Forensic Pathology: 101

Office of the Armed Forces Medical Examiner
Armed Forces Institute of Pathology

Firearm Injuries

Office of the Armed Forces Medical Examiner
Firearm Injuries I: Rifled Weapons

Handguns

- Revolver
  - Cylinder rotates when trigger pulled
  - Aligns hammer, chamber and barrel
Handguns

- Revolver
  - Cylinder rotates when trigger pulled
  - Aligns hammer, chamber and barrel
- Pistol (semiautomatic)
  - Energy from previous round used to chamber next round
  - First round has to be manually loaded
  - Cartridges stored in magazine ("clip")
Rifles

- Rifles
  - Fired from the shoulder (as opposed to handgun, which is fired from the hand)
  - Fires rifle rounds (as opposed to handgun rounds)
- Shotgun
  - Smooth bore (no rifling)

“Assault Rifles”

- Self-loading
- Capable of full automatic fire
- Large magazine (>20 rounds)
- Cartridge is intermediate in power between a rifle cartridge and a pistol cartridge
Machine guns

- Submachine gun (machine pistol)
  - capable of full automatic fire
  - chambered for pistol cartridges
- Machine gun
  - capable of full automatic fire
  - chambered for rifle cartridges

Rifling

- All small arms (except shotguns) are rifled
- Rifling is a series of grooves cut inside the barrel
  - The metal between the grooves is called lands
- The grooves vary in number from 2-20
- The “twist” is either right or left

Rifling

- Rifling imparts stabilizing twist to the bullet
- The twist and number of grooves provide class characteristics when imparted to a fired round
- Microscopic comparison of fired rounds is required for individual characteristics to link a bullet back to a specific weapon
Ammunition

- Rimfire
- Centerfire

Rimfire

- Primer is spun into the rim of the cartridge
- Gunpowder in direct contact with primer
- Firing pin crushes the rim, detonating primer
- Only .22 short, .22 long, and .22 Magnum currently available
- Handguns and rifles chambered for rimfire ammunition

Centerfire

- Majority of ammunition
- Primer in center of cartridge base
- Firing pin strikes center of base
- Detonation of primer forced through flash hole into powder
Caliber (rifled weapons)

- Supposed to be the land-land diameter of bore
  - 7.62 x 39 mm is 7.62 mm diameter bullet with 39 mm long cartridge
  - .30-06 is actually .308
  - .38 Special vs .357 Magnum
- Magnum
  - Extra powerful cartridge load for more velocity

Bullets

- .22
  - Short and long usually lead only; Magnum normally semi-jacketed or fully jacketed
- Most centerfire handgun ammunition is semi-jacketed
- Centerfire rifle ammunition must be semi-jacketed or fully jacketed
- Military ammunition (by law) must be full metal jacket

Gunpowder

- Smokeless
- Nitrocellulose, ± nitroglycerin
- Comes in flake, cylinder, and ball
  - Handguns and shotguns generally flake or ball
  - Rifles generally cylinder or ball
Cartridge Characteristics

- A cartridge might be linked back to a specific weapon via marks left by the:
  - firing pin
  - the ejector
  - the extractor
  - the magazine
- Don’t forget fingerprints on the cartridge casing!

Caliber (shotguns)

- .410 is .410 inches across barrel
- Others (12, 16, 20) are measured in gauge
- “Magnum”
  - increased weight of pellet load
  - velocity generally not increased

WOUNDING THEORY
Wounding theory

• Two major factors
  – Mechanical interaction
  – Temporary cavity formation

• Mechanical interaction: Direct tissue disruption by bullet
• Temporary cavity: Cavity created as tissue flung away from bullet

Temporary cavity

• Analogous to the wake of a speedboat
• May last only 0.005-0.010 sec
  – Series of gradual pulsations/contractions
  – May be up to 11 times bullet diameter
• Plays very little role for handgun rounds
• Plays very important role for centerfire rifle rounds

Temporary cavity

• Maximum damage at point where bullet is maximally expanded or turned sideways
• Centerfire rifle rounds may disrupt, rupture, or shred organs that are not directly hit
• More damaging to solid organs (liver, spleen); less so to compressible organs (lung, bowel)
  – Devastating to brain
Wounds and Kinetic Energy

- KE = (Mass x Velocity²)/2g
- Direct tissue destruction
- Temporary cavity
  - More important in rifle than handgun

Autopsy of the Gunshot Victim

- Direction of fire
- Range of fire
- Survival interval
- Recovery of evidence

Range of Fire

- Contact
- Intermediate
- Distant
What shoots out of the gun?

- The Bullet
- Gunpowder
- Metal
- Gas and soot

Contact Range

- Muzzle touches body
- Essentially all that leaves the gun enters the body
- Can be hard, loose, near, angled or partial
Contact over bone
**Intermediate Range**

- Have stippling (tattooing)
- Bits of gunpowder causing abrasions
- Difficult to cause stippling on palms and soles
Intermediate: What is the distance?

- Type of powder
  - Ball
  - Cylinder
  - Flake
- Length of barrel
- Caliber/load
Take Home Point(s)

• The only way to tell accurately how far away a weapon was when it caused a wound is to test-fire it with the same ammunition and replicate the stippling pattern
• The hole in the skin (or bone) correlates very poorly with bullet caliber
Distant Range Wounds

- Nothing but the bullet makes it to the body
- Anything farther than “intermediate”
- Cannot tell 10 feet from 1000 feet
Autopsy of the Gunshot Victim

- Range of fire
- Direction of fire
- Recovery of evidence
- Survival interval

Direction of fire

- Direction through victim’s body
  - Described in three planes (front-back, right-left, up-down)
  - NOT in “degrees” (too many variables)
  - Use standard anatomic position
- Have to be able to tell entrance from exit wound
Entrance Wounds

Abrasion Collar

Entrance Wound of Skull
Atypical entrance wounds
Tangential gunshot wounds

- Tags point toward gun
- Tears point in direction bullet is going
Exit Wounds
Shored Exit Wounds

- Exit wound with an abrasion due to "shoring" up or reinforced skin due to an object such as bra strap, heavy leather jacket, leaning against the wall etc as the bullet exits.
- Abrasions are typically large, irregular, and moist if fresh
- Commonly misidentified as an entrance wound by the less experienced (especially ER docs and surgeons)
Beveling of Bone

- Gunshot wounds of flat bones (skull and rib) will bevel bone in the direction the bullet is traveling.
Autopsy of the Gunshot Victim

• Range of fire
• Direction of fire
• Recovery of evidence
• Survival interval
Take Home Point

You cannot tell the caliber of a bullet, even an intact or pristine one, from an x-ray!

Autopsy of the Gunshot Victim

• Range of fire
• Direction of fire
• Recovery of evidence
• Survival interval

"Never underestimate the ability of a mortally wounded person to do damn near anything"

Firearm Injuries II:
Smooth Bore Weapons
Birdshot

- Varies from 0.05 to 0.22 inches diameter
- Can be steel or lead
- Assigned a number or letter
  - “#5” birdshot is 0.12 inches
  - “BB” shot is 0.18 inches
Range of Fire

• Contact - same as rifled weapons
• Intermediate - same as rifled weapons
• By spread pattern
Case #1: History

- Three USAF members went duck hunting 20 Dec 99
- 2 members went into water to place duck decoys
  - Set loaded weapons on shore, pointing at water
  - Hunting dogs left on shore with third member
- A shot rang out and JJ collapsed in water
Initial scene investigation

- Sheriff and deputies walked scene with hunting party
- Sheriff sniffed all three weapons
- Sheriff ordered deputy to fire all three weapons
- Firing pin impressions compared at scene with the naked eye
- Coroner determined accident; no autopsy needed
Autopsy findings

- Shotgun wound of entrance on right side of forehead
  - Multiple skull fractures
  - Extrusion of majority of brain
- No natural diseases identified
- Toxicologic studies all negative
Firearms examination

- Determined which gun had fired fatal round
- Trigger pull 3 3/4 pounds (expected 7-9 pounds)
- Test fired and compared to autopsy photographs
- Determined range of fire of 4-9 feet
Conclusions: General

• All firearm deaths require thorough investigation
• All firearm deaths require meticulous autopsy
  – Rule out other or contributing causes
  – Assist in determining range and angle of fire
  – Recover crucial evidence

Conclusions: Specific

• Multiple safety rules broken
  – Never load weapon until ready to use
  – Always point weapon in safe direction
• All evidence corroborated story as originally presented

Summary: Autopsy of the Gunshot Victim

• Direction of fire
• Range of fire
• Survival interval
• Recovery of evidence
Firearms Fatalities: Scene

- Bullets
- Shell casings
- Sift surrounding dirt if body buried
- Don’t forget the clothing
  - For pathologist to examine
  - May contain the bullet!

Blunt Force Injuries

Overview

- Explain the pathologist’s role and questions he/she can help answer
  - adults
  - children
- Convey basic terminology
- Provide examples
Blunt force injuries: Overview

- The most common trauma in lethal and nonlethal situations
- Interested parties
  - Police
  - Attorneys
  - Family
  - Insurance
  - Media

Classification

- Abrasion
- Contusion
- Laceration
- Fracture

Abrasion

- Definition
  A wound produced by friction scraping away epidermis, or disruption of the epidermis by direct pressure or rubbing
**Abrasion - synonyms**

- Scrape
- Scratch
- Floor-burn
- “Road rash”
- Skinned knee

---

**Abrasions - types**

- Brush/scrape abrasion
  - Baseball player sliding into home plate
  - Motorcyclist sliding on road
- Impact abrasion
  - Terminal fall on ground
  - Blow inflicted by swung object (hammer, pipe, etc)
- Graze abrasion
- Patterned abrasion

---

**Abrasions**

- Usually heal without a scar
- Antemortem
  - red/brown with weeping fluid
- Postmortem
  - yellow/orange and parchment-like
- May be overlooked or hard to see if wet
TAKE HOME POINT #1

BODIES RECOVERED FROM WATER SHOULD BE ALLOWED TO DRY TO RENDER INJURIES NOTICEABLE
Abrasions: Summary

- **Cause**: Rubbing off of superficial layer of skin
- **Synonyms**: scrape, scratch
- Sometimes give direction of force or shape of injuring object

Contusion

- **Definition**: A wound occurring as the result of hemorrhage into soft tissues due to rupture of blood vessels caused by blunt force injury

Appearance of contusions

- **Function of**: Force applied, Vascularity of tissue injured
- **Caveats**: Deep bruises may not be visible - some bruises take time to “develop” - May be harder to see in darker-skinned individuals - Can (rarely) develop post-mortem
Aging bruises
Stephenson and Bialas, Arch Dis Child, 1996
• 23 children, 8 months to 13 years old
• All were accidental bruises
• All were white
• Observer asked to age bruises as “fresh,” “intermediate,” or “old”
• 24 correct, 20 wrong
• Red seen only in those < 7 days old
• Green and yellow at least 24-48 hours old

Aging bruises
• The reality - when studied . . .
  – Red, blue, purple or black may appear at any time
  – Red has no bearing on the age of the bruise
  – Bruises of identical age and cause, on the same person, may appear different
  – A bruise with any yellow is at least 18 hours old (the converse is not true)

Contusions: Aging
• Old school
  – Color changes from blue-red to dark purple to green to yellow to brown
  – “The change of color may be used as a guide for aging the injury”
• Current data - aging bruises fraught with difficulty
TAKE HOME POINT #2
LACK OF EXTERNAL BRUISING DOES NOT RULE OUT INTERNAL, EVEN MASSIVE, INJURY!

Contusions: Patterns
• Steering column imprint
• Tire tread marks on pedestrian
• “Train tracks” from rod or pipe-like object
• Looped cord
• etc.

Appearance of contusions
• Function of:
  - Force applied
  - Vascularity of tissue injured
• Caveats:
  - Deep bruises may not be visible - some bruises take time to “develop”
  - May be harder to see in darker-skinned individuals
  - Can (rarely) develop post-mortem
Bite Marks

- Actual injury rare
- Patterned abrasion with underlying hemorrhages
- Often sexual in nature
- Can be compared with suspect’s dentition
Handling the bitemark

• Get forensic dentist ASAP
  - Swabs
  - Photographs
  - Casts of wound
• Get casts of suspect’s dentition
• Get cast of victim’s dentition
Lacerations

- May have abrasion and/or contusion of edges
- Soft tissue bridging is the hallmark
- May or may not recapitulate the instrument that caused it

Lacerations

- Injury may be at surface or at some distance from surface
- May have abrasion and/or contusion of edges
- Soft tissue bridging is the hallmark
- May or may not recapitulate the instrument that caused it

Lacerations

- Foreign material
- Glancing/tangential blows
- Must distinguish from sharp force injuries
TAKE HOME POINT #3

KNOW THE DIFFERENCE BETWEEN A LACERATION (BY DEFINITION, A BLUNT FORCE INJURY) AND A SHARP FORCE INJURY
Lacerations: Summary

• **Cause:** Tearing of skin (or tissue) by blunt force
• **Synonym:** none (but it is not a cut, stab, or other sharp force)
• Sometimes give shape of injuring object, but less frequently than contusions or abrasions

Fracture

• **Definition**

Lacerations of bone caused by blunt force injury, that occur when the quantity of force overcomes the strength of the bone
Fracture

• Different types of fractures
  – Motor vehicle crashes
  – Falls
  – Child abuse
• Don’t overlook trace evidence in fractures

Fractures

• Fatal fractures
  – Skull
  – Cervical spine
• Long bone fractures rarely fatal
  – Fat embolism syndrome

Head injuries

• Scalp
  – Contusions
  – Lacerations
  – Abrasions
• Skull fractures
  – Linear
  – Complex
  – Depressed
  – Basilar
• Brain
  – Contusion
  – Lacerations
  – Hematomas (epidural, subdural, subarachnoid)
### Blunt force injuries: Summary

<table>
<thead>
<tr>
<th>Injury</th>
<th>Synonym</th>
<th>Patterned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abrasion</td>
<td>Scrape, scratch</td>
<td>Sometimes</td>
</tr>
<tr>
<td>Contusion</td>
<td>Bruise</td>
<td>Sometimes</td>
</tr>
<tr>
<td>Laceration</td>
<td>Tear, rip</td>
<td>Rarely</td>
</tr>
</tbody>
</table>
Special cases: Road traffic victims

- Motor vehicle crashes
  - Who was driving?
  - Position of passengers
- Pedestrians
  - Position of pedestrian
  - Hit-and-run
  - Trace evidence
- Toxicology