Ballistics in Penetrating Trauma

Joe Hansler, MD
University of Kentucky
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Objectives

• Review types of penetrating trauma
• Discuss commonly encountered offenders
• Discuss basic ballistics
• Review expected wounds, operative planning, treatment
Types of penetrating trauma

- GSW
  - Rifle
  - Pistol
  - Shot gun
- Stab
- Blast
Why it matters

• It’s more complex than just “Billy Bob got shot, again.”
• ~500,000 gsw/year in USA
• Military, law enforcement, home protection
• Surgeons planning penetrating trauma treatment
Definitions

• **Ballistics**
  - The science of mechanics that deal with the flight, behavior, and effects of projectiles

• **Internal ballistics**
  - The study of processes originally accelerating the projectile

• **External ballistics**
  - The study of the projectile as it passes through space

• **Terminal ballistics**
  - The study of the interaction of the projectile with its target
Internal ballistics
More definitions

Muzzle velocity

- Velocity of the round as it leaves the barrel end

Kinetic energy (J) = 1/2 mass(kg) x velocity(m/sec)^2

- 1 ft-lb = 1.3558 J, 1 grain = 0.0648 grams

-High velocity (rifle) vs. Low velocity (pistol)

Permanent vs temporary cavity

Ballistic coefficient- friction/drag of air against projectile

- based on shape and weight of projectile

Caliber- bullet diameter in inches (ie .22, .45)

Gauge- diameter of shotgun barrel (ie 12 ga.)
Wound ballistic research

- Martin Fackler, MD – retired US Army colonel, battlefield surgeon
  - Developed ballistic gelatin to simulate human wound patterns
  - First researcher to demonstrate that yawing and cavitation do not typically cause as severe tissue trauma as fragmentation.
  - "Temporary stretch cavity" in which tissue is pushed by the shock wave following the projectile

- http://www.firearmstactical.com/
Gun shot wounds

- Type of weapon/bullet used
- Distance from weapon
- Location and trajectory/path of injury
- Permanent vs temporary cavity
Examples of energy from different calibers

- .22  170J (m = 36g, v = 350 m/sec)
- .223 1550J (m = 50g, v = 900 m/sec)
- .38  325J (m = 120g, v = 300 m/sec)
- 7.62x39 3500J (m = 165g, v = 850 m/sec)
Permanent vs temporary cavity

• Permanent, “crush”
• Temporary- blast effect, “stretch”
  – Based on amount and rate of tissue displacement

[Diagram showing permanent and temporary cavities, with reference to www.firearmstactical.com and Courtesy of Martin L. Fackler, M.D.]
Maximal temporary cavity diameters:

- .22 (170J) 4.0 -5.0 cm
- .38 (325J) 4.0 -8.3 cm
- .223 (1550J) 13.0 -14.0 cm
- 7.62mm (3500J) 17.0 -23.0 cm
ballistic gel
Bullet types

• Full metal jacket
• lead
• Softpoint, semi jacketed
• Hollow point, ballistic tips
The other Bulleit
Bullet fragmentation

• Increased tissue wounding compared to temporary cavity
  – Hague convention of 1899
  – Restrict use of expanding/fragmenting bullets
Common rounds

- .22
  - Cheap, available
  - Low energy, lead bullet
  - Tumble
Common rounds

- .38
  - Pistol
  - Low velocity
Thoracoabdominal .38 GSW
Common rounds

- 7.62 x 39
  - AK-47, military use
Common rounds

- 30-06
  - Rifle
  - Common hunting round
    - Fragmenting bullets
  - Old military use
shotgun

- **“bird shot”**
  - Multiple low energy spreading pellets, short range effect

- **“buck shot”**
  - Fewer larger pellets

- **Slug**
  - Single projectile, longer effective range
Shotgun ballistics

12 Gauge Shotgun
no choke

#4 Buckshot
Vel. - 1351 f/s (412 m/s)
Wt. - 540 gr (35 gm)
27 pellets of 24 Cal.

Temporary Cavity
Permanent Cavity
Wad

FirearmsTactical.com
Courtesy of Martin L. Fackler, M.D.
Shotgun wound
Shotgun wound
videos

• http://uk.video.yahoo.com/watch/3342632?fr=yvmtf
Knife trauma

- Types
  - Stab
  - Slash

» “It’s but a flesh wound.”
Knife trauma

- Type, length of cutlery
- Identify all external injuries
- Determine potential internal injuries
- Patient stabilization, ABC’s
- Local exploration, imaging, operation
Iatrogenic stabbing
Common fly fishing wounds
KY wooden knife wound
Arrow with broadhead
Blast injury

• Primary
  – Blast wave effect

• Secondary
  – shrapnel

• Tertiary
  – fall or landing blunt injury

• Other
  – Burn, inhalation, smoke
Penetrating abdominal trauma

• History:
  – 1800’s surgical dogma for nonoperative/supportive care of abdominal GSW
  – 1881 President James A. Garfield shot in abdomen. For result, please refer to the “Garfield’s death watch.”
  – 1890 Sir William McCormick, British chief army surgeon “if a man undergoes surgery after being shot, he dies, and lives if left in peace.”
  – Continued standard of care through most of WWI

Penetrating abdominal trauma

• History continued
  – WWI- higher M/M for non op pt’s.
  – WWII, Korean war standard of care reversed to mandatory laparotomy.
  – Continued until 1960- Shaftan and Nance endorse “selective conservatism” due to high rate of dusters, especially with abdominal stab wounds.

Penetrating abdominal trauma

• History to now
  – Evolution of DPL/CT/ FAST, increases non operative evaluation/treatment in stable pt’s.
  – Laparoscopic options

Britt, Rushing. “Penetrating Abdominal Trauma.”
Current surgical therapy. 9th Ed. Pp 964-5. 2008
Reviewing assessment of abdominal penetrating trauma

• ABC’s
• Controlled resuscitation
• Secondary survey
• Tertiary survey
  – Mark all injury sites prior to Xray
  – Hx of number of shots fired, type of weapon, length of knife, sites of pain, etc
  – Diagnostic planning
Indications for emergent laparotomy

- Peritonitis
- Hemodynamic instability
- Evisceration
- Blood from natural orifices
- Impaled object
- High velocity missile injury
UK algorithm

- Abdominal/flank GSW or stab

  CXR, consider local exploration

  - Unstable, peritonitis, evisceration, blood in NG/rectum
    - To OR for ex lap
  - Stable, no clinical indication for operation
    - CT abdomen/pelvis
    - Surgery, Observation, Discharge
Operative goals/plan

1. Stop the bleeding
2. Control contamination
3. Identify all injuries
4. Definitive repair of injuries vs damage control
Statistics of penetrating abdominal trauma

• Anterior gsw- 90% have injuries requiring operative management
  – 10-20% complication

• Anterior stab (stable/ no absolute indication for surgery)- image
  – High non-therapeutic laparotomy rate with local wound exploration.

Pearls of penetrating abdominal trauma

• Most common injured intraabdominal organ
  – Small intestine

• Most common injured solid organ
  – liver
Case study

• 30ish M walking to church, minding his own business, happened to “fall” on a butcher knife.

• Pt transferred from scene (local)
  – stable per EMS.
ER data

- Pt arrives awake, anxious, talking.
- 1st vitals:
  - Temp: 97.7
  - HR: 110
  - BP: 132/77
  - RR: 22, sats 99% on facemask
ER eval

• PE cont.
  – Equal BS bilaterally
  – Abd: mild distension, diffuse TTP, guarding.
    • 2 cm laceration in periumbilical/LLQ, bleeding from wound
    • No spine TTP, no step offs, no lesions
  – Normal rectal tone, no blood
  – Ext: MAE x 4, equal pulses
ER eval

• CXR- no ptx, mediastinum normal contour, no foreign bodies
• FAST- Positive in all abdominal and pelvic fields, negative for pericardial fluid
Pt’s next diagnostic test

• Ex lap
  – Repair of IVC injury.
  – Small bowel resection, sigmoid colorrhaphy.
Post op course

• ICU, extubated POD 1
• Remained stable
• Diet started POD 5
• Discharged home POD 7
• Another pleased SGB patient.
Questions?
Answers.