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A Gateway to All Post Graduate Courses

1. Learning Outcomes

After studying this module, you shall be able to know about-

- The various aspects of death due to Firearm Injuries
- Post- mortem appearance in deaths due to Firearm Injuries
- Medico- legal aspects of death due to Firearm Injuries

2. Introduction

"There are no dangerous weapons. There are only dangerous men".. Robert A. Heinlein

Forensic Ballistics is the branch of science dealing with the investigation of firearms, ammunition and the problems arising from their use.

A **firearm** is any weapon which discharges a missile by the expansive force of the gases produced by the burning of an explosive substance.

Proximal (Internal) Ballistics is the study of firearms and projectiles.

Intermediate (Exterior) Ballistics is the study of the motion of projectile after it leaves the gun barrel till the time it hits the target.

Terminal Ballistics involves the study of behavior of missiles once they penetrate their targets.

Wound Ballistics is the study of the effect of missiles on living tissue.

3. Classification of Firearms

1) **Rifled Firearms:**

   a) **High velocity:** Shoulder arms e.g., rifle.
      Automatic weapon e.g., Machine gun, Sten gun etc.
   b) **Low velocity**: hand arms e.g., revolver, pistol.

2) **Smooth-bore firearm (shot gun):**
   a) Singe barreled or double barreled.
   b) Breech loader or muzzle loader.
   c) Cylinder bore or choke bore
   .

3) **Air or gas operated firearm:** generally, referred to as air guns, since most often compressed air is used to propel a projectile, these weapons are by no means innocuous as generally believed.

4) **Country made firearm:** These are crude, smooth bore weapons, but can be lethal. The ammunition is usually loaded through the muzzle end of the barrel.

4. Rifled Firearm Injury

Entry wound:

The distance between the muzzle end of the fire arm and the target is called range. This may be:

A) **Contact Range:** If the muzzle end is in contact with the body.
B) **Close range:** If the range is within the distance travelled by flame (extends upto 8 cm).
C) **Near range:** If it is within the distance travelled by un burnt or partially burnt gunpowder (extends upto 40 to 50 cm with handguns and 60 to 100 cm in rifles).
D) **Distant range:** If it is beyond the range of flames, 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, called **abrasion collar or areola**. In some cases there is contusion instead of abrasion, in which case it is more appropriately called **contusion collar.** The diameter of the entry hole together with the abrasion collar may give the approximate diameter of the bullet. The barrel of a fire arm is generally lubricated between uses. When such a weapon is fired, the bullet as it is propelled through the barrel would naturally carry this grease used as lubricant 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 **grease or dirt collar.** The abrasion and grease collars normally measure only about 0.3 cm to 0.7 cm respectively. 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/singeing of the 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 or peppering results from the 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 caliber of the weapon, the type of powder used and the range. The same may be absent, if the 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 carbon particle deposition over the skin and hence can be easily wiped off with a wet sponge. The intensity of the smudging will depend on the caliber of the weapon, the type of powder used and the range. Thus, the greater the caliber of the weapon, wider the area of blackening and vice versa. Smudging may also be absent on the skin, if firing has taken place through clothing. The presence of blackening, especially if a smokeless powder is used, may not be clearly visible to the naked eye. In such cases infrared or ultra violet photography will help to visualize it. Carbon mono oxide is also evolved on explosion of gun powder and imparts a cherry red color to the surrounding tissues.

A lead ring or metal ring around the entry wound results from 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.

Contact Shot:

The firearm is placed in contact with the skin or clothing. A contact wound over a dense area, such as the vault of the skull, 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. 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 mono oxide and therefore cherry red in color. Cranial contact wounds are generally seen on the forehead or temple. 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. The surrounding hair is also singed.

Close Shot:

The fire arm was fired within the range of flame and powder blast but was not in direct contact with skin or clothing. Flame travels approximately upto 75 cm in case of revolver or pistol and 15 cm in case of rifle. The wound appears as a circular hole surrounded by scorching, singeing, blackening and tattooing. Abrasion collar and grease collar 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. Un burnt powder grains and small metallic particles travel approximately up to 60 cm in the case of revolver and pistol an d75 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 30cm. Grease collar and abrasion collar are present.

Distant Shot:

It means that the fire arm was discharged outside the range of flame and powder blast. The entry wound is circular with inverted margins. Scorching, tattooing and blackening are all absent. Grease collar and abrasion collar are present. Distant shots suggest 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 wound present in the victim.

Skull:

In the skull, the wound of entrance shows a punched-in hole in the outer table. The inner table is un supported and a cone-shaped piece of bone is detached forming a crater that is larger than the hole on the outer table and shows beveling. Fissured fractures often radiate form the defect. As the bone fragments have to pass through the dura, before entering the brain, lacerations are usually irregular and involve leptomeninges. At the point of exit, a punched-out opening is produced in the inner table and beveled opening on the outer table. The wound is funnel shaped, with the funnel opening up in the direction in which the bullet is travelling in both entrance and exit wound. The exit wound is larger due to deformity and tumbling of the bullet after entering the skull. They may often be associated with fissured fractures, radiating from the central hole.

Exit wound:

Exit wound vary greatly in size, shape and configuration. They are usually larger than the corresponding wound of entry. Scorching, blackening and tattooing are absent. Abrasion and grease collars are also absent. The edges are invariably everted and if the skin at the exit wound appears to be circular or nearly circular clear defect, surrounded by margin of abrasion (usually broader than entry wound) resembling a wound of entrance, then it is called shored or supported exit wound. This phenomenon is caused by a bullet fires at long range or through clothing or when the firearm is of small caliber and discharged in contact with the skin at a point where bone is not immediately below the skin surface.

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.

5. Smooth Bore Firearm Injury

Entry wound:

- **Contact shot-**

- The contact shot wound in the case of shot gun is usually a large, irregular hole, resulting from the explosive blast effect.
- The edge of the defect is scorched by flame and the skin surrounding it is blackened by smoke and tattooed by un burnt gun powder.
- An imprint abrasion produced by the muzzle end may be seen.
- The shot which comprises of bunch of pellets passes into the body as a solid mass.
- The injured tissue is usually cherry red in color.
- 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.

- **Close shot (upto 1 metre)-**

- This produces a circular defect with irregular inverted borders.
- The edges are scorched due to flame and blackened by smoke.
- A fairly wide zone of tattooing may surround the edges of the wound.
- Tissues often appear cherry red in color.
- The pellets enter the track en masse.
- 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 (upto 2 metre)-

- The wound is circular or oval in shape.
- Blackening may be evident around the wound up to a maximum distance of 30cm.
- 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 compact mass upto a distance of about 45 cm, after which they begin to disperse.
- The entry wound is approximately 2.5cm in diameter.
- If the shot enters at an angle less than 90^0, shape of the wound may become triangular or semi-circular.

➢ Distant shot (Beyond 2 metre)-

- Beyond a range of 2 metres, there will be burning, blackening.
- Tattooing also may be rare.
- Wad may be present in the wound upto a range of 5 metres.
- The dispersion of pellets becomes significant at ranges over 2 metres.
- Thereafter, the spread increases progressively and central defect diminishes in size proportionately.
- The old rule of thumb 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 to 10 metres, the central hole may shrink to nothing. At such ranges, the shots may not be lethal and the pellets, if they do penetrate the skin at all, may lie just in the subcutaneous tissue.

6. Medico-legal Aspects

The following questions needs to be answered:

1) The nature of the fire arm.
2) The range of the fire arm.
3) The direction of the fire arm.
4) The place from where the firing took place.
5) The cause of death.
6) The manner of death.

1. **The nature of the fire arm:** It is important to know the type of fire arm used, whether rifle or smooth bore weapon. An examination of the size of the bullet and its weight, calibre; number, size and direction of the rifling marks on it and the kind of metal it is made of, will give idea regarding the weapon used. The diameter of a bullet is measured with a micrometer. Bullets may be recovered at the scene of a shooting incident or form the dead body during autopsy. 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 for future examination by a ballistic expert. No forceps or metallic instruments should be used by any means to handling the bullet or retrieving it from the body cavity as it will cause artefacts and also will obliterate the existing rifling marks. Rubbers tipped forceps are best for handling projectiles. The size of the bullet, its weight, caliber, the number, size and direction of rifling marks on it, the kind of metal of which t is being made, any blunting of nose and other relevant details should be noted down.

The bullet is marked for future identification by inscribing the autopsy surgeon's initials on the 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 and to find out whether the bullet recovered had been fired from the suspect weapon or not, test firing is done.
- A test shot is fired from the weapon into a box, which is packed with cotton wool. The "test bullet" which is fired is recovered and both the "test bullet" and the bullet recovered from the crime scene are then compared under "comparison microscope". This is the kind of microscope under which two objects can be compared simultaneously. If the rifling marks are identical on the test and crime bullets, then the suspect weapon is considered to be used for the weapon of offence.
- Examination of a spent cartridge case will also provide valuable clues in identifying the crime weapon. The shot gun cartridge bears the name of the manufacturing firm and sometimes the caliber is imprinted on the casing. The size of the spent case provides a clue regarding the calibre of the weapon. In 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, generally in pistol or rifle, it is found few feet to the right of the spot where the weapon was discharged. The firing pin will make dent on the base, which is peculiar to that weapon.
- In shot gun wound, the nature of the shots eg., lead pellets, glass beads or stones etc used may help in identifying the weapon. Factory made shotgun cartridges use lead shot, while local made ones may use stones, glass beads, iron balls etc. The pellets should be wrapped in absorbent cottons and placed in empty cardboard box and preserved for examination.
- The presence of wad at the scene of crime or in the dead body conclusively indicates use of shot gun, the diameter of which may give clue regarding the caliber.

2. **The range of firing:** The range is deduced from the appearance of the entrance wound.

3. **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 will give the direction of fire. A case of devious tracks or deflection of projectile **(ricochet bullet)** can cause confusion in interpretation. An entry wound is circular if the projectile enters perpendicular to body surface and oval, if the entry is oblique. In case of oblique entry, the abrasion collar becomes eccentric, being wider at the side of the entry.

4. **The site of the firing:** Depends upon the calculation of range and direction of fire.

5. **Cause of death:** Usually, death is due to hemorrhage or damage to any of the vital organs such as the heart or brain.

6. **Manner of death:** The usual manner of death is homicidal or suicidal, while accidental deaths are less common.

7. Summary

1. The diameter of the entry hole together with the abrasion collar may give the approximate diameter of the bullet. The barrel of a fire arm is generally lubricated between uses.
2. The extent of tattooing will depend on the caliber of the weapon, the type of powder used and the range. The same may be absent, if the firing has taken place through clothing.
3. Blackening or smudging results from a superficial deposit of smoke on the skin. In other words, it is only carbon particle deposition over the skin and hence can be easily wiped off with a wet sponge.
4. The edges are invariably everted and if the skin at the exit wound appears to be circular or nearly circular clear defect, surrounded by margin of abrasion (usually broader than entry wound) resembling a wound of entrance, then it is called shored or supported exit wound.
5. A test shot is fired from the weapon into a box, which is packed with cotton wool. The “test bullet” which is fired is recovered and both the “test bullet” and the bullet recovered from the crime scene are then compared under “comparison microscope”.