- LDH isoenzyme pattern, presence of Y-body in the sperm, and human seminal plasma-specific antigens, are also highly characteristic of human semen.

Individualization of Seminal Stain

- ABO grouping, PGM, AK, HLA, LDH, GLO, etc., can all be demonstrated in the semen of secretors.
- With the advent of DNA fingerprinting, conclusive identity of the perpetrator can be fixed.
- Single photon fluorimetry has been used to differentiate between different semens, as it gives a superimposable band for the original semen with its diluted sample, or for the extract of such dried stains with deionized water.
- The ratio of the androgens (T:DHT), i.e., testosterone (T), and its precursor dihydro-testosterone (DHT), has been found to be specific for each and every individual.

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IDENTIFICATION OF SALIVARY STAINS

- Salivary stains on various substrates can be detected by the use of UV light, as they exhibit fluorescence. But as stated already, there are other body fluids and other substances which can interfere with the results.
- Detection of saliva by various chemical tests is based on the presence of amylase, thiocyanate ion, nitrite ion, alkaline phosphatase, etc. However, tests based on amylase are most commonly used.
  - Qualitative amylase tests are used for screening purposes, whereas quantitative tests are reliable in confirming a salivary stain, since amylase is present in maximum concentration in saliva as compared to other body fluids.
  - Several types of amylase isoenzymes have been identified exhibiting genetic variations and hence can be used for individualisation.
- Further individualisation methods include ABO grouping, red cell enzyme and serum protein polymorphisms in secretors, and DNA fingerprinting.

Medicolegal Importance

- Circumstantial evidence – The presence of saliva in cigarette butts, beedis, or sputum, at the scene of a crime can link the perpetrator to the crime.
- Sexual offences – The presence of saliva in a bite mark (if present), can help to identify the offender.
- Saliva is a non-invasive specimen which can be obtained with ease from anyone to test for drugs of abuse.

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CHAPTER 24

Forensic DNA Typing

The police said, OK we now believe all this DNA testing, let's go and pan the entire local community and see if we can flush out the true murderer.....The upshot of that was that the true perpetrator was flushed out, and the rest is history.

—**Sir Alec Jeffreys** (Born: 1950; British geneticist who discovered DNA fingerprinting)

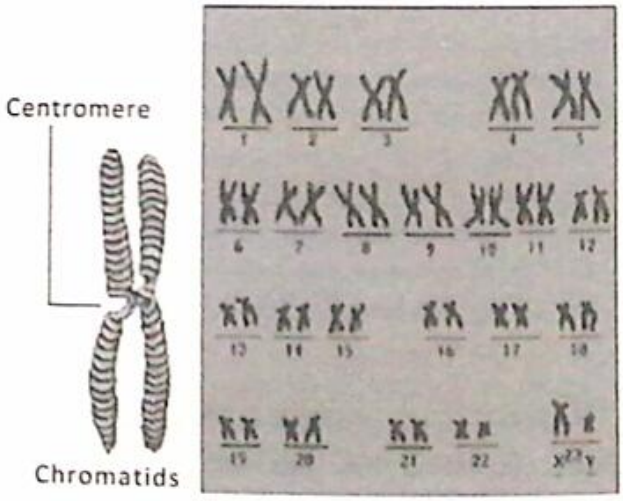
INTRODUCTION

- DNA typing (previously referred to as "DNA fingerprinting" or "Genetic typing") is the most important advance in the field of forensic sciences in recent years. The first application of DNA typing in forensic science was done by **Dr Alec Jeffreys** of Leicester University, who was called in by police to apply his new technique (called DNA fingerprinting by him at that time) to help solve two murders in Leicestershire (Box 24.1).
- DNA typing is a procedure wherein DNA extracted from a biological sample obtained from an individual is analyzed. The DNA is processed to generate a pattern for each person that is generally termed as a 'DNA profile.' This profile is unique for each person excepting that derived from identical twins.

PRINCIPLES OF DNA TYPING

Genes and Chromosomes

- A **chromosome** (Fig. 24.1) contains two complementary strands of **deoxyribonucleic acid** or **DNA** (Fig. 24.2).
- These are long polymers of nucleic acids (nucleotides) each consisting of
  - Phosphate
  - Deoxyribose, and
  - One of four "bases" which consist of
    - Adenine
    - Thymine
    - Guanine
    - Cytosine (A, T, C and G)
  - These always form base pairs based on hydrogen bonds between complementary bases: A-T or C-G. (The two strands are termed anti-parallel, in that they "run" in opposite directions.)
  - RNA differs from DNA in that the sugar consists of ribose rather than deoxyribose, and the base uracil (U) is present instead of thymine.
- Genes are the parts of chromosomes containing stretches of DNA which actually code for proteins. **A gene could be thought of as a discrete unit of information influencing inherited characteristics.**



| Fig. 24.1 Human Chromosomes |

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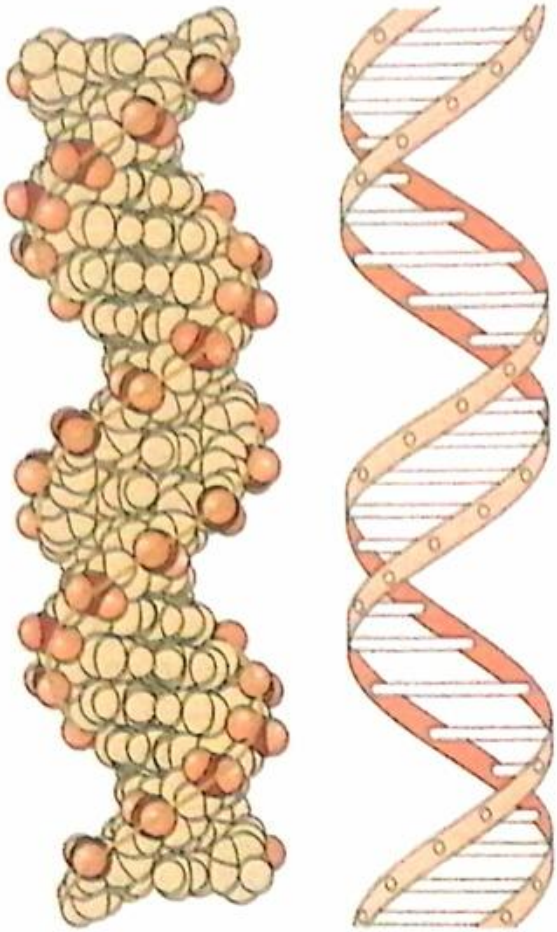

| Fig. 24.2 The Structure of DNA |

Genetic Polymorphism

- Within a species, one chromosome of a given type is very similar to another, but at some places (loci) on the chromosome, there may be some variability in the DNA sequence between chromosomes.
- These (physical) differences can lead to the (genetic) phenomenon of polymorphic alleles.
- **Alleles are detectable variations occurring at a single genetic locus, with the possibility that individual chromosomes may differ in the allele each has at a given locus**. Alleles are detected using genetic markers.
- Where allelic variation is frequently found (at least 10% of chromosomes have an allele other than the most commonly occurring one), it is known as a **polymorphism**.
- The term genetic marker can be used very broadly to apply to any observable variation which results from a variation at a single genetic locus.
  - This may be a serological marker such as ABO blood group, or
  - a DNA marker:
    - The four main types of DNA marker are
      - Restriction fragment length polymorphisms (RFLPs)
      - Variable number of tandem repeat polymorphisms (VNTRs)
      - Microsatellite polymorphisms based on di-, tri- or tetra-nucleotide repeats (STRs), and
      - Single nucleotide polymorphisms (SNPs).

The Scientific Basis of DNA Typing

- DNA typing is founded on a number of genetic and molecular principles. Basic to the understanding of the complexity of DNA typing is the concept of the cell.
  - A cell is the building unit of an organism made up of its component parts, one of which is the **nucleus** that functions as its command centre. As the command centre of the cell, the nucleus houses the **DNA** or **deoxyribonucleic acid** that codes for genetic information responsible for all cellular processes.
  - Several DNA molecules comprise **genes** which in turn are located in minute bodies called **chromosomes**. In humans, there are 23 pairs of chromosomes within a cell thus making up a total of 46 chromosomes.
  - Some chromosomal regions contain repeating units of the same type of DNA molecule which may or may not code for a specific protein. The number of repeating units in individuals may vary.
  - Today, chromosomal regions with short tandem repeating DNA units (known as **Short Tandem Repeats** or **STRs**) are most often used as markers for human identification in forensic casework.
- DNA can also be found in another part of the cell called the **mitochondrion**. Unlike nuclear DNA with two copies per cell, multiple copies of mitochondrial DNA (up to 100,000 copies) are present per

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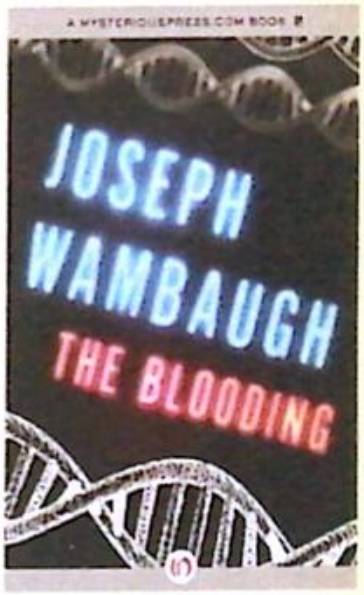
Box 24.1 The Blooding

The following landmark case is condensed from the book of the same title by Joseph Wambaugh.

At 7 pm on Nov. 21, 1983, 15-year-old Lynda Mann from a remote village in England left her home to visit a girlfriend. She never returned. The following morning her body was discovered, the victim of a savage rape and strangulation, near a footpath which abutted the grounds of a mental health hospital. The first murder investigation in the history of the quaint village convened, led by one inspector and about 150 policemen. The high sperm count in the seminal stains recovered from the victim's clothing indicated the assailant to be a male between the ages of thirteen and thirty-four, and with the use of computers, the police compiled a list of suspects.



But they failed to find the culprit, and by April 1984 the intense investigation had dwindled to a nominal investigation by only eight men. Less than ten miles from the murder scene, **Alec Jeffreys**, a 34-year-old geneticist at Leicester University, was probing the evolution of human genes through their genetic material (DNA). In September 1984, he discovered that by adding enzymes to fragments of blood cells and separating larger fragments from smaller by exposing them to an electric field, the resultant blotting onto a nylon membrane would reveal a radioactive pattern similar to a supermarket bar-code, that was unique to every individual. Further, he learned that the bands of genetic fingerprints were inherited from both parents, and that the bands were consistent in any bodily material. In March 1985, Jeffreys stated that the possibility of two people having the same genetic fingerprint was literally none.

On July 31, 1986, 15-year-old Dawn Ashworth from another village nearby, was seen alive for the last time at 5 p.m. as she entered a lonely footpath near some woods. On the morning of Aug. 2, police discovered the girl's body under heavy brush at the side of the path. She had suffered a vicious beating after being raped, and was then strangled to death. On Aug. 8, 1986, police arrested 17 year old Richard Buckland, a kitchen worker at the mental health hospital. After intense interrogation the simple-minded youth confessed to the crime. But at the suggestion of Buckland's father, samples of semen found in both victims were sent to Dr. Jeffreys. The police were shocked when Jeffreys stated that Buckland could not have been the murderer. On Nov. 21, 1986, on the date his murder trial was to begin, Richard Buckland became the first suspect in history to be released because of evidence refuted by genetic fingerprinting.

On Jan. 17, 1987, the police announced that all males between seventeen and thirty-four years of age would be required to provide blood and saliva samples. Even though 90 percent of the men readily responded, the laboratory was overtaxed to test the samples. By May, more than 3,500 men had submitted to the testing, but only half the samples had been tested. Six months after the second murder, virtually every potential perpetrator in the area had finally been tested, but no sample

contd.

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matched the indelible evidence left by the killer of the two teenaged girls.

On Aug. 1, 1987, while drinking in a pub, a bakery worker named Ian Kelly casually mentioned to a co-worker that he had taken the blood test for a fellow worker named Colin Pitchfork. The following day Ian Kelly was arrested for conspiracy to pervert the course of justice. Kelly stated that Pitchfork had begged him to take the test as he was terrified of injections. That same afternoon, Aug. 2, 1987, 27-year-old Colin Pitchfork was arrested on suspicion of murder shortly after he returned to his home. Pitchfork, married and the father of two, was a professional cake decorator who also had a history of sexual perversion. Before arriving at the police station, he had confessed to the two murders. On Sept. 21, Pitchfork was remanded to judicial custody on two counts of murder.

Prof Alec Jeffreys

The murder trial began on Jan. 22, 1988, and ended the same afternoon. Ian Kelly was given a suspended eighteen-months sentence for his unwitting cooperation in the cover-up. Pitchfork confessed to both murders and indecent assault charges, as well as conspiracy for involving Ian Kelly. He was sentenced to life for the two murders, ten years for both rapes, three years for both sexual assaults, and three years for conspiracy.

human cell. Because of this, **mitochondrial DNA analysis** is the method of choice when dealing with environmentally challenged samples, e.g., identification of mass disaster victims, exhumed human remains, etc.

- There are at least **five** different forensic techniques of DNA typing:
  - **RFLP—Restriction Fragment Length Polymorphism**, the oldest technique, essentially involves radioactive fragmentation and examiner comparison
  - **PCR—Polymerase Chain Reaction**, a copying technique for small or broken pieces of DNA, which is amplified, not cloned, and a computer or operator estimates match probabilities.
  - **STR—Short Tandem Repeats**, a method which uses markers for short, repeating segments of microvariant allele patterns, as short as three to seven base pairs, usually involving computer expert systems, although visual detection is also possible.
  - **Mitochondrial DNA Analysis**—A type of PCR used on samples subjected to extreme environmental conditions, and since mitochondrial DNA is inherited solely from the mother, it has also been used in cases of disputed maternity.
  - **Rapid DNA ID Microchip-Based Genetic Detectors**—These are field-ready laptop analysis units capable of being used at crime scenes, displaying profiles onsite, or electronically uploading to a CODIS database. The technology uses the same microchips that detect genetic diseases, but modified to transport, concentrate, and hybridize DNA, and to discriminate individual genetic markers.

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Most laboratories use the twin techniques of RFLP and PCR-STR as part of their double result requirement. From the year 2000, however, for forensic purposes, STR Typing alone is the recommended method, which must involve the study of at least 13 core loci.

RFLP DNA Typing

- The first step in RFLP DNA typing is extraction of the DNA from the sample, be it blood, saliva, semen or some other biological sample.
- The purified DNA is then cut into fragments by **restriction enzymes**.
  - Take the pattern GCGC, and imagine it occurs more than once in the DNA.
  - The number of times it occurs is unique to the individual. The restriction enzyme chops the DNA in two at every place where the GCGC pattern occurs. For example:

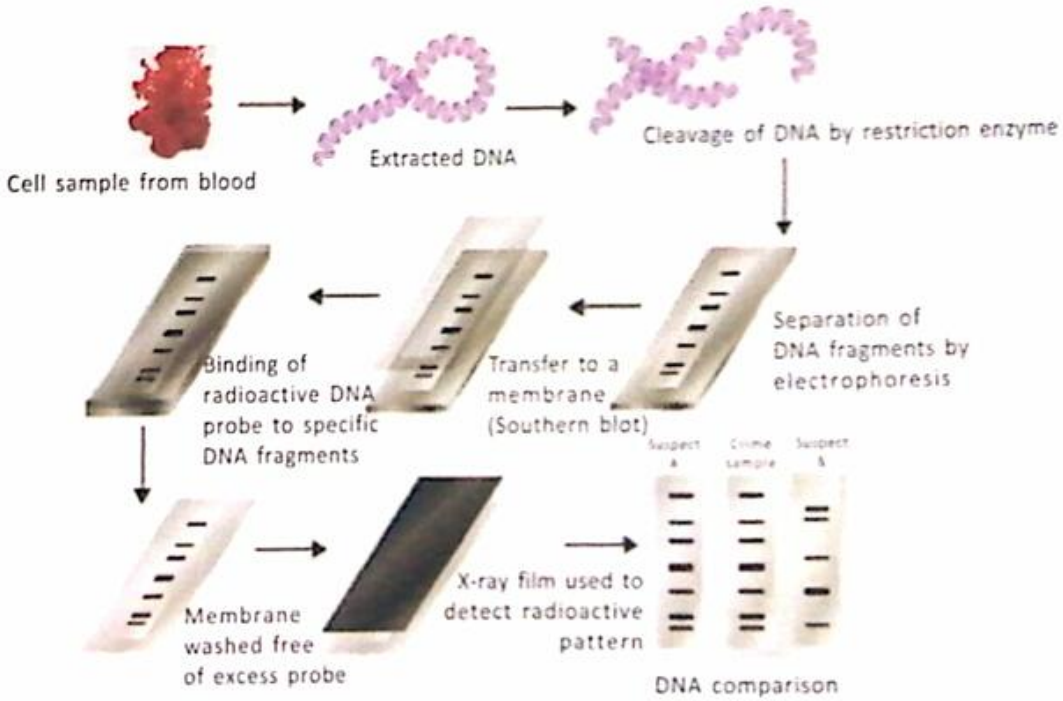
    Person 1: **GCGC**ATGTT**GCGC**AAGA**GCGC**

    Person 2: **GCGC**ATTGAATGCAAGTA**GCGC**

  In this example, Person 1 has the repeat sequence three times, while Person 2 has it twice. The restriction enzyme will cut between the first G and the first C. Thus,

  Person 1: CGCATGTTCGCAAGAG – 2 small fragments

  Person 2: CGCATTGAATGCAAGTAG–1 large fragment
- The restriction fragments have negative charge and can be separated by a technique called **gel electrophoresis**, which separates the pieces of DNA based on their size.
  - The samples of DNA that have been treated with restriction enzymes are placed in separate lanes on a slab of electrophoretic gel across which is placed an electric field.
  - The fragments migrate toward the positive electrode, the smaller fragments moving faster than the larger fragments, thus separating the DNA samples into distinct bands.
  - The bands can be visualised using autoradiography or luminescent dyes (Fig. 24.3).
- This approach to DNA typing requires quite large samples of biological material in order to obtain reasonable results. The entire procedure of RFLP-based forensic DNA typing is laid out in Fig. 24.4.



| Fig. 24.3 RFLP Technique |

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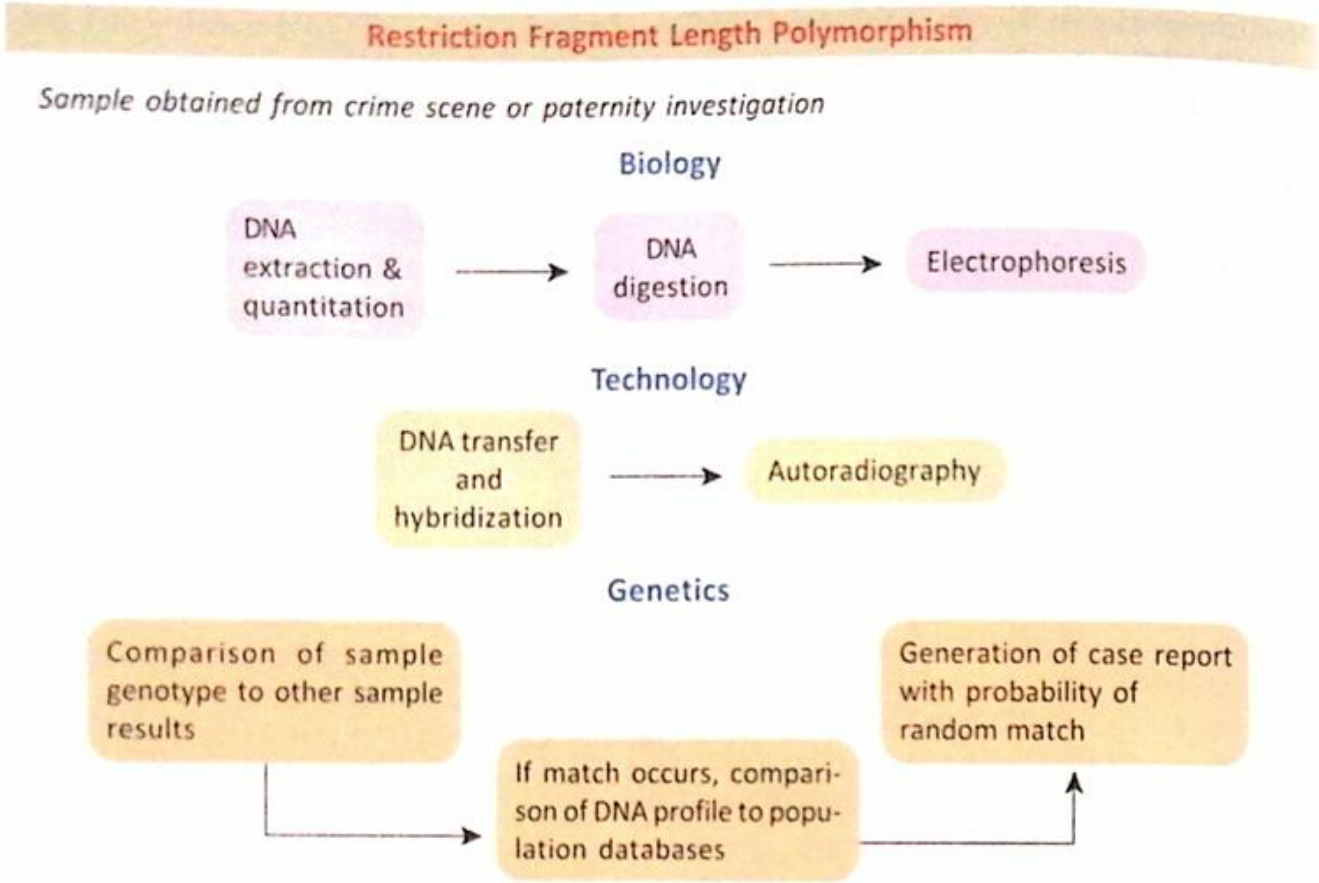

| Fig. 24.4 |

PCR Technique

- With PCR (polymerase chain reaction), a chemical solution is added to the sample and boiled to remove the DNA, which is then combined with short fragments of known DNA, called **primers**, and other chemicals that stimulate replication by means of a reaction called the polymerase chain reaction.
- To perform a PCR reaction, a small quantity of the target DNA is added to a test tube with a buffered solution containing
  - DNA polymerase
  - Oligonucleotide primers
  - Four deoxynucleotide building blocks of DNA, and
  - Cofactor $MgCl_2$.
- The PCR mixture is taken through replication cycles consisting of:
  - one to several minutes at 94–96 degrees C, during which the DNA is denatured into single strands
  - one to several minutes at 50–65 degrees C, during which the primers hybridize or "anneal" (by way of hydrogen bonds) to their complementary sequences on either side of the target sequence
  - one to several minutes at 72 degrees C, during which the polymerase binds and extends a complementary DNA strand from each primer.
  - As amplification proceeds, the DNA sequence between the primers doubles after each cycle. Following thirty such cycles, a theoretical amplification factor of one billion is attained (Fig. 24.5).
- PCR techniques offer the advantage of requiring only trace amounts of DNA, and they can be done very quickly.

DNA Typing Using STRs

- Tandemly repeated DNA sequences are widespread throughout the human genome and show sufficient variability among individuals in a population to have become important in several

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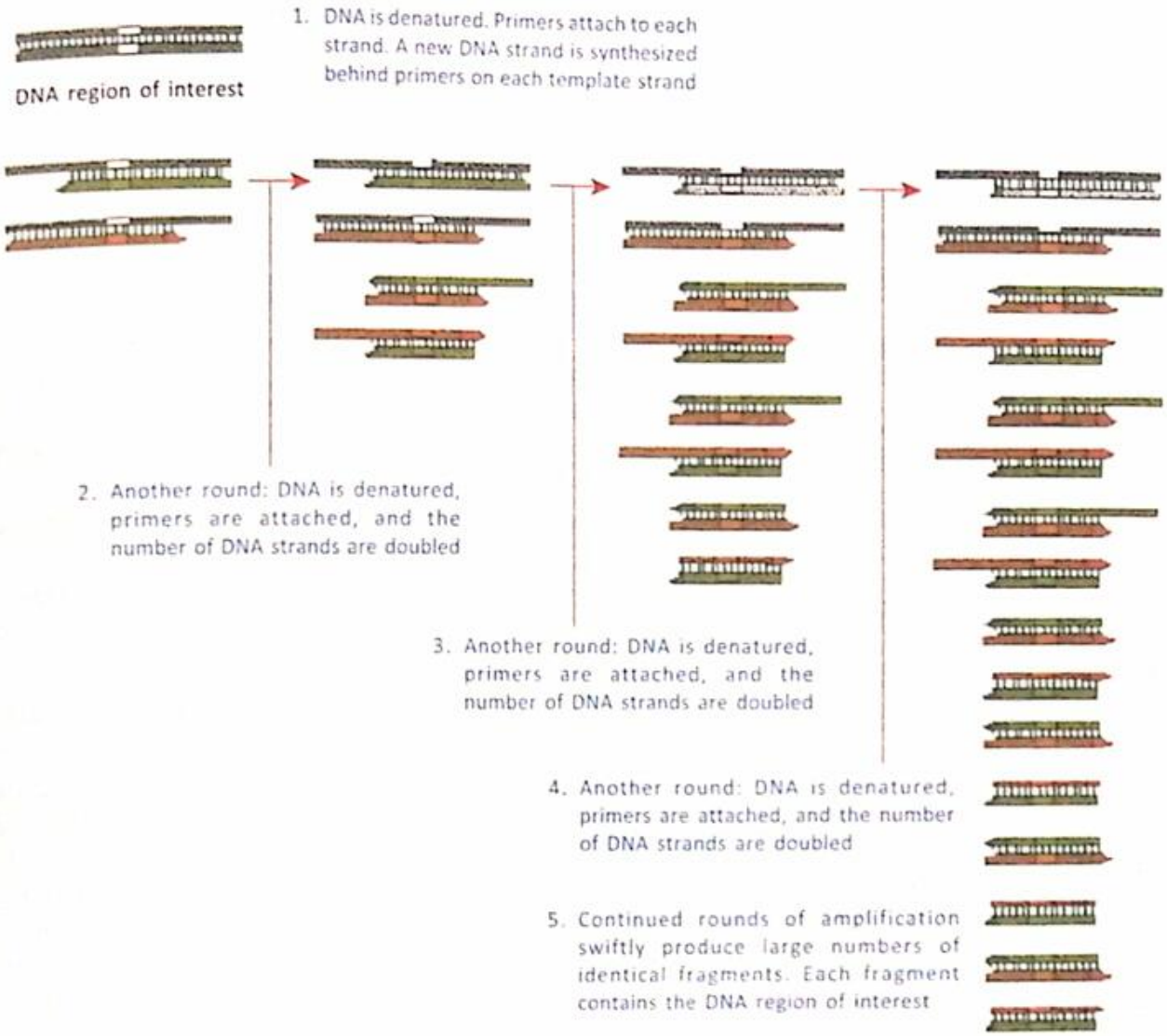

| Fig. 24.5 Polymerase Chain Reaction |

fields including human identity testing.

- These tandemly repeated regions of DNA are typically classified into several groups depending on the size of the repeat region.
  - **Minisatellites (variable number of tandem repeats, VNTRs)** have core repeats with 9–80 bp
  - **Microsatellites (short tandem repeats, STRs)** contain 2–5 bp repeats. The forensic DNA community has moved primarily towards tetranucleotide repeats, which may be amplified using the polymerase chain reaction (PCR) with greater accuracy than dinucleotide repeats.
- The variety of alleles present in a population is such that a high degree of discrimination among individuals in the population may be obtained when multiple STR loci are examined.
- PCR-based STRs have several advantages over conventional Southern blotting techniques of the larger variable number tandem repeats (VNTRs).
  - Discrete alleles from STR systems may be obtained due to their smaller size, which puts them in the size range where DNA fragments differing by a single basepair in size may be differentiated.
  - Smaller quantities of DNA, including degraded DNA, may be typed using STRs. Thus, the quantity and integrity of the DNA sample is less of an issue with PCR-based typing methods than with conventional RFLP methods.

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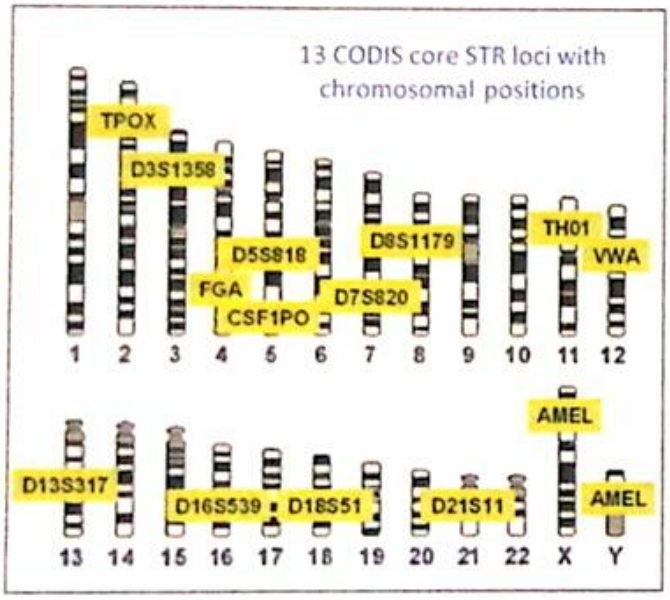
- There are hundreds of STR systems that have been mapped throughout the human genome. Several dozen have been investigated for application to human identity testing. These STR loci are found on almost every chromosome in the genome. Tetranucleotide repeats have been most popular among forensic scientists due to their fidelity in PCR amplification although some tri- and pentanucleotide repeats are also used.
- For forensic purposes, 13 selected loci are used, as stipulated by the FBI, USA (**Combined DNA Indexing System or CODIS**) (Fig. 24.6).
- The STR profiling kit that is currently used in the United Kingdom and many other parts of the world is the **AMPFISTR® SGM Plus™ PCR Amplification kit.** The SGM (Second Generation Multiplex) decreases the probability of a chance match from 1×10^{-8}, to **one in trillions** for unrelated individuals!



| Fig. 24.6 |

The entire procedure of STR-based forensic DNA typing is laid out in Fig. 24.7

For a brief history of the evolution of forensic DNA typing, see Box 24.2.

APPLICATIONS OF DNA TYPING

- Establishment of **paternity and maternity**
- Establishment of **biological relationship** for immigration purpose, kidney transplantation, etc
- Detection of cases of **child swapping**
- Identification of rapist in **rape cases** including gang rape cases
- Identification of **mutilated remains**, as in cases of murder, bomb blasts, mass disasters
- Identification of bodies in **exhumation** cases
- All cases of **wildlife identification**
- Determination of **pedigree** for seed or livestock breeds
- Detection of **bacteria and other organisms** that may pollute air, water, soil, and food
- Authentication of **consumables** such as wine

The Indian Scenario

- In India, initially the use of DNA testing in paternity cases far out numbered criminal cases. But today, use of forensic DNA typing in criminal cases is quite routine and is undertaken in such cases frequently. It all began with the very first case in 1988 (Box 24.3), which was a paternity dispute case, and since then the technique has rapidly gained acceptance among police and judicial personnel in relation to a wide variety of offences.
- Usually during court trials involving DNA typing evidence, emphasis is laid on **population genetics**, i.e., how the probability has been calculated that a particular suspect's DNA profile matches with that of the DNA evidence. Often the labs carrying out DNA typing calculate the odds of one in millions or billions against a random match. For example, the chance that the semen stains present on a victim's undergarment originating from someone other than the suspect whose DNA typing matches, would be one in 82 billion. Naturally, such high odds indicate that the suspect alone must be the culprit. The chance that the suspect's DNA coincidentally matches with the crime sample depends on how frequently the particular pattern of genetic variants revealed in his

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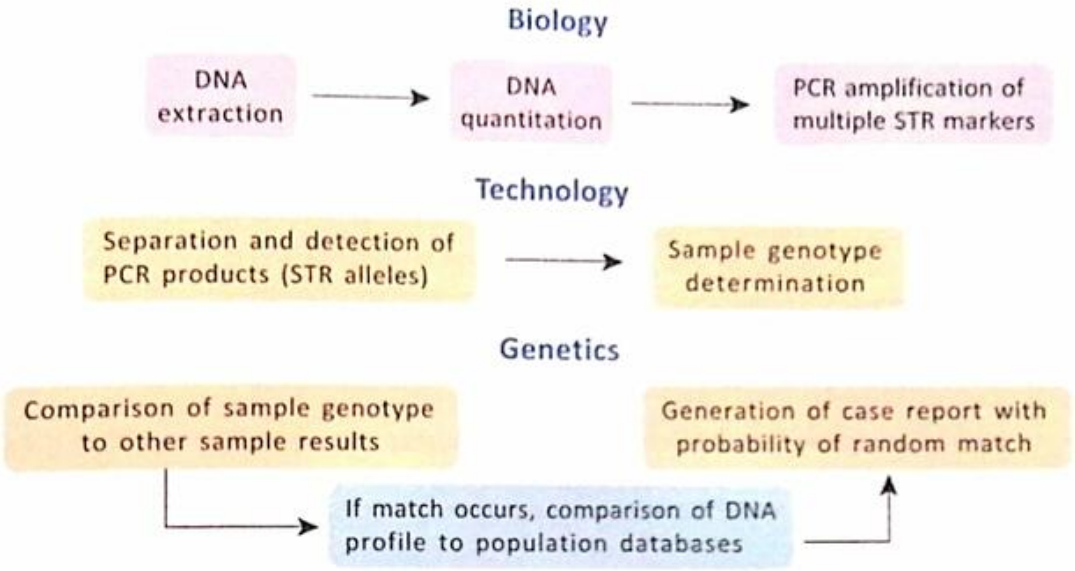
STR Typing

Sample obtained from crime scene or paternity investigation



| Fig. 24.7 |

Box 24.2 Brief History of the Evolution of Forensic DNA Typing

Progression of forensic DNA typing:

- 1980 - Ray White describes first polymorphic RFLP marker
- 1985 - Alec Jeffreys discovers multilocus VNTR probes
- 1985 - First paper on PCR by Kary Mullis
- 1988 - Federal Bureau of Investigation (FBI) starts DNA casework
- 1991 - First STR paper
- 1995 - Forensic Science Service (FSS) starts UK DNA database
- 1998 - FBI launches CODIS database
- 1999 - Multiplex STR kits are validated in numerous labs
- 2000 - FBI and other labs stop running RFLP cases and convert to multiplex STRs

Progression of DNA typing markers:

RFLP

- multilocus VNTR probes
- single locus VNTR probes (32P and chemiluminescence)

PCR

- DQ-alpha (reverse dot blot)
- PolyMarker (6 plex PCR; dots for SNPs)
- D1S80 (AMP-FLPs)
- singleplex STRs with silver staining
- multiplex STRs with fluorescent dyes

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Box 24.3 Kunhiraman Case – The First Forensic DNA Case of India

DNA typing started its journey through the Indian legal system in 1988. It is a matter of pride that in India, the first use of DNA evidence in a paternity trial was in Kerala in 1988 during the maintenance case of Manoj, i.e., from the very next year of its first admission in the United States. This very first trial resulted in the admissibility of the technique in Indian courts.

The facts in connection with the case were that the petitioner's mother Vilasini and the counter-petitioner **Kunhiraman** were neighbours. Vilasini was working as an agent in an insurance company. As a part of her job she went to the house of Kunhiraman for canvassing him to take a policy of the company, and he readily obliged. She later stated that Kunhiraman took great interest in her and offered to help her by canvassing policies for her from others. In connection with such insurance work, when one day Vilasini went to meet Kunhiraman, he was alone in the house, and he forced her to have sex with him on the promise that he would marry her. This sexual relationship became regular and when she became pregnant, Kunhiraman denied all the facts and changed his attitude towards marrying her.

After the birth of her child, Manoj, Vilasini filed a maintenance suit under Section 125 of the Code of Criminal Procedure before the Chief Judicial Magistrate, Thalassery. In the absence of a legal marriage between Vilasini and Kunhiraman, the court found it difficult to apply section 12 of the Indian Evidence Act in order to fix the legitimacy of the child. The court was of the opinion that the legitimacy of Manoj and the responsibility of Kunhiraman as the father of Manoj could be established only through scientific evidence. For that, the court ordered for the novel scientific technique of DNA typing to be done for determining the paternity of Manoj.

Manoj, Vilasini and Kunhiraman proceeded to the Centre for Cellular and Molecular Biology (CCMB), Hyderabad for giving their blood samples for conducting DNA typing. After conducting the test, the CCMB reported that Kunhiraman and Vilasini were the biological parents of Manoj. Senior scientist **Dr Lalji Singh** gave his opinion supported by adequate scientific explanation detailing the procedure of conducting the test. But when the case came for trial, Kunhiraman raised objection by stating that though the DNA test conducted in Western countries was fool-proof, the DNA test conducted by CCMB was not fool-proof because the process and techniques developed in CCMB were slightly different and did not have the same reliability. Therefore, the court permitted the parties to examine the expert witnesses for determining the reliability of the report of the CCMB.

Dr Lalji Singh was examined, and in his chief examination he stated that the process that he had followed in this case was recognized and the papers published by him on the subject were also recognized. Regarding his experience, he stated that he had experience in molecular biology since 1976 and he had worked for 13 years in the University of Edinburgh. When he was cross examined, he admitted that there were certain differences between the method propounded by CCMB and the DNA Fingerprinting technique conducted in other countries. The court examined other expert witnesses who corroborated Dr Singh's statement and pronounced judgement accepting the technique's admissibility.

Dr Lalji Singh

Kunhiraman was declared to be the biological father of Manoj and was asked to pay maintenance costs to Vilasini for rearing Manoj. On appealing the verdict, the High Court of Kerala confirmed the findings of the lower court and ruled that the result of DNA test could be taken as conclusive in deciding paternity. The unique work of Dr Lalji Singh in this and other cases, prompted the Government of India's Department of Biotechnology (DBT) to form an autonomous institution 'Centre for DNA Fingerprinting and Diagnostics (CDFD)' in 1995 in Hyderabad.

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or her DNA profile occurs in the general population. Obviously, if all the three billion nucleotides of the suspect's DNA were compared, then there would be no doubt about the interpretation of a match. Methods available today, reduce the possibility of random matches by examining more and more specific physical sites on DNA. Well established and highly proficient DNA typing laboratories such as the **Centre for DNA Fingerprinting and Diagnostics (CDFD), Hyderabad**, or the **Central Forensic Science Laboratory (CFSL), Kolkata**, usually maintain databases of the markers used. As more and more such loci are included, the odds against the chance match would become even higher.

- Another point being debated hotly today is the creation of a **national database**, i.e., mapping the DNA pattern of every single individual. That way, when a rape is committed, there is no need to look for a suspect. All that needs to be done is to take the semen sample and elucidate its DNA pattern, and check it against the national database to find out whom it belongs to.
- In India, DNA testing has caught on very well. While the underlying principles of DNA typing cannot be questioned, legal scrutiny of the technique can only revolve around questions relating to the collection, forwarding, and authentication of the samples. Therefore, it is imperative to follow strict guidelines as a standard procedure when samples are being collected or forwarded. Unfortunately, most medical officers in India are unclear as to the exact method of collection and forwarding of crime samples for DNA analysis. One of the prerequisites for successful DNA typing is an efficient method of collection of these samples from the scene of crime, and submitting them (along with control samples), to the DNA typing laboratory with minimum delay. The infallibility of DNA analysis depends mostly on the skill, ability, and integrity shown by police officers and medical officers. Since DNA typing is highly sophisticated and the results are unassailable, the scientists (DNA analysts) should be provided with the samples in the prescribed manner, so that they can process the samples and give their opinion based on the results they obtain, in the most befitting manner.
- Obviously, a technology that is so powerful and so sensitive must be used extremely cautiously, since for example, if a DNA scientist sneezes while working, his DNA could contaminate the sample being examined. So there is this tremendous need to avoid contamination. Whether laboratory practices in India are up to that or not can only be tested by having proficiency tests put in place. These are areas of current concern.

COLLECTION AND FORWARDING OF FORENSIC SAMPLES FOR DNA TYPING

Liquid Blood Samples

- In cases where blood samples have to be sent as evidence samples (e.g., paternity or maternity disputes) or as control samples (e.g., criminal cases), 2–5 mL of intravenously drawn blood should be collected into sterile, leak-proof screw-capped tubes containing heparin or EDTA as an anticoagulant.
- The sample should be mixed thoroughly, but slowly, with the anticoagulant, and then the tube should be placed in a container filled with ice (e.g., a thermos flask) if it is to be transported immediately.
- The sample tube should be labeled properly, displaying clearly the source of the blood sample, the name of the doctor collecting the blood sample, time and date of collection, and other details such as the forwarding authority, etc.
- If there is going to be some delay before the sample can be transported, it should be stored in a refrigerator.
- In case it appears to the medical officer who has carried out the blood collection that the person is suffering from an apparent genetic disorder, this fact should be mentioned in the forwarding note/letter of advice. This would help the DNA analyst to interpret the results correctly.
- An identification card should be completed and sent along with each blood sample.

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Semen Samples/Vaginal Swabs

- In criminal cases involving rape, or rape-murder, DNA typing can conclusively help in the identification of the culprit, provided suspects/accused persons are available for obtaining their blood samples for subsequent comparison with that of the DNA profile of the seminal stain/swab (Fig. 24.8).

| Fig. 24.8 Identical DNA Patterns in a Rape Case. Lane 1: Vaginal Swab of the Victim; Lane 2: Semen Stain on the Clothing of the Victim; Lane 3: Blood of the Suspect |

- In rape cases, the role of the police officer is of utmost importance because any delay in getting the medical examination of the victim done could lead to loss of valuable evidentiary material, i.e, the seminal fluid/stain. The investigating officer should get the medical examination of the victim done by a medical officer without unnecessary delay.
- Sterile cotton ear buds can be used as swabs. After collection, the swabs should be completely air-dried, placed in dry sterile tubes, sealed, and labelled.
- Other relevant information about the sample should be enclosed separately, and sent along with the sample.
- In gang rape cases, more than two vaginal swabs should be collected and sent in separate individual tubes.
- The genital parts of the victim should be swabbed with wet cotton swabs, i.e., moistened with sterile water (for instance, water for injection available in medical stores can be used for this purpose).
- These tubes should be packed in separate vials and sent to the DNA laboratory.
- The clothes worn by the victim at the time of the offence also should be air-dried, packed in dry paper, and sent to the laboratory.
- No attempt should be made to dry the samples by either a hair drier, or by placing them under direct sunlight.
- In cases of delay in despatching the samples to the laboratory, the vaginal swabs should be stored at 4°C either in a refrigerator, or a cold room of a hospital.
- Cloth materials if any, may be stored at room temperature and sent along with the vaginal swabs.
- Microscope slides smeared with vaginal swabs should be packed individually and sent at room temperature to the laboratory. The medical officer or chemical examiner concerned should not use colouring dye or stain on smeared slides because that would hamper the DNA analysis.
- Blood samples of the accused should be collected as already described.

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Stains From Automobile/Scene of Crime/ Large Material Objects

- Body fluid stains on automobiles or large objects could be swabbed with cotton buds moistened with sterile water. Ampoules containing water for injection could be used for moistening.
- The cotton buds should be air-dried, placed in a clean bottle, and sent to the DNA laboratory at room temperature.

Blood/Semen from Individuals Under Field Conditions

- Blood/semen from individuals should be collected into a sterile tube or container, and the same should be spread on a sterile bandage cloth folded several times so as to make it absorb all the fluid.
- This should be air-dried under shade and not under direct sunlight.
- After complete drying, it should be placed in a clean envelope, sealed, labelled, and sent to the DNA laboratory at room temperature.

Visceral Samples

- Cases occur wherein mutilated bodies are recovered whose identification is difficult to establish by usual forensic methods. In such cases, DNA typing can help to establish the source of the mutilated body with relative or absolute certainty.
- Of the various body tissues, muscle is the best source for extracting DNA. Therefore, muscle samples of approximately 100 mg in weight can be dissected out using sterile scalpel blades and scissors, and placed in a sterile glass or polypropylene tube containing normal saline (0.9% NS Injection IP) as a preservative. The saline solution prepared conventionally in mortuaries is not recommended because of inconsistencies in salt concentration. In hospitals or research institutions where dimethyl sulphoxide (DMSO) is available, a 20% solution of DMSO saturated with sodium chloride can be prepared, which is a better preservative.
- In cases where several pieces of body are found, it is recommended that sufficient number may be collected individually and sent as separate exhibits so that the identity of the mutilated body can be established more precisely. This is especially true in the case of mass disasters/air crashes/bomb blasts, etc., where several bodies get mutilated and mixed up.
- The sample tubes containing the tissues should be properly sealed and made leak-proof so that the preservative does not leak from the bottle during transportation to the laboratory.
- With regard to foetal tissue, it is recommended that associated maternal and placental tissues are dissected out, and only the foetus (preferably as a whole) is sent in normal saline (0.9% NS Injection IP), or DMSO as mentioned above.
- The jar containing the foetus should be placed in a thermocol box containing ice, and sent to the DNA laboratory.
- In exhumation cases, if dry tissues are present, they should be placed in a sterile bottle and sent at room temperature to the laboratory.

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Bones, Teeth, Hair

- DNA typing can help to establish the identity of mutilated bodies, exhumed bodies, and skeletal remains with a remarkable degree of certainty.
- Bones, especially long and intact bones such as humerus or femur, are most suitable for DNA typing analysis.
- In criminal cases where skulls are recovered (with teeth), molar teeth should be detached from the upper and lower jaw bones and sent to the laboratory for analysis. If molar teeth are not available, any other teeth present could be sent for analysis.
- Bones should be packed in clean paper/cloth and placed in a polyethylene cover, sealed, and sent to the laboratory at room temperature.
- Ice or preservatives need not be used for transportation of bones. Also, there is no necessity to wash the bones before they are packed.
- Teeth should be placed in a clean polyethylene cover and sent to the laboratory for analysis. **Teeth along with the skull, which have been subjected to superimposition test, are not useful for DNA analysis.** Therefore, a few teeth

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should be removed from the upper and lower jaws of the skull before they are subjected to superimposition test.

- Hair samples should be packed in clean paper, sealed, and sent at room temperature. If possible, hair with roots should be sent for analysis.
- No preservatives should be used for storing hair.
- At autopsy, the doctor should look for loose hair in the palms of a murdered person, which could be useful for identification of the culprit.

Fingernail Scrapings

- Fingernail scrapings in cases of rape or murder constitute a good source of DNA of the assailant. So caution should be exercised while collecting these scrapings at the time of autopsy.
- The palms of the victim should be placed over a clean polyethylene sheet and examined. Using a sterile sewing needle or a toothpick, the inner portions of the fingernails must be scraped gently.
- All the material that falls on to the polyethylene sheet should be collected and sent to the laboratory without any preservative.

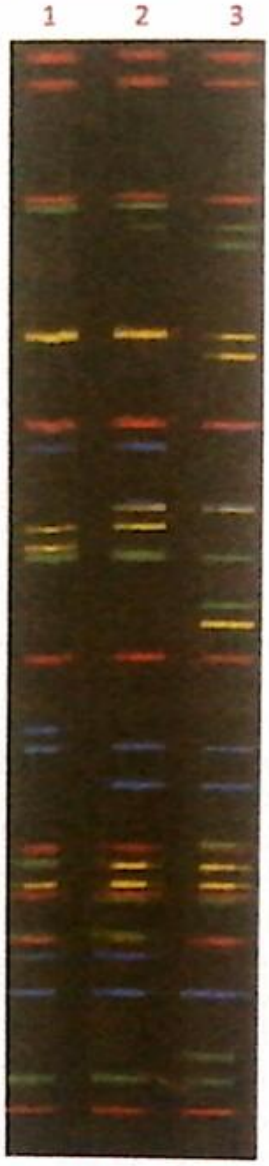
Authentication and Forwarding

- Blood samples in a case of paternity dispute, and in a case where they are used as control samples for identification purposes need to be collected in the presence of a judicial officer. By doing so, questions relating to authenticity of the samples will not arise.
- The samples should be sealed, and a specimen of the seal on paper or cloth should accompany the samples for verification at the laboratory.
- The identification card and the forwarding note need to be completely filled, certified, and sent along with the samples.
- Blood samples should not be collected from persons who have undergone blood transfusion within three months preceding the date of collection.
- **The following officials are authorised to forward a case to the DNA laboratory**:
  - Judicial First Class Magistrate, or Subordinate Judge, or District & Sessions Judge.
  - Any police officer above the rank of Sub-Inspector.
  - Medical Officer of the rank of Asst. Civil Surgeon or above, of a Government Hospital.
  - Officers of the Collectorate holding executive powers.

STATUS OF DNA TYPING AS A FORENSIC TOOL

Advantages

1. Most conclusive method of identification of individuals (along with digital fingerprints).



| Fig. 24.9 DNA Profiles
Lane 1: DNA Profile of Mother; Lane 2: DNA Profile of Child; Lane 3: DNA Profile of Father |

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2. Since DNA is very stable, the technique can be applied even on very old (aged) stains or specimens.
3. Extremely small quantities of body fluid or tissue is sufficient for analysis.

Disadvantages

1. DNA typing cannot differentiate between identical twins. However, newer modifications have been developed to overcome this.
2. It is relatively expensive, when compared to most other methods of establishing identity.
3. Interpretation of results requires a great deal of expertise and experience (Fig. 24.9).
4. While DNA evidence has been questioned in a few cases, and even discredited in some, it has never been because of the soundness of the underlying principles being doubted, but because of other reasons such as improper collection or preservation of samples, or laboratory errors, etc. One such case that attacked DNA evidence with considerable success was the sensational case involving the famous American footballer **OJ Simpson** (Box 24.4).

Box 24.4 The OJ Simpson Case

The **OJ Simpson** murder case was a criminal trial held at the Los Angeles County Superior Court in California, USA. The trial spanned from Nov 2, 1994 to Oct 3, 1995. Orenthal James Simpson (born July 9, 1947), also nicknamed 'The Juice', is a retired American football player. The former professional football star (and actor) was tried on two counts of murder after the deaths of his ex-wife, **Nicole Brown Simpson**, and her friend **Ronald Lyle Goldman**, in June 1994. The case has been described as the most publicized criminal trial in American history.

OJ Simpson

Brown and Simpson were married on Feb 2, 1985, five years after his retirement from professional football. The couple had two children. The marriage lasted 7 years, during which Simpson was repeatedly accused of spousal abuse. Brown filed for divorce on Feb 25, 1992 citing "irreconcilable differences".

At 12:10 a.m. on June 13, 1994, Nicole Brown and Ronald Goldman were found murdered outside Brown's Bundy Drive condo in the Brentwood area of Los Angeles. Evidence found and collected at the scene led police to suspect that OJ Simpson was the murderer. Nicole Brown had been stabbed multiple times in the head and neck and had defensive wounds on her hands.

Lawyers convinced the police to allow Simpson to turn himself in at 11 a.m. on June 17, 1994, even though the double murder charge meant no bail and a possible death penalty verdict if convicted. Over 1,000 reporters waited for Simpson at the police station, but he failed to appear. At 2 p.m., the Los Angeles Police Department issued an all-points bulletin. At around 6:20 p.m., a motorist in Orange County saw Simpson riding in his white Ford Bronco, driven by his friend Al Cowlings, and notified police. The police then tracked calls placed from Simpson on his cell phone. At 6:45 p.m., a police officer saw the Bronco going north on Interstate 405. When the officer approached the Bronco with sirens blaring, Cowlings yelled that Simpson was in the back seat of the

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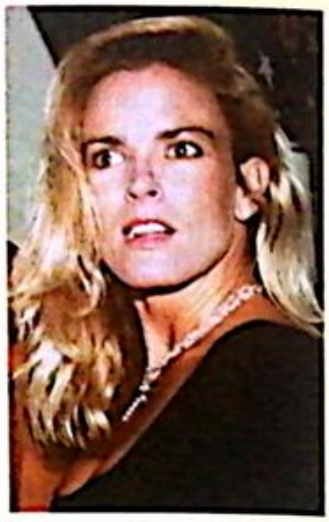
vehicle and had a gun to his own head. The officer backed off, but followed the vehicle with up to 20 police cars participating in the chase. Over 20 helicopters joined the chase!

Police detective Tom Lange, who had previously interviewed Simpson about the murders on June 13, realized that he had Simpson's cell number and called him repeatedly. Lange pleaded with Simpson to "throw the gun out the window" for the sake of his mother and his children. Thousands of spectators and onlookers packed overpasses along the procession's journey waiting for the white Bronco. They and millions of others watched the chase on television. The chase ended at 8:00 p.m. at Simpson's Brentwood home. After remaining in the Bronco for about 45 minutes, Simpson was allowed to go inside for about an hour to speak to his mother. A few minutes later, Simpson surrendered to authorities.


Nicole Brown Simpson

On June 20, Simpson was arraigned and pleaded not guilty to both murders. The presiding judge ordered that Simpson be held without bail. Rather than a grand jury hearing, a 'probable cause' hearing was held to determine whether or not to bring Simpson to trial, which was a minor victory for his lawyers who would now have access to evidence as it was presented by the prosecution in contrast to a grand jury hearing. Following the preliminary hearing, the case was moved from Santa Monica to the Criminal Courts Building in downtown Los Angeles. At his arraignment on July 29, when asked how he pleaded to the murders, Simpson firmly stated: "Absolutely, one hundred percent, not guilty."

Televised by Court TV, the trial began on Jan 24, 1995. Los Angeles County prosecutor Christopher Darden argued that Simpson killed his ex-wife in a jealous rage. The prosecution spent the opening weeks of the trial presenting evidence that Simpson had a history of physically abusing Nicole. Even with no murder weapon and no witnesses to the murders, the prosecution felt they had a very strong case. Supported by DNA evidence, they fully expected a conviction. From the physical evidence collected, the prosecution claimed that Simpson drove to Nicole Brown's house on the evening of June 12 with the intention of killing her. They maintained that Nicole, after putting her two children to bed and while getting ready to go to bed herself, opened the front door after responding to a knock, where Simpson grabbed her before she could scream and attacked her with a knife. Forensic evidence suggested that Ron Goldman arrived at the front gate to the townhouse sometime during the assault where the assailant apparently attacked him and stabbed him repeatedly in the neck and chest. According to the prosecution, as Nicole Brown was found lying face down, the assailant, after finishing with Goldman, pulled her head back using her hair, put his foot on her back, and slit her throat with the knife, severing her carotid artery. They then argued that Simpson left a "trail of blood" from the condo to the alley behind it; there was also testimony that three drops of Simpson's blood were found on the driveway near the gate to his house on Rockingham Drive.

According to the prosecution, Simpson was last seen in public at 9:36 p.m. that evening when he returned to the front gate of his house with a family friend who lived in a guest house on Simpson's estate. Simpson was not seen again until 10:54 p.m., when he came out of the front door of his house to a waiting limousine hired to take him to Los Angeles Airport to fly to a convention in Chicago. Both the defense and prosecution agreed that

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the murders took place between 10:15 and 10:40 p.m., with the prosecution saying that Simpson drove his white Bronco the five minutes to and from the murder scene. They presented a witness in the area of Bundy Drive who saw a car similar to Simpson's Bronco speeding away from the area at 10:35 p.m.

According to his testimony, limousine driver Allan Park arrived at Simpson's estate at 10:24 p.m. He did not see Simpson's white Bronco parked at the curb. Prosecution presented exhibits to show that the position in which the Bronco was found the next morning was right next to the house (implying that Park would surely have noticed the Bronco if it had been there at that time). Park began to buzz the intercom at the gate at 10:40, getting no response. He saw that the house was dark with no lights on, save for a dim light coming from Simpson's bedroom. At about 10.50, Park testified that he saw "a tall black man" of Simpson's height and build enter the front door of the house from the driveway area, after which lights went on and Simpson finally answered Park's call, explaining that he had overslept and would open the front gate soon. He then opened the gate by remote control to let Park drive in to the estate grounds, and came out of his house through the front door a few minutes later. Park helped Simpson put his belongings in the trunk of the limo for the ride to the airport. Park remarked in his testimony that Simpson looked agitated.

Simpson's initial claim that he was asleep at the time of the murders was replaced by a series of different stories. According to the defense lawyer Johnnie Cochran, Simpson had never left his house that night and that he was alone in his house packing to travel to Chicago.

The prosecution used several tactics to show Simpson's culpability. DNA analysis of blood found on a pair of Simpson's socks found in his bedroom identified it as Nicole Brown's. Both socks had about 20 stains of blood. DNA analysis of the blood found in, on, and near Simpson's Bronco revealed traces of Simpson's, Brown's, and Goldman's blood. DNA analysis of bloody socks found in Simpson's bedroom proved this was Brown's blood. A few strands of African-American hair were found on Goldman's shirt. Several coins were found along with fresh blood drops behind Nicole's condo, in the area where the cars were parked.

DNA analysis of blood on the left-hand glove, found outside Brown's home, was proven to be a mixture of Simpson's, Brown's, and Goldman's. Although the glove was soaked in blood, there were no blood drops leading up to, or away from the glove. No other blood was found in the area of the glove except on the glove. The gloves contained particles of hair consistent with Goldman's hair and a cap contained carpet fibres consistent with fibres from Simpson's Bronco. A black knit cap at the crime scene contained strands of African-American hair. Several strands of dark blue cotton fibres were found on Goldman, and the prosecution presented a witness who said Simpson wore a similarly-coloured sweat suit that night. The left-hand glove found at Nicole Brown's home and the right-hand glove found at Simpson's home proved to be a match.

However, the LA County District Attorney's Office and the Medical Examiner's Office could not explain why 1.5 cm^3 of blood were missing from the original 8 cm^3 taken from Simpson and placed into evidence. Much of the incriminating evidence: bloody glove, bloody socks, blood in and on the Bronco, was discovered by Los Angeles Police Detective Mark Fuhrman, who was later charged with perjury for making some false claims.

The bloody shoe prints at the crime scene were identified by FBI shoe expert William Bodziak as having been made by a pair of extremely rare and expensive Bruno Magli shoes. The large size (12) prints matched Simpson's shoe size.

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Evidence collected by LAPD criminalist Dennis Fung came under criticism. He admitted to "having missed a few drops of blood on a fence near the bodies", but on the stand he said that he "returned several weeks afterwards to collect them". Fung also admitted that he had not used rubber gloves when collecting some of the evidence.

The DNA evidence: Samples from bloody shoe prints leading away from the bodies and from the back gate of the condominium were tested for DNA profiles, which matched. Dennis Fung testified that this DNA evidence put Simpson at Nicole Brown's townhouse at the time of the murders. But during cross-examination (which lasted 8 full days!) most of the DNA evidence was questioned. Blood evidence had been tested at two separate laboratories, each conducting different tests. Despite that safeguard, it emerged during the cross-examination of Fung and the other laboratory scientists that the police scientist Andrea Mazzola (who collected blood samples from Simpson to compare with evidence from the crime scene) was a trainee who carried the vial of Simpson's blood around in her lab coat pocket for nearly a day before handing it over as an exhibit! What should have been the prosecution's strong point became their weak link amid accusations that bungling police technicians handled the blood samples with such a degree of incompetence as to render the delivery of accurate and reliable DNA results almost impossible. On May 16, Gary Sims, a California criminalist who helped establish the Dept of Justice's DNA laboratory, testified that a glove found at Simpson's house tested positive for a match of Goldman's blood.

One dark leather glove was found at the crime scene, its match found near the guest house behind Simpson's estate. Brown had bought Simpson two pairs of this type of glove in 1990. Both gloves, according to the prosecution, contained DNA evidence from Simpson, Brown and Goldman, with the glove at Simpson's house also containing a long strand of blonde hair similar to Brown's. On June 15, 1995, defense attorney Johnnie Cochran goaded assistant prosecutor Christopher Darden into asking Simpson to put on the leather glove that was found at the scene of the crime. The prosecution had earlier decided against asking Simpson to try on the gloves because the glove had been soaked in blood from Simpson, Brown and Goldman, and frozen and unfrozen several times. The leather glove seemed too tight for Simpson to put on easily. The prosecution stated their belief that the glove shrank from having been soaked in blood and later testing. A photo was presented during the trial showing Simpson wearing the same type of glove that was found at the crime scene.

Prosecutors claimed that the presence of Simpson's blood at the crime scene was the result of blood dripping from cuts on the middle finger of his left hand. Police noted his wounds on June 13, 1994, and asserted that these were suffered during the fatal attack on Ronald Goldman. However, the defense noted that none of the gloves found had any cuts. Plus, both prosecution and defense witnesses testified to not seeing any cuts or wounds of any kind on Simpson's hands in the hours after the murders took place. The defense also alleged that Fuhrman may have planted the glove at Simpson's house after taking it from the crime scene, and that the analysis finding that the hair could be Brown's could not be reliable. The prosecution contended that this was not the case, pointing out that by the time Fuhrman had arrived at the Simpson home after leaving Nicole Brown's home, the crime scene had already been combed over by several officers for almost two hours, and none had noticed a second glove at the scene. On Sept 8, 2012, Darden accused Cochran of tampering with the glove before the trial.

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At 10 am on October 3, 1995, the jury returned a verdict of 'not guilty'. An estimated 100 million people worldwide stopped what they were doing to watch or listen to the announcement. Many were shocked at the verdict.

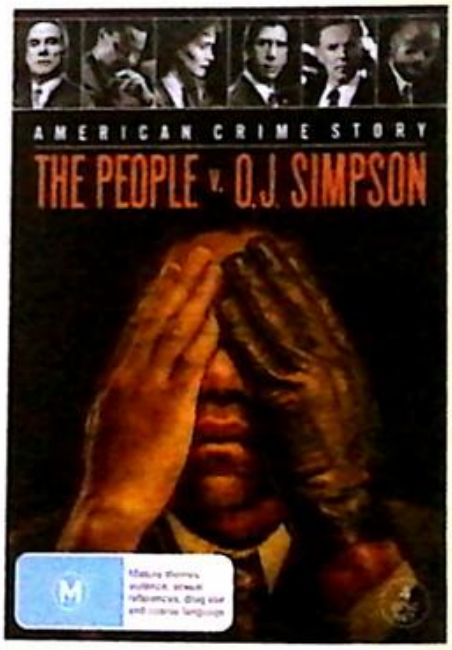
In 1997, the parents of Ron Goldman brought a civil suit against Simpson for wrongful death, and Brown's estate, represented by her father, also brought a suit against Simpson. The trial took place over 4 months in Santa Monica and was not televised. The jury in the civil trial awarded Brown and Simpson's children, Sydney and Justin, $12.6 million from their father as recipients of their mother's estate. The victims' families were awarded $33.5 million in compensatory and punitive damages.

In Sept 2007, Simpson was arrested in Las Vegas, Nevada, and charged with numerous felonies, including armed robbery and kidnapping in another case. In 2008, he was found guilty and sentenced to 33 years imprisonment, with a minimum of nine years without parole. He is currently serving his sentence at the Lovelock Correctional Center in Lovelock, Nevada.

The case has been adapted into a highly acclaimed TV Mini Series titled **'The People v. O.J. Simpson: American Crime Story'** (Box 24.5).

Box 24.5 The People v. OJ Simpson: American Crime Story

'The People v. O.J. Simpson: American Crime Story' is the first season of the FX true crime anthology television series - American Crime Story. The season, which debuted on February 2, 2016, revolves around the O. J. Simpson murder case and is based on Jeffrey Toobin's book 'The Run of His Life: The People v. O.J. Simpson' (1997). The TV series has been acclaimed by critics, receiving praise for most of the performances, directing and writing. For the 68th Primetime Emmy Awards, the season received 22 Primetime Emmy Award nominations, in 13 categories, winning nine, more than any other show. It also won the Golden Globe Awards for Best Miniseries or Television Film; and Best Actress - Miniseries or Television Film for Sarah Paulson.



The review aggregator Rotten Tomatoes gave the TV series an approval rating of 97%, based on 64 reviews, with an average rating of 8.6/10. The site's critical consensus reads, "The People v. O.J. Simpson: American Crime Story brings top-shelf writing, directing, and acting to bear on a still-topical story while shedding further light on the facts - and provoking passionate responses along the way." On Metacritic, another review aggregator, the series has a score of 90 out of 100, based on 43 critics, indicating "universal acclaim".

However, Ron Goldman's father, Fred Goldman, has been highly critical of the series. He stated that there was not enough material about Ron, who is only depicted on the show as a corpse, and also expressed concern that the generations of people who were too young to understand the events at the time would consider everything to be accurate. Nicole Brown's sister, Tanya Brown, lashed out at the cast members for what she saw as a lack of consultation with the families.

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CHAPTER 25

Recent Advances in Forensic Science

Part A: Scientific Methods of Forensic Investigation

I didn't invent forensic science and medicine. I just was one of the first people to recognize how interesting it is.
–**Patricia Cornwell** *(b:1956; American crime fiction writer)*

INTRODUCTION

New advances in forensic science technology are taking the field of crime investigation to an entirely new level, assisting the police as they solve crimes that had previously stumped even the best police officers and forensic scientists around the world. Today, revolutionary methods are being perfected that can help investigators and forensic experts solve the most brutal and challenging crimes, including assault, rape, and murder. The following is a glimpse into some of these intriguing new advances.

Alternative Light Photography

For a clinical-forensic expert (or forensic physician), being able to quickly ascertain how much physical damage an injured/assaulted patient has suffered can be the difference between life and death. Although they have many tools at their disposal to help make these calls quickly and accurately, Alternative Light Photography is emerging as one of the best techniques to help visualise damage even before it is visible on the skin. A camera such as the Omnichrome (Fig 25.1) uses blue light and orange filters to clearly show bruising below the skin's surface even before it becomes visible to the naked eye.

Forensic Facial Reconstruction (Forensic Facial Approximation, Forensic Sculpting)

This is the process of recreating the face of an individual (whose identity is often not known) from their skeletal remains through an amalgamation of artistry, forensic science, anthropology, osteology and anatomy. It is one of the most subjective-as well as one of the most controversial-techniques in the field of forensic anthropology. Despite the controversy, facial reconstruction has proved successful frequently enough that research and methodological developments continue to be advanced.

| Fig. 25.1 Omnichrome Camera |

Types

Two-dimensional reconstruction

Two-dimensional facial reconstructions are based on antemortem photographs, and the skull. Occasionally skull radiographs are used, but this is not ideal since many cranial structures are not visible or at the correct scale. This method usually requires the collaboration of an artist and a forensic anthropologist. A commonly used method of 2D facial reconstruction was pioneered by **Karen T Taylor** of Austin, Texas during the 1980s. Taylor's method involves adhering tissue depth markers on

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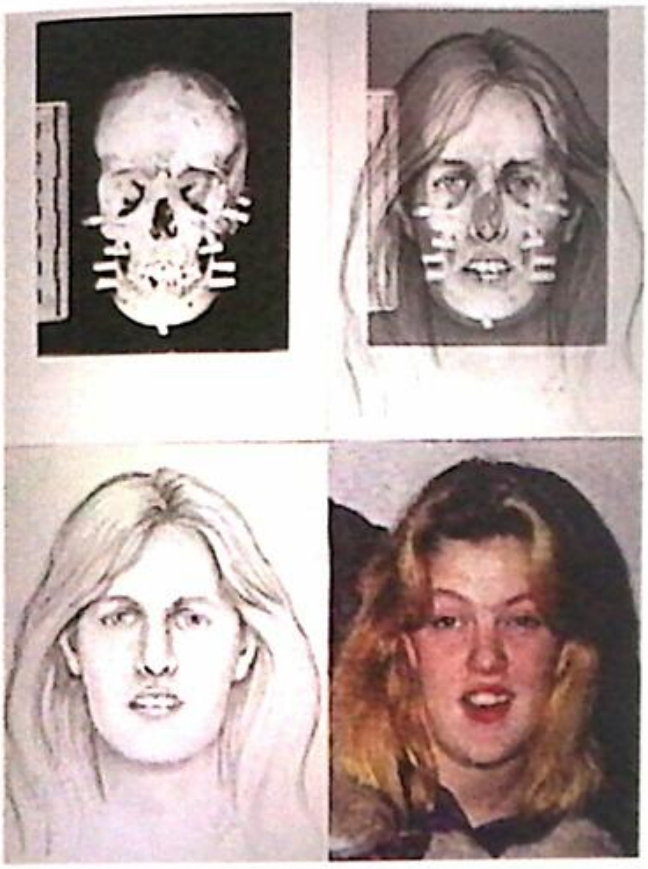
an unidentified skull at various anthropological landmarks, then photographing the skull. Life-size or one-to-one frontal and lateral photographic prints are then used as a foundation for facial drawings done on transparent vellum (Fig 25.2). Recently developed, the F.A.C.E. and C.A.R.E.S. computer software programs quickly produce two-dimensional facial approximations that can be edited and manipulated with relative ease. These programs may help speed the reconstruction process and allow subtle variations to be applied to the drawing, though they may produce more generic images than hand-drawn artwork.



| Fig. 25.2 An example of a 2D facial reconstruction conducted by Karen Taylor, and the subsequent identification of the victim, April Dawn Lacy |

Three-dimensional reconstruction

Three-dimensional facial reconstructions are either: 1) sculptures (made from casts of cranial remains) created with modelling clay and other materials or 2) high-resolution, three-dimensional computer images. Like 2D reconstructions, three-dimensional reconstructions usually require both an artist and a forensic anthropologist. Computer programs create three-dimensional reconstructions by manipulating scanned photographs of the unidentified cranial remains, stock photographs of facial features, and other available reconstructions. These computer approximations are usually most effective in victim identification because they do not appear too artificial. This method has been adapted by the National Center for Missing & Exploited Children, which uses this method often to show approximations of an unidentified decedent to release to the public in hopes to identify the subject.

One of the most sensational cases solved by forensic facial reconstruction of an absconding criminal who had killed his entire family and then disappeared for 18 years, by utilizing the procedure of an age-progressed clay bust, sculpted by forensic artist **Frank Bender** is that of **John Emil List** (Box 25.1).

Automated Fingerprint Identification System (AFIS)

Automated fingerprint identification is the process of automatically matching one or many unknown fingerprints against a database of known and unknown prints. Automated fingerprint identification systems are primarily used by law enforcement agencies for criminal identification initiatives, the most important of which include identifying a person suspected of committing a crime or linking a suspect to other unsolved crimes. Many countries, including USA, Canada, the European Union, the United Kingdom, Italy, Australia, India, etc., have their own systems, which are used for a variety of purposes, including criminal identification, applicant background checks, receipt of benefits, and receipt of credentials (such as passports).

The Integrated Automated Fingerprint Identification System (IAFIS) is a national automated fingerprint identification and criminal history

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Box 25.1 John Emil List - The Bogeyman of Westfield

John Emil List was born in 1925 in Bay City, Michigan, USA, the only child of German American parents, who were very religious and brought up their son with strict discipline. In 1943, John List joined the Army and served in the infantry during World War II. After his discharge in 1946, he earned a bachelor's degree in business administration and a master's degree in accounting. In November 1950, as the Korean War escalated, List was recalled to active military service. At Fort Eustis, in Virginia, he met Helen Morris Taylor, the widow of an infantry officer killed in action in Korea, who lived nearby with her daughter, Brenda. John and Helen married on December 1, 1951, in Baltimore, and the family moved to northern California where List served as an Army accountant.

John Emil List with his family - 1971

After completion of his second tour in 1952, List worked as an audit supervisor at a paper company in Kalamazoo, where their three children were born. By 1959 List had risen to general supervisor of the company's accounting department; but Helen, an alcoholic, had become increasingly unstable. In 1960, Brenda married and left the household, and List moved with the remainder of his family to Rochester, New York, to take a job with Xerox, where he eventually became director of accounting services. In 1965, he accepted a position as vice president and comptroller at a bank in Jersey City, New Jersey, and moved with his wife, children, and mother into Breeze Knoll, a 19-room Victorian mansion in Westfield.

The house of horrors where the murders were committed

On November 9, 1971, List methodically murdered his entire family, using his own 9mm semi-automatic handgun and his father's Colt .22 calibre revolver. While his children were at school he shot his wife Helen, 46, in the back of the head, and then his mother Alma, 84, above the left eye, as she lay in bed. When his daughter Patricia, 16, and younger son Frederick, 13, arrived home from school, he shot each of them in the back of the head. After making himself lunch, List drove to his bank to close his own and his mother's bank accounts, and then to Westfield High School to watch his elder son John Jr., 15, play in a soccer game. He drove the boy home, then shot him repeatedly in the chest and head.

List placed the bodies of his wife and children on sleeping bags in the mansion's ballroom. He left his mother's body in her apartment in the attic. In a five-page letter to his pastor, found later on the desk in his study, he wrote that he saw too much evil in

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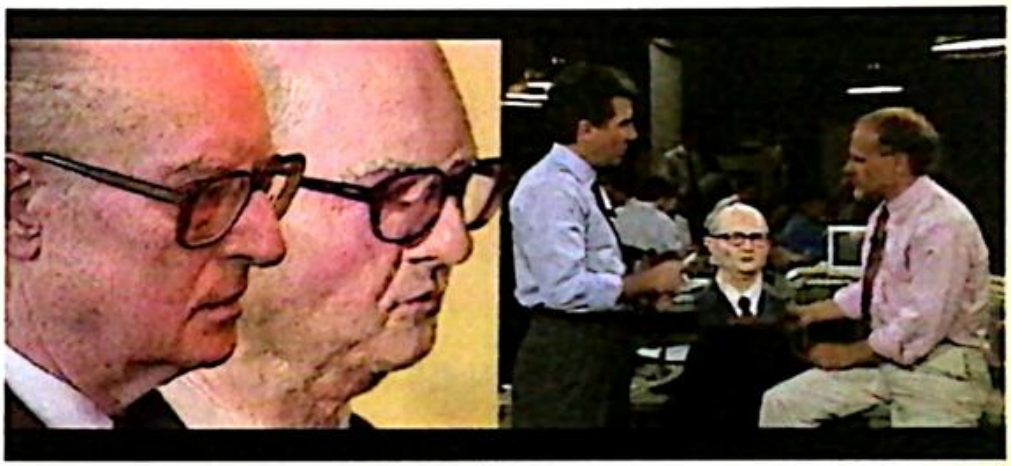
the world, and he had killed his family to save their souls. He then cleaned the various crime scenes, carefully cut his own picture out of every family photograph in the house, tuned a radio to a religious station, and departed.

The murders were not discovered until December 7, nearly a month later, due in part to the family's reclusiveness, and in part to notes sent by List to the children's schools stating that the family would be visiting Helen's mother in North Carolina for several weeks. He also stopped milk, mail and newspaper deliveries. Neighbours noticed that all of the mansion's lights were illuminated day and night, with no apparent activity within. Finally, as the lights began burning out one by one, they called the police.

The case became the most notorious crime in New Jersey history, and a nationwide manhunt was launched. Police investigated hundreds of leads without success. All reliable photographs of List had been destroyed. The family car was found parked at Kennedy Airport, but there was no evidence that he had boarded a flight.

Eighteen years later, on May 21, 1989, the murders were recounted on the television program "America's Most Wanted". The broadcast featured an age-progressed clay bust, sculpted by forensic artist **Frank Bender**, which turned out to bear a close resemblance to List's actual appearance. List was located and arrested in Virginia less than two weeks after the episode was broadcast.

In 1971, as the FBI later discovered, List had travelled by train from New Jersey to Michigan, and then Colorado. He settled in Denver in early 1972 and took an accounting job as Robert Peter "Bob" Clark, the name of one of his college classmates. From 1979 to 1986 he was the comptroller at a paper box manufacturer outside Denver. He joined a Lutheran congregation and ran a car pool for church members. At one religious gathering he met an Army clerk named Delores Miller and married her in 1985. In February 1988 the couple moved to Midlothian, Virginia, where List, still using the name Bob Clark, resumed work as an accountant.



John List alongside his bust, sculpted by Frank Bender (right)

On June 1, 1989 he was arrested at a Richmond, Virginia, accounting firm after a Denver neighbour viewed the "America's Most Wanted" broadcast, recognized the profile, and alerted authorities. He continued to stand by his alias for several months, even after extradition to Union County, New Jersey, in late 1989; however, faced with irrefutable evidence-including a fingerprint match with List's military records and then with evidence found at the crime scene-he confessed his true identity on February 16, 1990.

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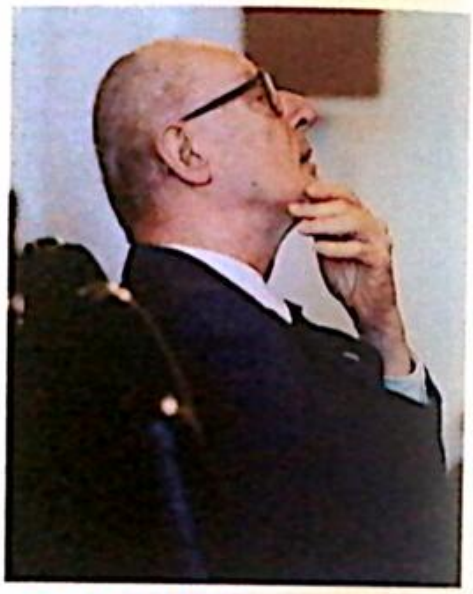
At trial, List testified that he was faced with grave financial difficulties in 1971: he had lost his job at the Jersey City bank. To avoid sharing this humiliating development with his family, he spent each workday at the Westfield train station, reading newspapers until it was time to come home. He skimmed money from his mother's bank accounts to avoid defaulting on his mortgage. He was also dealing with his wife's alcoholism and her untreated tertiary syphilis, contracted from her first husband-the Army lieutenant killed in combat in Korea-and concealed for 18 years.

A court-appointed psychiatrist testified that List suffered from obsessive-compulsive personality disorder and that he saw only two solutions to his situation: accept welfare or kill his family and send their souls to Heaven. Welfare was an unacceptable option, he reasoned, because it would expose him and his family to ridicule and violate his authoritarian father's teachings regarding the care and protection of family members.



John List at his trial

On April 12, 1990, List was convicted of 5 counts of first degree murder. At his sentencing hearing he denied direct responsibility for his actions: "I feel that because of my mental state at the time, I was unaccountable for what happened. I ask all affected by this for their forgiveness, understanding and prayer." The judge was unpersuaded: "John Emil List is without remorse and without honour," he said. "After 18 years, 5 months and 22 days, it is now time for the voices of Helen, Alma, Patricia, Frederick and John F. List to rise from the grave." He imposed a sentence of 5 terms of life imprisonment, to be served consecutively - the maximum permissible penalty at the time.

List later expressed a degree of remorse for his crimes: "I wish I had never done what I did," he said. "I've regretted my action and prayed for forgiveness ever since." When asked by a reporter in 2002 why he had not taken his own life, he said he believed that suicide would have barred him from Heaven, where he hoped to be reunited with his family.

List died from complications of pneumonia at age 82 on March 21, 2008, while in prison custody at St. Francis Medical Center in Trenton, New Jersey. In reporting his death, the local newspaper referred to him as **"the bogeyman of Westfield"**.

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system maintained by the Federal Bureau of Investigation (FBI) in the U.S. IAFIS provides automated fingerprint search capabilities, latent searching capability, electronic image storage, and electronic exchange of fingerprints and responses. IAFIS houses the fingerprints and criminal histories of 70 million subjects in the criminal master file, 31 million civil prints and fingerprints from 73,000 known and suspected terrorists processed by the U.S. or by international law enforcement agencies. Employment background checks and legitimate firearms purchases cause citizens to be permanently recorded in the system. For instance, the State of Washington mandates that all applicants seeking employment in an inpatient setting that houses vulnerable minors (such as children who are mentally challenged, physically or emotionally ill) are fingerprinted and entered into IAFIS as part of their background check in order to determine if the applicant has any record of criminal behaviour.

Fingerprints are voluntarily submitted to the FBI by local, state, and federal law enforcement agencies. These agencies acquire the fingerprints through criminal arrests or from non-criminal sources, such as employment background checks and the US-VISIT program. The FBI then catalogues the fingerprints along with any criminal history linked with the subject.Law enforcement agencies can then request a search in IAFIS to identify crime scene (latent) fingerprints obtained during criminal investigations.

DNA Sequencer

The importance of DNA testing in the forensic science lab is well known today. Still, many people are unaware exactly what DNA sequencers are and how they may be used in forensic DNA analysis. Most forensic scientists and crime lab technicians use DNA profiling to identify criminals and victims using trace evidence like hair or skin samples. In cases where those samples are highly degraded, however, they often turn to the more powerful DNA sequencer, which allows them to analyze old bones or teeth to determine the specific ordering of a person's DNA nucleobases, and generate a "read", or a unique DNA pattern, that can help identify that person as a possible suspect or criminal.

STRmix

STRmix™ is a promising breakthrough for forensic DNA analysts as it can assist investigations using DNA evidence that was previously considered too complex to interpret. The software has been developed by New Zealand Crown research institute ESR, with Forensic Science South Australia (FSSA). STRmix™ includes a function that allows the software to match mixed DNA profiles directly against a database. This is a major advance for cases where there are no suspects, and there is DNA from multiple contributors in one sample.

With STRmix™ a forensic analyst can:

- interpret DNA results faster
- compare profiles against a person of interest and calculate a likelihood ratio
- resolve previously unresolvable, complex DNA mixtures with no restriction on the number of contributors
- use more of the information in a DNA profile
- search complex, mixed DNA profiles against a database.

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Part B: Scientific Methods of Suspect Interrogation

To call something an 'enhanced interrogation technique' doesn't alter the fact that we thought it was torture when the Japanese used it on American prisoners, we thought it was torture when the North Koreans used it, we thought it was torture when the Soviets used it. You know, it's almost the moral equivalent of saying that rape is an enhanced seduction technique.

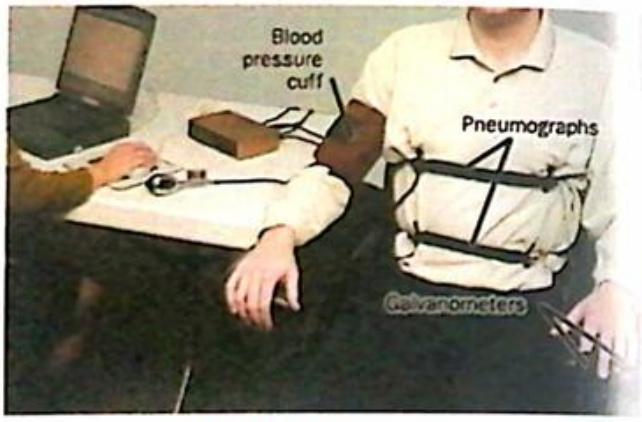
—**Ted Koppel** (b.1940; American broadcast journalist)

INTRODUCTION

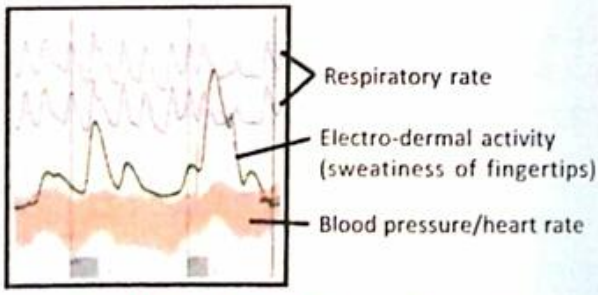
- **Interrogation** or **questioning** is a method employed by the police for getting information from a suspect, witness, or victim after a crime has been committed.
- There are multiple methods of interrogation including interviewing, torture, increasing suggestibility (sleep deprivation, hypnotism), using mind-altering drugs (narcoanalysis), and probing the subconscious by specialized techniques (polygraph, brain fingerprinting, brain mapping, etc).
- Methods of torture and their legal and ethical aspects have been dealt with in **Chapter 6**. Police interview methods such as the **Reid Technique** are not within the scope of this book, and therefore will not be discussed at all.
- In this chapter, only the scientific methods of interrogation will be discussed, though some of these are actually more in the realm of pseudo-science than pure science.

Polygraph (Lie Detector)

- A **polygraph** (popularly known as a **lie detector**) is an instrument that measures and records several physiological responses such as blood pressure, pulse, respiration, breathing rhythms, body temperature, and skin conductivity while the subject is asked and answers a series of questions, on the theory that false answers will produce distinctive measurements (Fig. 25.3). In other words, the polygraph measures physiological changes caused by the sympathetic nervous system during questioning (Fig. 25.4).
- This method of interrogation is sometimes referred to as **psychophysiological detection of deception (PDD)**.



| Fig. 25.3 Polygraph |



| Fig. 25.4 A Typical Polygraph Recording |

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The Beginning

- A device recording both blood pressure and galvanic skin response was invented in 1921 by **Dr John A. Larson** of the University of California, and first applied in law enforcement work by the Berkeley Police Department. Further work on this device was done by **Leonarde Keeler**.
- **William Marston** (1893–1947), who used blood pressure and galvanic skin response to examine German Prisoners of War, however, is the self proclaimed "father of the polygraph" despite his predecessors' contributions (Fig. 25.5). In 1938 he published a book, *The Lie Detector Test*, wherein he documented the theory and use of the device.

| Fig. 25.5 William Marston |

The Technique

- Today there are two types of instrumentation: analogue and computerized. In many countries, the computerized instrumentation is preferred.
- A typical polygraph test starts with a pre-test interview to gain some preliminary information which will later be used for "Control Questions," or CQ. The tester will then explain how the polygraph is supposed to work, emphasizing that it can detect lies, and that it is important to answer truthfully.
- This is followed by the actual test:
  - Some of the questions asked are "Irrelevant" or IR ("Is your name Gopal?"), others are "probable-lie" Control Questions that most people will lie about ("Have you ever stolen money?") and the remainder are the "Relevant Questions," or RQ, that the tester is really interested in.
  - The different types of questions alternate. The test is passed if the physiological responses during the probable-lie control questions (CQ) are larger than those during the relevant questions (RQ).
- An alternative is the Guilty Knowledge Test (GKT), or the Concealed Information Test (CIT):
  The test is usually conducted by a tester with no knowledge of the crime or circumstances in question. The administrator tests the participant on their knowledge of the crime that would not be known to an innocent person. For example: "Was the crime committed with a knife or a gun?"
  The questions are in multiple choice and the participant is rated on how they react to the correct answer. If they react strongly to the guilty information, then proponents of the test believe that it is likely that they know facts relevant to the case. This method is considered more valid by supporters of the test because it contains many safeguards to avoid the risk of the administrator influencing the results.

25

Reliability

- Some studies of polygraph validity have achieved rates of 80–95% accuracy in criminal cases. Despite such claims, critics argue that rather than a "test," the method amounts to an inherently unstandardizable interrogation technique whose accuracy cannot be established.
- A 1997 survey by 421 psychologists estimated the test's average accuracy at only 61%, a little better than chance.
- In 2001, William G. Iacono, Distinguished Professor of Psychology and Neuroscience at the University of Minnesota published a paper in which he stated that "Although this technique may be useful as an investigative aid and tool to induce confessions, it does not pass muster as a scientifically credible test."
- Polygraph evidence is not admissible in court in most countries of the world, including India.
- The **Frye standard** (Frye test, 'general acceptance test') is a test to determine the

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admissibility of scientific evidence.* It provides that expert opinion based on a scientific technique is admissible only where the technique is generally accepted as reliable in the relevant scientific community. This standard comes from Frye v. United States (1923), a case that discussed the admissibility of polygraph test as evidence. The Court in Frye held that expert testimony must be based on scientific methods that are sufficiently established and accepted. The Judge in this case expressed reservations about (a precursor of the current) polygraph test.

Voice Stress Analysis (Voice Risk Analysis)

Voice stress analysis (VSA) or Voice risk analysis uses computers to compare pitch, frequency, intensity, and micro tremors in the voice of a person. In this way, voice analysis detects minute variations in the voice thought to signal lying. It can even be used covertly over the phone, and has been used by banking and insurance companies in the West. Customers are assessed for truth in certain situations by banks and insurance companies where computers are used to record responses. Software then compares control questions to relevant questions assessed for deception. However, its reliability has been debated by peer-reviewed journals.

Recently conducted studies have however, identified that the detection of deception is possible with the use of voice stress analysis software loaded onto a laptop computer. Some studies have suggested that voice stress analysis (VSA) technology can identify emotional stress better than polygraph. One scientific investigator was able to show that VSA detected stress associated with criminal activities in 95% of the cases studied. He found no cases wherein a confession was obtained in the absence of stress. In particular, the most considerable stress levels were detected during the investigation of murder and sexual crimes.

Narcoanalysis

- **Narcoanalysis Test** or **Narco Test** refers to the practice of administering barbiturates or certain other chemical substances, most often pentothal sodium (thiopentone sodium), to lower a subject's inhibitions, in the hope that the subject will more freely share information and feelings.
- The term "Narcoanalysis" was coined by **Horseley**. Narcoanalysis first reached the mainstream in 1922, when **Robert House**, a Texas obstetrician, used scopolamine on two prisoners. Since then narco testing has become largely discredited in most democratic states, including the United States and Britain. There is a vast body of literature calling into question its ability to yield legal truth. Additionally, narcoanalysis has serious legal and ethical implications.

The Technique

- Experts inject the suspect with barbiturates like pentothal sodium (thiopentone sodium) or sodium amytal (amylobarbitone) under controlled circumstances of the laboratory (Fig. 25.6)
- The dose is dependent on the person's sex, age, health and physical condition.
- The subject who is put in a state of hypnotism is not in a position to speak up on his own, but can answer simple questions, after giving some suggestions.

Reliability

- In most Western countries, narcoanalysis is not admissible in court as evidence.
- Studies have shown that it is possible to lie under narcoanalysis, while conversely, an innocent person may inadvertently implicate himself in a crime.
- Unfortunately, India still continues to use narcoanalysis, though the result of such a test cannot be used as evidence in the court of law, since it violates the fundamental right against

Today the **Daubert standard is used by most courts of law while deciding on the legal admissibility of a new scientific technique, which considers the following points: whether the theory or technique is testable; whether it has been subjected to peer review and publication; the potential error rate; the existence of standards and controls concerning its operation; and the degree to which the theory and technique is accepted by the scientific community.*

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self-incrimination (Article 20(3) of the Constitution of India).

- However on May 5, 2010, the Supreme Court in the case 'Smt Selvi vs State of Karnataka' held that narcoanalysis, polygraph and brain mapping tests can be allowed after obtaining consent of the accused. When they are conducted with consent, the material so obtained is regarded as evidence during trial of cases according to Section 27 of the Evidence Act.

| Fig. 25.6 Narcoanalysis. A suspect is being 'narcoanalysed' in Bangalore in a 2004 double murder case. In the drug-induced state, she spoke about a knife and purse allegedly involved in the crime but neither was recovered by the police. The outcome: acquittal owing to a lack of evidence. The judge also ruled that the narcoanalysis report and videograph could be used only for investigative purposes and not to convict suspects. *Pic: Courtesy "The Hindu"* |

Brain Fingerprinting

- **Brain Fingerprinting** is a controversial forensic science technique that determines whether specific information is stored in a subject's brain by measuring electrical brainwave responses to words, phrases, or pictures that are presented on a computer screen.
- Brain fingerprinting was invented by **Lawrence Farwell** (Fig. 25.7). The theory is that the brain processes known, relevant information differently than it processes unknown or irrelevant information. The brain's processing of known information, such as the details of a crime stored in the brain, is revealed by a specific pattern in the EEG (electroencephalograph).

| Fig. 25.7 Lawrence Farwell |

- Farwell's brain fingerprinting originally used the well known **P300** brain response to detect the brain's recognition of the known information.
  - P300 is emitted from an individual's brain beginning approximately 300 milliseconds after it is confronted with a stimulus of special significance, e.g., a rare vs. a common stimulus, or a stimulus the subject is asked to count.
  - The application of this in brain fingerprinting is to detect the P300 as a response to stimuli related to the crime or other investigated situation, e.g., a murder weapon, victim's face, or knowledge of the internal workings of a terrorist cell.
  - Because it is based on EEG signals, the system does not require the subject to issue verbal responses to questions or stimuli.
- Later Farwell discovered the **MERMER** ("Memory and Encoding Related Multifaceted Electroence-phalographic Response"), which includes the P300 and additional features and is reported to provide a higher level of accuracy than the P300 alone.

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- The person to be tested wears a special headband with electronic sensors that measure the EEG from several locations on the scalp. The subject views stimuli consisting of words, phrases, or pictures presented on a computer screen (Fig. 25.8). Stimuli are of three types:
  - **Irrelevant stimuli**, that are irrelevant to the investigated situation and to the test subject.
  - **Target stimuli**, that are relevant to the investigated situation and are known to the subject.
  - **Probe stimuli**, that are relevant to the investigated situation and that the subject denies knowing. Probes contain information that is known only to the perpetrator and investigators, and not to the general public or to an innocent suspect who was not at the scene of the crime. Before the test, the scientist identifies the targets to the subject, and makes sure that he/she knows these relevant stimuli. The scientist also makes sure that the subject does not know the probes for any reason unrelated to the crime, and that the subject denies knowing the probes. The subject is told why the probes are significant, but is not told which items are the probes, and which are irrelevant.

| Fig. 25.8 Brain Fingerprinting in Progress |

- By comparing the responses to the different types of stimuli, the brain fingerprinting system mathematically computes a determination of "information present" (the subject knows the crime-relevant information contained in the probe stimuli) or "information absent" (the subject does not know the information) and a statistical confidence for the determination (Fig. 25.9). This determination is mathematically computed, and does not involve the subjective judgment of the scientist.

Reliability

- In peer-reviewed publications Farwell and colleagues report over 99% accuracy in laboratory research and real-life field applications.
- Brain fingerprinting has been applied in a number of high-profile criminal cases, including helping to catch serial killer JB Grinder, and to exonerate an innocent convict **Terry Harrington** (Box 25.2) after he had been falsely convicted of murder.
- Brain fingerprinting has been ruled admissible in American courts.
- The situation is unclear in India. In the controversial Sister Abhaya murder case, the Ernakulam Chief Judicial Magistrate Court had asked the Central Bureau of Investigation to make use of all modern investigation techniques, including brain fingerprinting, lending judicial credibility to the technique.
- Brain fingerprinting technique has been criticized on a number of fronts. Although independent scientists who have used the same or similar methods as Farwell's brain fingerprinting have achieved similar, highly accurate results, different methods have yielded different results.
  - For example, Peter Rosenfeld used P300-based tests incorporating fundamentally different methods, resulting in as low as chance accuracy, as well as susceptibility to errors, and criticized brain fingerprinting based on the premise that the shortcomings of his alternative technique should apply to all other techniques in which the P300 is among the brain responses measured.

Brain Electrical Oscillation Signature Profiling (BEOS)

- This is a technique developed by an Indian neuroscientist, **Dr CR Mukundan** in 2003, for

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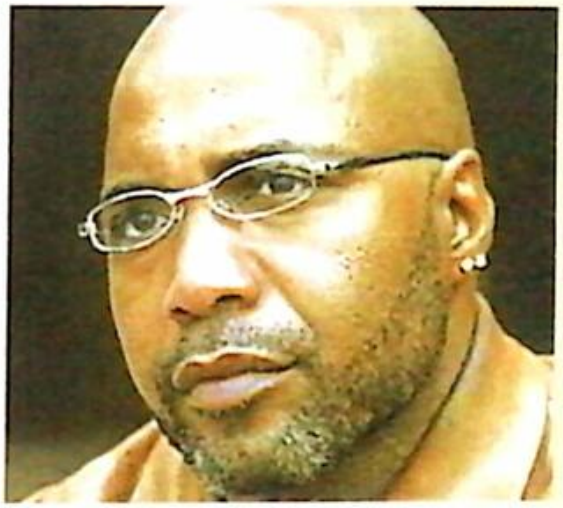
Box 25.2 The Terry Harrington Case

Terry Harrington spent over half of his life in prison for murder. Twenty-two years after his conviction, Dr Lawrence Farwell used Brain Fingerprinting testing to show with a 99.9% statistical confidence level that the record stored in Harrington's brain does not match the crime scene and does match his alibi. The testing showed that significant details of the crime are not stored in his brain. On February 26, 2003, the Iowa Supreme Court reversed his murder conviction and ordered a new trial. In October 2003, the State of Iowa elected not to re-try Mr Harrington and released him from prison.

In 1977, Harrington, who was 17 at the time, was arrested for the murder of John Schweer, a retired police captain who had been working as a security guard. Court records contain contradictory accounts of the events of the evening of the crime. In the trial, Harrington said that he had been with friends at a concert the evening of the murder. Several witnesses corroborated this alibi. The primary prosecution witness, 16-year-old Kevin Hughes, told a different story. He gave a detailed account of Harrington's alleged perpetration of the crime. A year later Harrington was found guilty and sentenced to life without parole, based almost entirely on Hughes' testimony.



Terry Harrington

In 1997, nineteen years after his conviction, Harrington petitioned the Iowa District court for post-conviction relief alleging several grounds for granting him a new trial, and in March 2000, he amended his petition to include the results of the Brain Fingerprinting testing.

In the Brain Fingerprinting tests, Harrington's brain did not emit a MERMER in response to critical details of the murder, details he would have known if he had committed the crime, indicating that this information was not stored in his brain. In a second Brain Fingerprinting test, one that included details about Harrington's alibi, Harrington's brain did respond with a MERMER, indicating that his brain recognized these events. The details used in the second test were facts about the alibi that Dr Farwell obtained from official court records and alibi witnesses.

When Dr Farwell confronted him with the Brain Fingerprinting test results exonerating Harrington, Kevin Hughes, the key prosecution witness, recanted his testimony and admitted that he had lied in the original trial, falsely accusing Harrington to avoid being prosecuted for the murder himself.

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Using Brain Waves to Detect Guilt

Brain fingerprinting uses brain waves to test memory. A crime suspect is given words or images in a context that would be known only to police or the person who committed the crime.

How It Works

A suspect is tested by looking at three kinds of information represented by different coloured lines

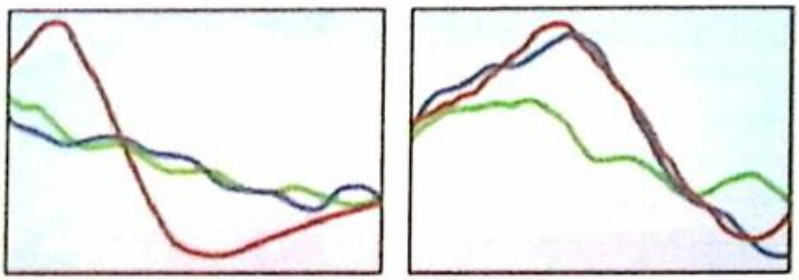
- Red: Information the suspect is expected to know.
- Green: Information not known to suspect.
- Blue: Information of the crime that only perpetrator would know

Not guilty

Because the blue and green lines closely correlate, suspect does not have critical knowledge of the crime.

Guilty

Because the blue and red lines closely correlate, suspect has critical knowledge of the crime.



| Fig. 25.9 Brain Fingerprinting – Recording and Interpretation |

extracting an 'electrophysiological signature' of an experience during its remembrance. In BEOS profiling, the subject is presented with a probe, which contains references to the episode to be remembered. The electrical oscillations/ activity related to remembrance is called the 'signature' of the experience. The awareness of the remembered episode is called 'experiential knowledge'. The test is supposed to measure remembrance of the 'experiential knowledge'. The results of BEOS are obtained in the form of electrical activity from the brain related to probes.

- The test expects the subject to remain silent and only listen to a narrative presented as short verbal statements (probes) in sequence. The subject need not give any oral response to the stimulus, but the brain waves indicate that the brain has some information in regard to these items.
- The system that performs this task is the 'Neuro Signature System' (NSS) which represents a complete deviation from the conventional method of asking questions. It is based on the finding that remembrance of an experience triggers a neural activation of the brain different from that seen in knowing or recognition of mere familiarity. NSS extracts indicators such as activation from the EEG of the subject being examined.
- The proponents of this technique (which is considered of dubious value by some Western investigators) claim that this method can be used to find the differential roles of suspects when two or more suspects have been involved, or for detecting the involvement of a suspect, even when they refuse to cooperate with questioning/interrogation. They say that the findings of the test can help identify and differentiate suspects from criminals. In which case if further examination is carried out based on the findings, it could help to recover material evidence or elicit confessions from them.
- Currently, this technique has not been validated thoroughly to the satisfaction of Western scientific investigators, even though it has been applied in a few criminal cases in India.

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Brain Mapping

- Brain mapping is a higher form of neuroimaging, producing brain images supplemented by the result of additional (imaging or non-imaging) data processing or analysis. For example, maps projecting (measures of) behaviour onto brain regions, such as the technique called functional magnetic resonance imaging (fMRI).

Functional Magnetic Resonance Imaging (fMRI)

- It is a type of specialized MRI scan, and measures the haemodynamic response related to neural activity in the brain or spinal cord of humans. It is one of the most recently developed forms of neuroimaging, and has the advantages of low invasiveness, lack of radiation exposure, and relatively wide availability.
- Changes in blood flow and blood oxygenation in the brain (haemodynamics) are closely linked to neural activity.
  - When nerve cells are active they increase their consumption of energy from glucose and switch to less energetically effective, but more rapid aerobic glycolysis.
  - The local response to this oxygen utilization is an increase in blood flow to regions of increased neural activity, occurring after a delay of approximately 1-5 seconds. This haemodynamic response rises to a peak over 4-5 seconds, before falling back to baseline.
  - This leads to local changes in the relative concentration of oxyhaemoglobin and deoxyhaemoglobin, and changes in local cerebral blood flow.
- Blood-oxygen-level dependent or **BOLD** is the MRI contrast of blood deoxyhaemoglobin, and is critical for functional brain imaging with MRI.
  - Neurons do not have internal reserves of energy in the form of glucose and oxygen, so their firing requires more energy to be delivered quickly. Through a process called the haemodynamic response, blood releases oxygen to them at a greater rate than to inactive neurons.
  - The magnetic resonance (MR) signal of blood is slightly different depending on the level of oxygenation. Higher BOLD signal intensities arise from increases in the concentration of oxygenated haemoglobin, since the blood magnetic susceptibility now more closely matches the tissue magnetic susceptibility.
  - By collecting data in an MRI scanner, one can assess changes in BOLD contrast. These changes can be either positive or negative depending upon the relative changes in both cerebral blood flow (CBF) and oxygen consumption. Increases in CBF that outstrip changes in oxygen consumption will lead to increased BOLD signal, and vice versa.
  - The signal difference is very small, but given many repetitions of a thought, action or experience, statistical methods can be used to determine the areas of the brain which reliably show more of this difference as a result, and therefore which areas of the brain are active during that thought, action or experience.
- BOLD effects are measured using rapid volumetric acquisition of images with contrast. Such images are usually taken every 1-4 seconds, and the voxels in the resulting image typically represent cubes of tissue about 2-4 mm on each side in humans.
- Subjects participating in an fMRI experiment are asked to lie still, and are usually restrained with soft pads to prevent small motions from disturbing measurements. An fMRI experiment usually lasts between 15 minutes and 2 hours. Depending on the purpose of study, subjects may view images, hear sounds, smell odours, perform cognitive tasks, press a few buttons, or perform other tasks.
- Upon completion of the experiment, the computer takes the slice images from the MRI and uses mathematical transformations and reconstruction algorithms to render the images, and then correct for distortion, subject movement, etc.

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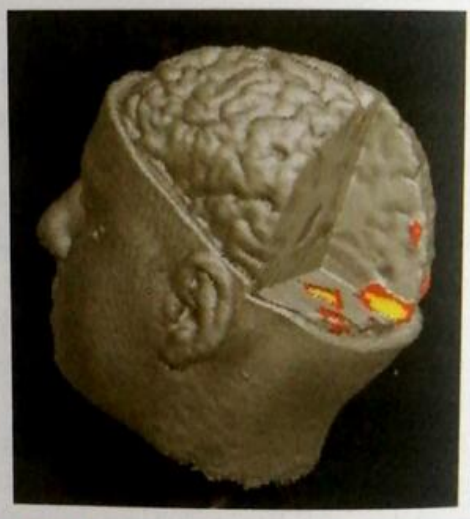
| Fig. 25.10 Temporal Sequence of MRI Scan (Single Slice) |

- The final image illustrates areas of activity during the experiment as coloured patterns overlaid upon the original high resolution scan (Fig 25.10). Researchers can also render the combined activation slice images into 3-D images which can be rotated to any angle (Fig 25.11).

Reliability

- This technology is in its early stages of development, but many of its proponents hope to replace older lie detection techniques with fMRI in the near future.



| Fig. 25.11 fMRI–3D Image of Brain Activation (Lighted Areas) |

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