Gunshot Wounds
- ED Management

新光急診 張志華

Jack CF Chong, MD
Emergency Department
Shin-Kong Wu Ho-Su Memorial Hospital

天祐台灣

問題 (1)

- 請問 .33 口徑子彈的直徑是幾 mm？
  - *A. 約11 mm*
  - *B. 約8 mm*
  - *C. 約5 mm*
  - *D. 約3 mm*

問題 (2)

- 何者不是entrance wound常見的特徵？
  - *A. 傷口周圍有碳粒 (soot)*
  - *B.傷口周圍有燒焦 (seared)*
  - *C.傷口周圍有 tattooing 現象*
  - *D. 傷口有 abrasion collar*
  - *E. 傷口呈星狀且邊緣為 外推現象 (everted)*

問題 (3)

- 請問何者是決定子彈傷口外觀的因素？
  - *A. Caliber*
  - *B. Velocity*
  - *C. Jacketed or not*
  - *D. Tissue type*
  - *E. All of the above*

問題 (4)

- 請問哪種子彈的傷害最可能併發vascular embolism的現象？
  - *A. Lead nose*
  - *B. Hollow point*
  - *C. Fully jacketed bullets*
  - *D. Teflon bullets*
  - *E. Magnum rounds*

問題 (5)

- 高速子彈是指速度超過？
  - *A. 500 fps*
  - *B. 1000 fps*
  - *C. 1500 fps*
  - *D. 2000 fps*
  - *E. 2500 fps*

Hint: fps = feet per second

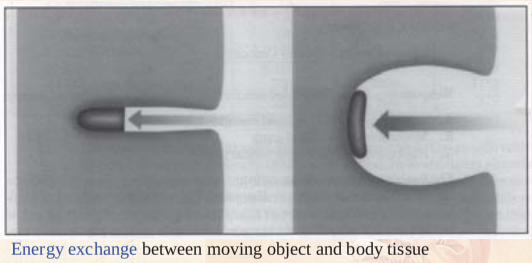
Definitions

- **Missile injury**
  - *any object that travels and causes physical contact and hence injury*
- **Ballistics (彈道學)**
  - *motion of projectiles*
- **Internal ballistics**
  - *study of projectiles in weapons*
- **External ballistics**
  - *study of projectiles in air*
- **Wound ballistics**
  - *study of projectile penetration of tissues*

Wounding Potential

- **Rules**
  - *Kinetic Energy = ½MV²*
  - *Energy cannot be created or destroyed*
- **Consider**
  - *Range*
  - *Weapons*
  - *Ammunition characteristics*
  - *Path & entry profile*
  - *Anatomy of impact site*

Cavitation



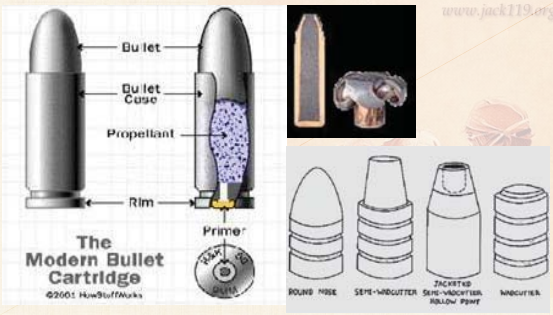
Energy exchange between moving object and body tissue

1. Surface area of impact point
2. Density of tissue
3. Velocity of projectile at impact

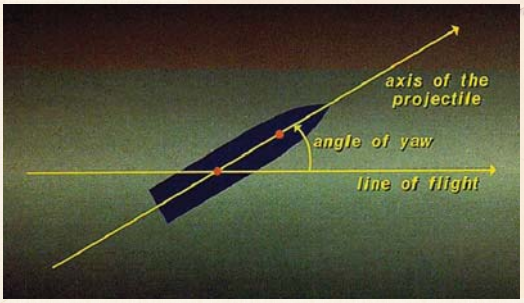
Wound at Point of Impact

- Shape of missile ("mushroom")
- Ballistic tumble and yaw
- Fragmentation (shotgun, bullet fragments, special bullets)

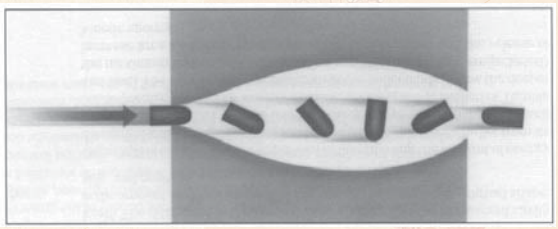
Mushroom (Deformation)



Yaw (偏航)



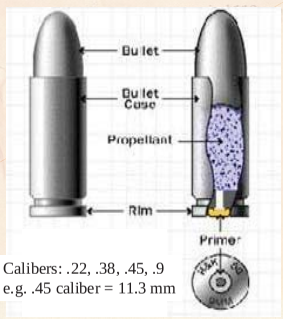
Tumble (翻滾) and Yaw



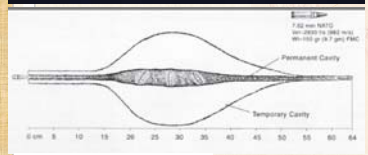
Bullets

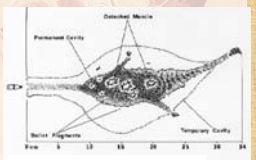
- **Low-velocity missiles**
  - *Lead bullets: melt if > 2000 ft/s*
  - *Semijacketed bullets: lead nose / hollow point – designed to mushroom*
- **High-velocity missiles**
  - *Fully jacketed with copper-nickel or steel*
- **Teflon bullets**
  - *Slugs (散彈), pellets (小彈珠)*
- **Magnum rounds**
  - *Cartridges with greater amount of gunpowder*

Low-Velocity Missiles



Calibers: .22, .38, .45, .9
e.g. .45 caliber = 11.3 mm





M80, velocity = **2800 fps**

M16, velocity = **3035 fps**

High-Velocity Missiles

Teflon Bullets

Magnum Rounds (高彈藥量子彈)

Size

Energy Level of Projectiles

- **Kinetic energy**
  - *Kinetic Energy = ½MV²*
  - *Muzzle velocity ≠ Impact velocity*
- **Low-energy weapons**
  - *Knife / hand energized missiles*
- **Medium-energy weapons**
  - *Hand guns*
- **High-energy weapons**
  - *Hunting / military rifles*

ATLS

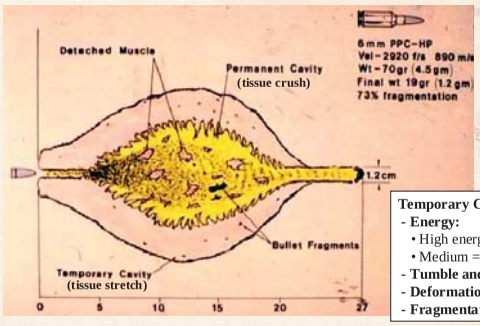
Velocity and Energy Level

- **Conventional classification:**
  - *Low velocity < 1000ft/s (305m/s)*
    - Handguns / air-rifles
  - *Medium Velocity 1000-2000 ft/sec (305-610m/s)*
    - Shotguns
  - *High Velocity >2000ft/s (>610m/s)*
    - Rifles / semi-automatic / automatic
- **BUT**
  - *Energy of weapon ≠ Energy on impact with tissue*
  - *The velocity of a projectile is highest at the muzzle and drops off steadily because of air resistance*
  - *Treat the wound not the weapon*

Missile Kinetic Energy

Caliber and Manufacturer	Bullet Weight (Grains)	Velocity (Feet/ Second)	Energy (Feet/ Pound)
Rifle Ammunition			
.22 Remington Rim Fire	40	1180	124
6 mm, 243 Winchester	75	3500	2037
.300 H and L Magnum	180	3670	3670
.375 H and H Magnum	270	2720	4440
Handgun Ammunition			
.25 Remington Automatic	50	810	73
.32 Short Remington	80	745	100
.32 Automatic Remington	71	960	140
.357 Magnum Remington	158	1410	540
.38 Special Remington	158	855	255
9 mm Automatic	140	935	270
10 mm Automatic	170	1340	680
.44 Magnum Remington	240	1470	1150
.45 Automatic Remington	230	850	370

Temporary Vs. Permanent Cavity



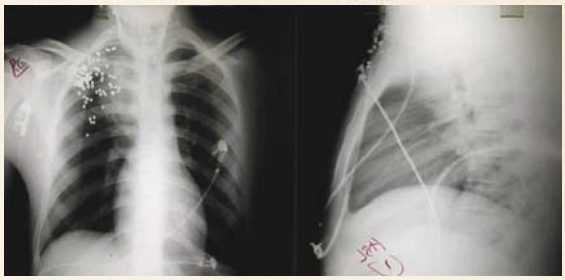
Temporary Cavity:
- **Energy:**
  - High energy = 30 x
  - Medium = 5 to 6 x
- **Tumble and yaw**
- **Deformation**
- **Fragmentation**

Shotgun Wounds

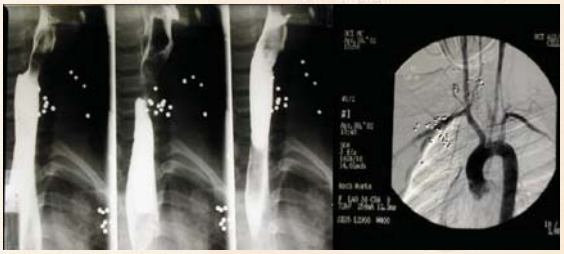
- Spread occurs at 14 inches
- Close-range shots may introduce clothing and wadding (infection)
- Pool ball effect
- Blast effect
- Rarely exit
- Embolize
- Lethal at close range; ineffective at greater distance

（ 包裝、填塞物 ）

Shotgun Wounds



Shotgun Wounds



Range of Fire

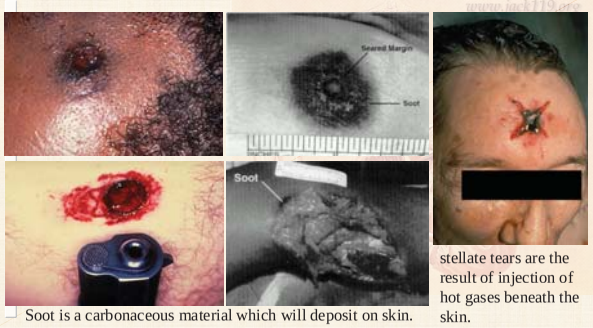
- **Wound characteristics vary:**
  - *Contact*
    - The most devastation
  - *Close Range*
    - Arm's length
  - *Distant*
    - Most handguns: significant decrease in KE at 100 m
    - Most military rounds: retain large KE at 500m

At Close / Contact Range

Entrance Vs. Exit Wounds

- Caution!
- Wound appearance:
  - *Type of projectile*
  - *Jacketed or not*
  - *Hollow-point / ball ammunition*
  - *Velocity*
  - *Yaw*
  - *Tissue type*
- Legal purpose?

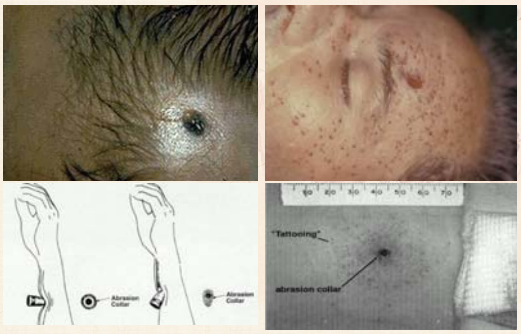
Entrance Wound



Soot is a carbonaceous material which will deposit on skin.

stellate tears are the result of injection of hot gases beneath the skin.

Entrance Wound



'Tattooing' = punctate abrasions from unburned grains of gunpowder.

Entrance Wound

- Only one single wound
- Histologic evidence of powder burns around wound

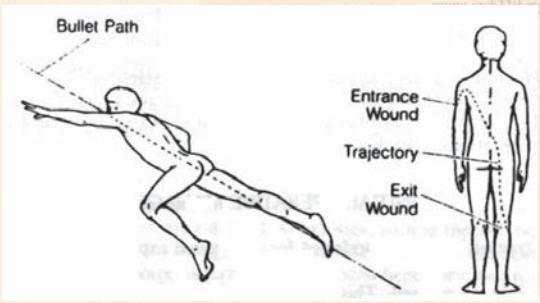
Exit Wound

1. Skin edges are generally everted.
2. Abrasion collars and soot are not usually associated with exit wounds.
3. Tattooing is never seen at an exit wound.
4. Are NOT always larger than its corresponding entrance wound.
5. May not appear directly opposite the entrance wound.

Clinical Purpose

- **2 holes = entrance & exit**
  - *Anatomy damaged*
  - *Type of surgical procedure*
- **Entrance**
  - *Round or oval with surrounding 1 to 2-mm blacked area of burn or abrasion*
  - *Close range: tattooing, subcutaneous air*
- **Exit**
  - *Stellate / slit-like in appearance*

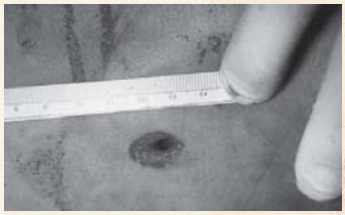
Entrance Vs. Exit Wounds



GSW?

Entrance or Exit?

Entrance or Exit?



A 'shored' exit wound has the appearance of a 'false' abrasion collar. This false abrasion collar results when epithelium is forced outward and makes contact or is slapped against a supporting structure, i.e. floor, wall or furniture. A short exit may also be referred as a supported exit wound.

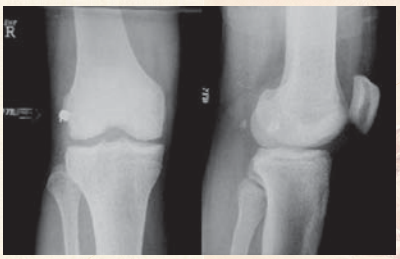
ED Management

- **ATLS approach**
  - *A – B – C – D – E – Secondary survey - Transfer*
- **Consider Intra-abdominal injury**
  - *Small wounds can have associated extensive internal damage*
  - *Missile do not always travel in straight lines*
- **Signs of vascular injury**
  - *Hematoma, pulse deficit, bruit, pulsitile or uncontrolled bleeding*
  - *Need urgent investigation*
- **Wound description and projectile collection**
  - *Legal-forensic consideration*
- **Beware multiple wounds**

Abdominal GSW

- **Peritoneal penetration in > 80%**
  - *Significant visceral injury in > 95%*
  - *Laparotomy mandatory*
- **Studies**
  - *Biplanar radiographs*
  - *DPL* / FAST / CT / Angio*
  - *Wound exploration – impractical*
  - *PE alone – unreliable (FN > 20%)*

Imaging



- Look for FBs, fractures, gas
- If cannot find bullet, re-examine patient!

Surgery

- **Indications**
  - *Significant tissue damage*
    - Ecchymosis, swelling
  - *Neuro-vascular injury*
  - *Obvious contamination*
  - *Joint involvement*
  - *Unstable fractures*

High Energy Transfer

- **Evidence**
  - *Functional disturbance and swelling*
  - *Bullet fragmentation*
  - *Visible cluster on x-ray*

Disposition

- **Surgery or**
- **Superficial debridement**
  - *Betadine dressing*
  - *Left open*
  - *Antibiotics (oral or IV)*
  - *Follow up in OPD until healed*
    - 2% infection – Staph or Strep

Questions ?

GSW: Summary

- More and more common
- Legal & Forensic issues
- Wounding potential
- Treat patient and wound NOT the weapon
- Surgery
- Antibiotics

Thank You

Fashion Accessories