PROJECTILE TRAUMA

- Information that can be gained from a bullet wound to bone include:
  - Firearm type
  - Characteristic of projectile
  - Placement of weapon (distance from victim)
  - Sequence of multiple wounds
  - Handedness of assailant

**Types of Small Arms Weapons:**

- **Handguns**
  - Single-shot pistols
  - Derringers
  - Revolvers
  - Automatic pistols

- **Rifles**
  - Manual reloading types
  - Semi-automatic
  - Fully automatic
  - Submachine guns
  - Machine guns
  - Shotguns

**Firearm Nomenclature**

- **Rifled barrel**
  - Lands
  - Grooves
  - Bore

- **Caliber**
  - Supposedly the diameter of the bore from land to land - in reality, caliber doesn't always reflect exact bullet size
  - Caliber can be expressed in inches or mm

**Pistol Ammunition**

- Jacketed Hollow Points
- Plain Lead Bullets
- Full Metal Jackets
- "Hydra-shock"

**Rifle Ammunition**

- 45 S&W Centerfire Cartridge

**Shotgun barrel diameters are measured in gauges**

- Refers to maximum weight of lead ball that would fit down the barrel
- i.e. 10 gauge refers to a 1/10th pound lead ball
- The shot pellets are referred to by number:
  - #12 = 0.05 in. diameter
  - #2 = 0.10 in. diameter
Projectile Velocity

- Velocity is more important than caliber when considering extent of trauma
- A bullet has kinetic energy and kinetic energy and velocity are related
  \[ KE = \frac{WV^2}{2g} \]
  So, doubling the velocity (V) without changing bullet weight (W) quadruples the kinetic energy
- High velocity bullets can create massive tissue damage
  Rifle bullets generally have higher velocities than hand gun bullets

Bullet Travel

- Rifling (spiral grooves) in barrel cause the bullet to spin on its long axis
- Bullets begin to yaw and then tumble as they travel
  - The bullet may impact on its side, causing a non-circular wound
  - The bullet may have been fired at an angle to the target, causing a graze or tangential wound

Effects on Bone

- General scheme
  Bullets generally cause a funnel-shaped wound with beveled edges
- Types of bevels created
  Inward - seen at the entry site
  Outward - seen at the exit site
  Reverse - beveling in the opposite direction at either the entrance or exit site
  Reverse beveling is not extensive

Wound Shape

- If bullet is not tumbling and is perpendicular to bone, the entrance wound will be round
- If the bullet is jacketed, it will be less likely to fracture and it may create a similarly-sized exit wound - but with outward beveling
• A bullet with low kinetic energy may ricochet once inside the cranium, therefore not producing an exit wound

About 10-25% of cranial gunshot wounds have no exit wound

• Bullets that are tumbling or do not strike perpendicular to the bone will produce an oval hole

• Keyhole shapes are usually produced when a bullet grazes the bone, so it is simultaneously an entrance and an exit wound

The bullet may fragment, part of it continuing on into the cranium

Keyhole wound

• Irregularly-shaped wounds are more typical of exit wounds than of entrance wounds

These shapes are caused as the bullet deforms or shatters

Hollow-points and soft-point bullets are most likely to deform

Entrance or Exit?

Wound Size

• Factors affecting wound size:
  Entrance vs. exit wound
  Bullet characteristics (caliber, construction, velocity)
  Thickness of bone

• In general (for cranial wounds)
  Larger caliber bullets create larger entry wounds
  Unjacketed ammunition tends to create larger wounds than the same caliber of jacketed ammo

• There is considerable variation in wound size caused by the same caliber bullet

Larger-than-caliber wounds may be caused by vault thickness - thicker vault causes increased deformation in bullets

Smaller-than-caliber wounds may result from:
  Bending of bone which resists fractures, thus bone may “snap back” after bullet passes through
  Bullet fragments
  Impact near previous fracture or at suture
Fracture Lines
- Fracture lines on the vault have been more intensively studied than those on long bones.
- Radiating fracture lines are caused by the impact, fracture lines follow weaknesses in the bone tissues.
- Fracture lines will stop when the energy dissipates.
  - They may meet a foramen, a suture, or a preexisting fracture.
  - When the energy is high, fracture lines may meet a suture, follow the suture for a while, then continue through the adjacent cranial bone.
- Concentric fractures are caused by an increase in intracranial pressure.
  - The pressure is created as soft tissue (the brain) is compressed by the bullet.
  - Extensive concentric fractures occur when gasses expelled from the gun enter along with the bullet.

Bullet Wound Analysis
- Bullet entrance wounds on long bones tend to be lozenge-shaped (butterfly fracture) - exit wounds tend to be irregular in shape.
- One should locate the entrance and exit wound (if present).
  - Document the location, size, and shape of each.
- The smallest diameter of entrance wound may be used to estimate caliber.
  - Caliber should only be estimated as large vs. small (up to .32 caliber).
- Bullet construction is difficult to estimate because high-velocity jacketed bullets can cause as much damage as lower-velocity non-jacketed bullets.
- Velocity is difficult to estimate and can only be estimated as high vs. low.
  - All other factors being equal - high-velocity bullets cause greater damage with radiating and concentric fractures.
  - Direction of fire can be estimated by aligning entrance and exit wound.
  - With keyhole wounds, the defect with inward beveling points to the direction of fire.
- Estimation of sequence relies on the fact that fracture lines will not cross preexisting fractures.

Pellet Wounds
- Direction of fire and range of fire can be estimated from wounds.
  - Direction of fire is estimated by determining on which aspect of the body the wounds are on.
  - Range of fire is estimated by a ballistics expert.
  - Distance = contact to 2 feet
  - Distance = 3 feet
  - Distance = 4 feet
Entrance Multiple Exits
Postcranial Gunshot Wound

“Exit wound” on inner table from tear gas canister