Firearm injuries I

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Objectives

- To know the mechanism of causation of missile injury
- To know the causation of injury with regards to velocity of the weapon.
- To know the 2 basic types of firearms and there features and differences

Objectives cont--

- To know the factors determining the firearm injuries
- To identify different features of rifle wounds at different ranges.
- To know the features of bullet wounds in bones
- To know the features of firearm exit wounds
- To know the wounding mechanisms of shot guns at different ranges.

Fire arm injuries

- The injuries are caused by a missile or projectile discharged by a firearm.

Mechanism of missile injury

To cause damage

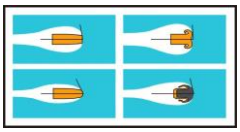
- Needs absorption of some or all of the kinetic energy

Transfer of energy is based on:

1. The resistance of the tissue.
   - In a soft tissue, absorption is minimal (apart from the bullet tract)
   - May not be fatal unless a vital organ is affected.

2. Make of the bullet

1. **Bullets are modified:**
   - Soft headed bullets – flatten on impact
   - Air cavity within the tip- splay open on impact

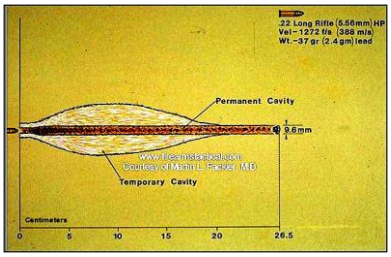


2. **Trajectory or course of the bullet**
   - Tumble end over end
   - Bullet yaw along axis

3. Velocity of the bullet

- Low velocity - 1100 feet/second
  (tissue damage is limited)
- High velocity – 4800 feet/second
  (rises the tissue pressure to extreme (temporary cavitation)

High velocity bullet effect



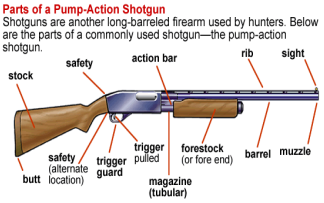
Types of firearms

- The nature of the wound varies with the type of the weapon.
  - 2 main types:
    - Shot guns or smooth bore weapons
    - Rifled weapons.

SHOT GUN SHOOTING

RIFLE SHOOTING

Shot guns or smooth bore weapons

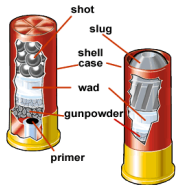


Smooth bore weapon

- 1 or more metal barrels
- Relatively wide diameter
- Smooth inner surface
- Slightly tapers towards the muscle (choking)
- Variable number of pellets
  - Large number of pellets (bird shot)
  - Few large projectiles (Buck shot)
  - Single slug

Ammunition

- Cartridge: cardboard or plastic cylinder with a metal base
- Contain from bottom to top:
  - Charge of propellant (gun powder)
  - Wad (cardboard or plastic discs)
  - Pellets
- Modern devices are improved to increase efficiency



Rifled weapons

- Fire 1 projectile at a time
- A thicker barrel with spiral groves (rifling of the interior)
  - Gives rotatory movement to bullet
  - Increases the stability

Rifled weapons

There are many varieties

- **Hand guns** (revolvers and automatic pistols) low velocity
- **Rifles** – long barreled,
  - velocity varies from 1500 feet -5000 feet /second
- **Submachine guns** (machine pistols) more powered than pistol but less powered than rifle
- **Machine guns-** design to fire rifle bullets in quick succession

Various types of rifled firearms


handgun


Submachine gun

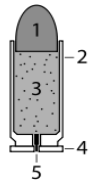

Rifle


Machine gun

Ammunitions

Basically the design is:

1. **Bullet, a** lead core covered in a steel/nickel jacket is firmly clamped into the open end
2. **Shell /cartridge /casing** (metal cylinder closed at one end)
3. Inside the shell loaded with **explosive propellant**
4. **Rim** – part of casing used for loading
5. **Primer** – which ignite the propellant



The mechanism of action:

- Once detonated produce large volumes of hot gases under pressure
- Expel the bullet

Bullet

Fire arm injuries

The nature of the injuries is affected by:

- Type of weapon (shot gun/rifle)
- Velocity of the weapon
- The nature of the projectile
- The nature of propellant
- Degree of choke (if any)
- The range of discharge
- Angle of discharge

Penetrating and perforating injuries

- **Penetrating trauma**
  - object does not pass through
- **perforating injury**
  - object enters and passes all the way through

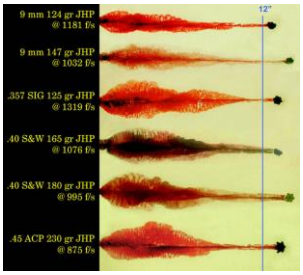
Firearm damage to internal organs

- **In low velocity missiles**
  - Lacerations
  - Contusions
  - Complete mechanical disruption (in mass of shot guns and gas strikes, and low velocity rifle bullets)

In high velocity missiles

- Disproportionate damage relative to diameter
- Due to cavitation effect
- Specially in solid organs

Cavitation effect in different handguns



How to describe a gunshot/ Firearm wound?

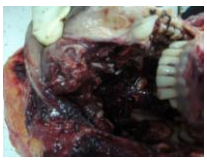
- **Gunshot wound of xxx perforating penetrating** :
- **Entrance**:
- **Path of bullet**:
- **Exit** or
- **Site of lodgment**:
- **Direction in body**:
- **Comment**:

Entrance:

- Anatomical site:
- Position: xxx cm from the top of the head and xxx cm xxx to the midline plane
- Size: ~ xxx cm
- Marginal abrasion: Concentric, eccentric (xxx)
- Marginal effects: No blackening (xxx); stippling (xxx)
- Special features:
- Pathological range:

Path of bullet:

- Wound path: Entrance wound → xxx → xxx→ xxx → xxx→ xxx → xxx
- Hemorrhage:



Exit:

- Anatomical site:
- Position:
- Size: ~ xxx cm
- Shape, margin:

Site of lodgment:

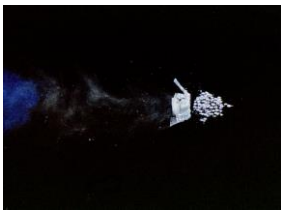
- Anatomical site:
- Position:
- Projectile:

Shot gun injuries

- Injuries may be contributed by:
- Lead pellets
- Soot in the form of smoke and debris
- Unburned and burning propellant particles
- Flame and hot gases under pressure
- Carbon monoxide
- Wads
- Detonator constituents
- Fragments of cartridge case

What happens once a shot is fired?

- Initially the compact mass emerges
- Begins to disperse:
  - Starts at about 2m
  - Separate satellite pellet wounds and central main hole after 1-2m
  - Spread of pellets increases and central wound disappear –mid to distant range



What happens once a shot is fired? Cont--

- Flame and hot gases follow the shot
- High pressure and temperature exists just outside the muzzle
- Among the gases carbon monoxide is found
- Soot from combustion of propellant and still burning propellant are expelled

What happens once a shot is fired? Cont--

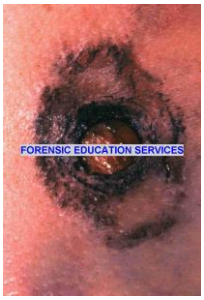
- Wads are expelled
- Traces of elements from detonator or percussion cap are expelled (can be detected from laboratory tests)
- Fragments of cartridge case may also be ejected

Range of fire in shot guns

- Depending on the type of shot gun
- Different barrel of same shot gun and different ammunition marked variations
- Test firing is the ideal for determination of range.

Contact shotgun wounds

1. Shape
   - Single circular wound with approximate diameter of bore of the weapon (only on none bony areas)



Contact wounds over bones with thin soft tissue –

- different appearance
- large amount of discharged gas cannot dissipate
- can have disruption of the cranium due to explosive effects
- also can see gas reflected back by the bone
- rises a dome of skin and subcutaneous tissue
- press against muzzle – produce a muzzle imprint
- split to form a cruciate/ stellate wound

Massive disruption of skull

2. Burning and blackening

- If a tight contact – minimal or none around
- Recoil taking muzzle away or none firm contact – burning and blackening in the skin of immediate vicinity

- If clothing intervene- soot escape sideways found in each layer of fabric, and underlying skin, clothe singed at the edge of hole and ring of burning around skin wound

3. Muzzle impression

- Seen in a tight contact (holding the weapon firmly or when skin is lifted forcibly against)
- Most useful indicator of contact wound

- If double barreled weapon is used –muzzle mark adjacent to entry

4. Carbon monoxide

- Produces due to incomplete combustion
- When combine with haemoglobin /myoglobin- cherry pink colour
- Useful in distinguishing entry from exit

5. Wads within the wound

Close range shot gun wound

- Muzzle is held near skin within 6 inches
- Single circular wound
- Singeing of hair around the wound
- Burning of skin (narrow rim of hyperaemia or blistering)
- Tissues around and in may be cherry pink from carbon monoxide

Close range shot gun wound cont--

- Blackening due to soot/smoke – can get easily washed off
- Powder tattooing around the wound – due to impact of un burnt partially burnt or burning gun powder, punctuate lesions (not washed off)
- Shape of the wound is circular (weapon held right angles) or elliptical (weapon slanted)

Close range shot gun wound cont--

- Appearance can be modified by clothing
- Wad within the wound
- If clothing present burning, blackening and tattooing may be absent.

Close range shot gun wound chest

Intermediate range shot gun wound

- 6 inches to 6 feet
- Burning and singing of hair disappears first
- Soot soiling/blackening diminishes and vanishes in 8 -16 inches
- Powder tattooing may persist further than this

Intermediate range shot gun wound

- At 6feet/upper end of this range –crenated and scalloped edges of the wound (rat hole)
- Satellite pellet wounds around the main wound
- Wad mark associated with injury (laceration/bruise) - may be found below the main wound sometimes up to 5 meters

Intermediate range shot gun entry wounds

Wad mark

Distant or indeterminate range shot gun wound

- no burning, smoke staining or powder tattooing
- spread of pellets increases
- central rat hole diminishes

Shotgun entry wound distant range

Shotgun entry wound distant range

Direction of shot gun injury

- Right angle-circular hole and associated other factors
- Other positions –elliptical
- Shelving and undercutting are helpful
- Track of wound in deeper tissues (radiographs are much beneficial)
  - But the track is difficult to determine
  - Internal damage is diffuse and associated with disruption
  - Is caused by direct mechanical disruption (by gas and shot)
  - No cavitation effect

Secondary damage

- Can occur by mass of pellets striking a bone and releasing fragments as secondary missiles
- Can emerge resulting in exist- (can be mistaken for multiple shots)

Shotgun injuries in bones

- Usually destroys a larger area of the skull
- In a thin bone like cranium, sternum or pelvis there is usually a special pattern called beveling
- Individual pellets – rarely penetrate
- Thicker bones are involved result in comminuted fractures and bony fragments can acquire a velocity causing secondary injuries.

Shot gun entry with beveling

Shot gun exit wound

- Uncommon in the trunk as energy not enough to pass through
- Head, neck and limbs may have exit wounds
- Range of fire is a determining factor for exit wound (specially in contact and close range)
- The appearance of exit depends on the anatomical part injured

appearance of exit depend on the anatomical part injured

- Extremely ragged, irregular and large with everted edges
- Disrupt the tissues due to large volumes of gases
- Comminuted bone fragments
- Shot gun fired into the mouth may remove a large portion of the back of the head as an exit wound- **burst head** (gas plays a role)
- Chest or abdomen often fail to exit
- Pellets often penetrate the distal chest wall –held up beneath the skin (Bruises seen)

Mechanism of death

- Haemothorax due to damage to pleura and lungs
- Haemopericardium
- Intracranial damage from shattering of skull and facial bone

What are elective sites for suicide?

- Temple
- Mid forehead
- Intraoral
- Under the chin
- Left chest/mid chest

Rifled weapon injuries

- Depending on the velocity of the projectile wound characteristics vary.
- **Common features**
  - Usually single bullet from one discharge (unless defect in the weapon firing 2 at once)
  - Automatic weapons may show multiple wounds in close succession

Features due to

- Bullet
- Flame
- Gases eliminated
- Soot
- Burnt and un burnt gun powder
- Muzzle mark (in close range)

Contact rifled weapon injuries

- Wound small and circular unless on a bony surface
- Over bony support can split to form a cruciate/ stellate wound
- Burning and blackening of the immediate wound edges (if the contact is lose)

Contact rifled weapon injuries cont--

- Soot deposition within the wound
- Areola of hyperaemia - extend beyond muzzle imprint
- Cherry pink discolouration due to CO.
- Muzzle imprint
- There may be complex imprints due to foresights and mechanisms for self loading automatics

Back spatter or blow back in to barrel

- Contact and close range discharge can result in entering of blood and tissue fragments in to the muzzle.
- Due to the momentary suction effect as pressure of gas blast diminishes.

Close range rifle wounds

- Circular in shape.
- Margins of the wound -inverted but sometimes due to rebounding gases may be everted
- Abrasion collar around the margin
  - Due to the inversion of the skin with the entry of missile causing the bullet to wipe the epidermis
  - Caused by friction and heat

Close range rifle wounds

- Burning within a few cm. with hair singeing
- Hyperaemia around the wound
- Most propellant used now are clean however there may be blackening
- Powder tattooing around the vicinity (distribution helpful in determining the direction)
- Fouling (tiny lesions around the entry wound caused by fragments of metal expressed)

Intermediate or distant range wounds

- No difference
- Circular central hole with inverted margins (usually smaller than bullet)
- Abrasion collar around the central hole

Intermediate or distant range wounds cont--

- Grease ring- inner edge of the abrasion collar may be black (heating and dirt)
- There may be bruising around the wound
- No burning, blackening or tattooing around

In extreme distance:

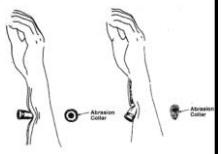
- Reduced velocity of the bullet
- Bullet begin to wobble and yaw or even tumble (turn end over end)
- If the bullet strikes the body sideways- rectangular wound mimicking a laceration

Direction of discharge

- In close range rifle injuries shelving or undercutting are useful-indicates angle entry
- Burning, blackening and tattooing are less evident and therefore of little help

Direction of discharge cont--

- Shape of the abrasion collar-
  - More useful
  - Asymmetrical in angle entry
  - Join the trajectory between entrance and exit(unless bullet diverted within)
  - Consider posture of the victim



Exit wounds of rifled weapon

- Many are perforating
- Again the velocity of the bullet is a determining factor
- High velocity often pass through-

If an intact bullet emerges:

- Exit wound is a small everted defect (classically stellate could be slit like or linear)
- There is no abrasion collar
- No burning, blackening or tattooing

Exception to usual exit

- If emerges against supported skin (tight garments, floor/wall) a circular exit wound
- This is called a **shored exit**
- Has an abrasion collar as well
- Difficult to differentiate from an entrance
- (specially in distance and intermediate range)

When the bullet is deformed or emerged side ways

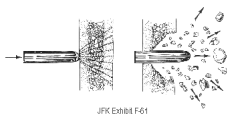
- Exit can be of any size or shape
- May be multiple (if fragmented/pieces of bones also exit)

Re-entry

- Penetration of 2 parts of the body
- Commonly through and through wound of the limb re-entering the chest/abdomen

Bullet wound in bones

- In a thin bone like cranium, sternum or pelvis - beveling
- Initial contact punches a clean hole in outer table.
- When emerges internally causes a crater that is larger than the external hole / erosion of the margins of the inner table
- "cone" shape in the direction of the bullet path



Bullet wound in bones cont--

- Same pattern occurs when bullet exists the cranium / outer table shows erosion (cone shape facing outwards)
- In addition there are fissured or comminuted fractures
- Thicker bones - comminuted fractures and bony fragments
- can acquire a velocity causing secondary injuries.

Entry vs exit

Key hole wounds

- A missile striking the skull tangentially produces a keyhole defect
- Here the entrance and exit defects overlap
- One end of the perforation - inner beveling , while the other end - external beveling

Glancing rifled wounds

- Can occur when bullet enters in an angle.
- Can have a superficial course
- Damage may be little
- In irregular surfaces can have several re-entries and exits
- May follow skull/rib curvatures without entering through

Summary

- Kinetic energy of the missile determines the extent of damage.
- Energy transfer is based on tissue resistance, and course and velocity of the bullet
- Damage from the low velocity missiles is limited only to the bullet tract while in high velocity missiles severe disruption within a wide zone around the bullet track is seen.

Summary cont--

- There are 2 basic types of firearms rifle, and shot gun.
- Shotgun fires a variable number of pellets.
- Rifle fires 1 projectile (Bullet) at a time which has a rotatory movement due to the grooves in the barrel.
- Entrance, path of bullet, exit/site of lodgment are the key areas in describing a gunshot wound.

Summary cont.

- Entry wound of a shot gun is single and circular in contact and close range discharges while in intermediate range discharge there are satellite pellet wounds around the main wound
- Distant range shot gun entry wounds show injuries from single pellets.

Summary cont--

- Rifle bullet entry wounds are usually small and circular with abrasion collar.
- Burning, blackening and tattooing are seen in contact and close range firearm injuries.
- Presence of a muzzle imprint indicates contact firearm injury.
- Inner or outer beveling of the skull are determining factors for entry or exit wounds.
- Exit wounds are not common in shot guns while they are commonly irregular or slit like in rifled firearms.