Firearms, Tool Marks and Impression Evidence

CHE 113
Forensic Science

Firearm Forensics

Firearms: Ballistics

- **Ballistics** - the science of the travel of a projectile in flight. The flight path of a bullet includes: travel down the barrel, path through the air, and path through a target.

- **Ballistics** -
  - The controlled expansion of burning gunpowder
  - The area is the base of the bullet (equivalent to diameter of barrel)
  - Bullet travel through a gun barrel is characterized by increasing acceleration as the expanding gases push on it. The longer the barrel, the greater acceleration.

  \[
  \text{Kinetic Energy (KE)} = \frac{1}{2} MV^2
  \]
Firearms

- Caliber - diameter of the bore (usually in 1/100 inch or mm (.22 cal. or 9mm)).
- Firearm Identification:
  - Size and shape of bullet/case
  - Rifling match
  - Firing pin/Case impression match
  - Striations on bullet match
  - Serial numbers (can be restored)

Bullets

- Long, heavy needle would go right through the target without dispersing any of its energy.
- Spheres would be slowed down the greatest and release more energy, but might not get to the target.
- A compromise shape is a parabolic curve with low frontal area and wind-splitting shape.
  - best bullet composition is lead (Pb) which is high density and cheap. Its disadvantages are a tendency to soften, causing it to smear the barrel or melt completely.
  - Allying the lead with antimony or sealing the bullet with copper, that has a higher melting point

Bullets

- Tumbling dictates the injury pattern
  - A short, high velocity bullet begins tumbling more rapidly in tissue.
  - A longer, heavier bullet might have more KE at a longer range when it hits the target, but it may penetrate so well that it exits the target without much energy loss.
  - Even a bullet with a low energy can impart significant tissue damage if it can be designed to give up all of its energy into the target (as with handguns).
Basic Compositions of Bullets

- Lead
- ½ Jacketed
- Jacketed (Full metal jacket)

Bullet Injury

1. Laceration and crushing - Low velocity bullets, as in handguns, do virtually all their damage via crushing.
2. Cavitation - Significant with projectiles travelling in excess of 1000 fps. A "permanent" cavity is caused by the path of the bullet itself, causing the wound cavity to be stretched outward.
3. Shock waves - Shock waves compress the medium and travel ahead of the bullet, as well as to the sides. At high velocity, generated shock waves can reach up to 200 atmospheres of pressure.

Handgun v. Rifle

- Handguns have relatively low velocity

Gun Comparisons

- Gun barrels are a solid steel tube hollowed out by drilling.
- Inner tube has spiral groves (rifling) to spin bullet (better trajectory - no tumbling).
Rifling

- Made by drilling spiral grooves into barrel.

The faster the spin, the less likely a bullet will turn sideways and tumble. Thus, increasing the twist of the rifling from 1 in 7 will impart greater spin than the typical 1 in 12 spiral (one turn in 12 inches of barrel).

Bullets become scarred by rifling as they travel down the barrel of a gun.
Rifling

- Barrels have:
  - Grooves and lands
  - Striations (small lines) - microscopic imperfections from rifling tools or chips of steel from broach cutter.

- No two rifles barrels, even those made in succession, will have identical striation markings.

Forming Rifling

- Broach cutters: cuts all the grooves simultaneously by forcing cutter down barrel and rotating the cutter.

Forming Rifling

- Use of a "button": a desired number of grooves that's forced down the barrel under high pressure. Uses no cutting but compresses metal.

- A mandrel with correct rifling is inserted into an oversized bore and the barrel compressed around the mandrel by rolling or hammering the barrel.

Groves and Lands

Important Info:
(1) Number of lands
(2) Rotation direction (R or L)
(3) Rate of rifling (twist)

Each class of firearm has fixed groove-land info that doesn't not change
**Bullet Comparison**

Impression are made on a soft bullet by running through grooves and lands. Since the rifling is worn away irregularly by each shot, the grooves make a unique impression on the bullet.

**Striations**

- Striations form the individual characteristics of the barrel.

**Comparison Microscope**

- Most important tool for firearms examiner
- Two compound microscopes combined into one unit
- Viewer looks through the eyepiece and a field divided into two equal parts is observed
- Bullet comparisons require reflective light
Bullet Comparison

- Obtain sample bullet.
- Fire similar bullet from suspect gun (into water or cotton-filled tank).

Bullet Comparison

- Compare striations, grooves/lands, twist direction and angles between test and sample bullets.
- Problem: each successive bullet will be a little different due to wear of barrel so matchup will not be perfect.
Cartridge Cases

- Pulling trigger releases the firing pin that then strikes the primer and ignites the powder.
- The bullet case is propelled backwards (as the bullet moves forward) and is imprinted by the breechblock (back of barrel).
- The shape of the firing pin will be impressed into the relatively soft metal of the primer on the cartridge case.
- Spent case extractors also leave identifiable marks.

Comparison Microscope

Split-image comparison of firing pin

Computerized Imaging

- Computerized imaging technology has made it possible to store bullet and cartridge surface characteristics.
- The Integrated Ballistic Identification System (IBIS) and National Integrated Ballistics Information Network (NIBIN) produces database files from bullets and cartridge casings retrieved from crime scenes or test fires from retrieved firearms, often linking a specific weapon to multiple crimes.
- Final comparison will be determined by the forensic examiner through traditional microscopic methods.
- Used to link multiple crimes to a single weapon.

Gunpowder Residues

- The firing pin of a firearm strikes the primer of a cartridge.
- Gunpowder in the cartridge case burns, causing it to change from a solid material to a gas creating pressure.
- When the bullet exits the muzzle, pressure behind it blows the gunshot residues out of the firearm's barrel under high velocity. The residues are expelled from the barrel in a smoky cone shaped pattern.

Visible gunshot residues around bullet entrance hole.
Gunpowder Residues

- Firing a weapon does not fully consume all the propellant (e.g., gunpowder).
- Unburned and partially burned propellant with smoke are emitted.
- Can determine firing distance (if smoke, etc. is on victim, pattern of residue deposition, etc.).
- Chemical analysis of residues.

Tests done:
- Examine microscopically for presence of gunpowder residue
- Sodium rhodizionate test (lead)
- Greiss test – presence of Nitrates

**SODIUM RHODIZONATE TEST**

- Tests for the presence of lead.
- Converts lead to lead rhodizinate.

**GRIESS TEST**

- Tests for the presence of nitrites.
- Converts nitrites to nitrates.
Serial Number Restoration

- Many metal manufactured items have serial numbers stamped in them for ID.
- Apply etching agent to show original numbers.

Restoration of Serial Nos.

- Scratched out serial numbers can be restored since stamping marks on metal deforms layers deep into the metal structure.
Tool Marks

Defined as any impression, cut, gouge, or abrasion caused by a tool coming into contact with another object

- Typical features (class characteristics)
- Cuts, tears, gouges or other wear marks are used to individualize the tool.
Tool Marks: Preserving Evidence

Silicone casting material

Si Cast

UNDER NO CIRCUMSTANCE SHOULD THE CRIME SCENE INVESTIGATOR ATTEMPT TO FIT THE SUSPECT TOOL INTO THE TOOL MARK

Other Impression Evidence

- Footprints
- Bitemarks
- Tire/wheel tracks
- Other non-flat objects

Other Impression Evidence

- Footprints
**Footprints**

![Footprint Diagram]

**Dental/Bite Marks**

- Dental Impression of gum, food, victims, etc.
- At Left: A. Chewing gum found at crime scene. B. dental impressions of victim and suspect. Unique root canal work of suspect found on gum.

**Dental/Bite Marks**

- Ted Bundy picked up for murder two sorority women at FSU using fake name and ID.
- One victim had bite marks on buttock.
- Casting of Bundy’s teeth taken (forcibly). Found to overlay (match) exactly the bite wound.
- Defended himself but convicted and sentenced to death.
- Before execution admitted to more than 40 other murders (but gave no info or details).
Suspect picked up prostitute and showed fake police badge in plastic case to get extra favors. There was a fight and assault. The suspect discarded the badge that was later found (A at Left). The suspect still had the plastic case that showed a perfect impression in the plastic of the badge (B at Right).