

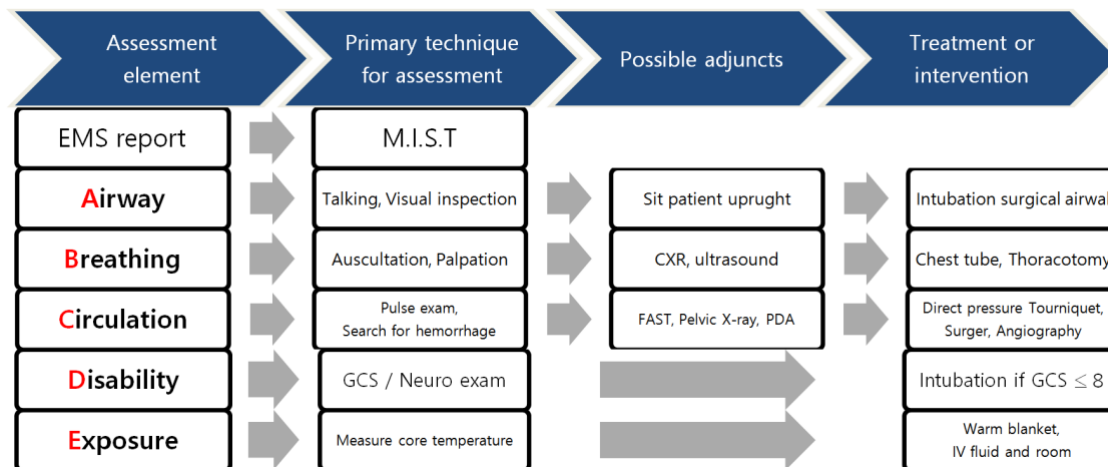
# Initial Trauma Assessment and Management of Gunshot Wound

Seoul National University College of Medicine

2015-17673 Heeju Hong

From June 27<sup>th</sup> to July 25<sup>th</sup>, 2018, I did observership at Marcus Trauma Center in Grady Memorial Hospital. I witnessed plenty of penetrating and blunt Trauma cases during my observership. Regardless of whether it was penetrating or blunt trauma, the initial Assessment was common: ABCDE. After the assessment, specific management was done according to severity and location of the injury. In this essay, I would like to handle the principle of Initial Assessment and some gunshot wound (GSW) cases categorized by its location.

## Element of Initial Assessment

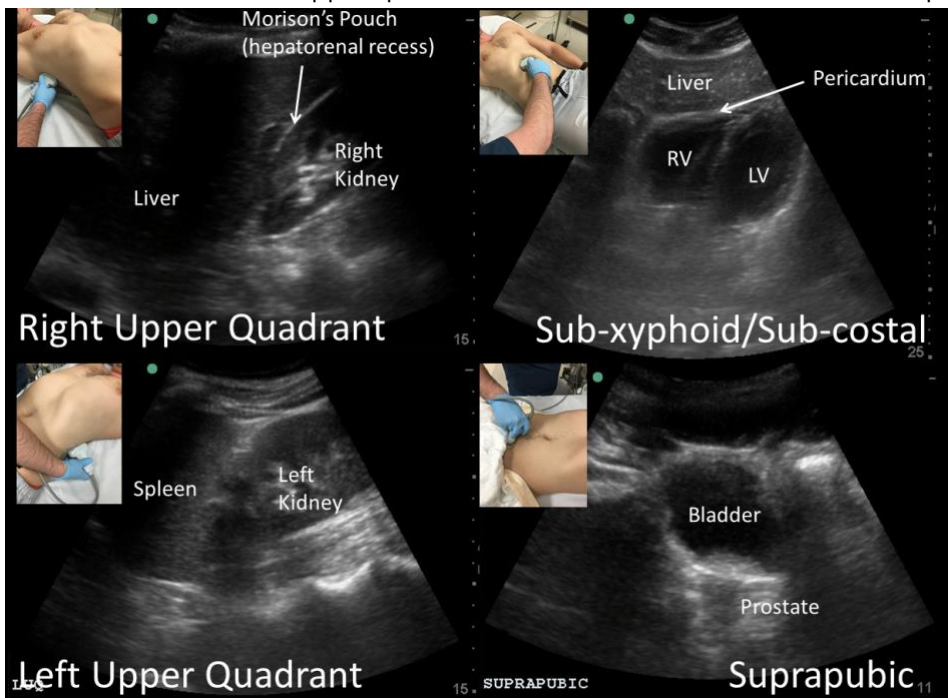


The initial assessment can represent as ABCED, which is Airway, Breathing, Circulation, Disability, and Exposure.

<b>Airway</b>	<ul style="list-style-type: none"> <li>- Begins with assessment of patency                             <ul style="list-style-type: none"> <li>: a Patient who is able to speak in their normal voice does not have airway obstruction</li> </ul> </li> <li>- <b>Conditions which need urgent airway</b> <ul style="list-style-type: none"> <li>: Significant maxilla-facial bleeding into the airway</li> <li>: Destruction in the area of the oropharynx or neck</li> <li>: Significant alteration in mental status (GCS≤8)</li> <li>: Intoxication and/or Head injury</li> </ul> </li> </ul>
<b>Breathing</b>	<ul style="list-style-type: none"> <li>- Auscultation of each hemithorax for absence / presence of breath sound                             <ul style="list-style-type: none"> <li>-&gt; Identify the presence of potentially life-threatening injury (Hemo- or Pneumothorax)</li> </ul> </li> <li>- Continuous pulse oxymetry: Check occult hypoxemia</li> <li>- In Chest trauma, we have to look for the following sign                             <ul style="list-style-type: none"> <li>: <b>Significant deformity, bony crepitus, subcutaneous emphysema, tachypnea</b>, etc.</li> </ul> </li> </ul>
<b>Circulation</b>	<ul style="list-style-type: none"> <li>- Palpation of central and distal pulses                             <ul style="list-style-type: none"> <li>· Minimal threshold systolic pressure: Carotid (60~79mmHg), Femoral (70~80mmHg), Radial (90~100mmHg), Pedal (&gt;100mmHg)</li> </ul> </li> <li>- intravenous access is not immediately obtainable (ex. patient in shock) -&gt; Intraosseous access</li> <li>- External bleeding control: Whip stitching, Tourniquet, Blind clamping</li> <li>- <b>Searching for Internal bleeding</b>: Chest X-ray, Pelvic radiography (searching for pelvic fracture bleeding), DPA or DPL(Diagnostic peritoneal aspirate or lavage)</li> </ul>

<b>Disability</b>	<ul style="list-style-type: none"> <li>- Focus on the patient's neurologic</li> <li>· <b>Glasgow Coma Score (GCS)</b></li> <li>· <b>Pupil response</b> (Dilatation – Edinger Westphal nu. damage, uncal herniation, CN III damage)</li> <li>· Lateralizing sign<sup>1</sup></li> <li>- Present with signs of spinal cord injury -&gt; Rapid assessment of their likely injury level</li> </ul>
<b>Exposure</b>	<p>All clothing should be removed.</p> <p>Concern for keeping the patient warm (use of warm blanket)</p>

### Adjuncts to initial survey

<b>Chest X ray</b>	<ul style="list-style-type: none"> <li>- Screening tool to quickly evaluate a patient for life-threatening conditions</li> <li>-&gt; Identify Hemo- or Pneumothorax, Ruptured diaphragm, Aortic injury, Multiple rib fracture</li> <li>- Confirms placement of both endotracheal and chest tubes</li> </ul>
<b>Pelvic X-ray</b>	<ul style="list-style-type: none"> <li>- Indications</li> <li>: Unexplained hypotension in which a simple intervention such as pelvic binding might be beneficial</li> <li>: Obvious skeletal injuries where a hip dislocation may be considered</li> </ul>
<b>FAST</b>	<p>= Focused Assessment of Sonography in Trauma</p> <p>@ Pericardium, Rt &amp; Lt. upper quadrants, bladder -&gt; Check for fluid in 3<sup>rd</sup> space</p>  <p>(Reference: <a href="https://cdemcurriculum.files.wordpress.com/2016/05/figure-10-normal-fast.png">https://cdemcurriculum.files.wordpress.com/2016/05/figure-10-normal-fast.png</a>)</p>
<b>DPL</b>	<p>= Diagnostic Peritoneal Lavage</p> <p>To check intra-abdominal hemorrhage, bowel leakage</p>
<b>CT scanning</b>	<p>While CT scanning revolutionized Trauma care and is of undisputed importance in the complete identification of injuries, we believe that <b>physiologically unstable patients should not go to CT.</b></p>
<b>Laboratory</b>	<p>"Trauma panel": CBC, Coagulation profile, Alcohol level, Arterial blood gas, Venous lactate</p>

<sup>1</sup> Unequal pupils, Deviation of the eyes to one side, Facial asymmetry, Turning of the head to one side, Unilateral hypo-hypertonia, Asymmetric deep reflexes, Unilateral extensor plantar response(Babinski)

## Management of Gunshot wound (GSW)

### ① Head

**Case:** Young male with **Gunshot wound on the head**

#### <Assessment>

Found in passenger seat in car,  
The car was struck by a streetlight, the driver did not know

- At Rt. temporal ~ parietal region, large hematoma (4cm)
- Active bleeding is not severe
- Vital sign WNL (BP 121/66, HR 71)
- **GCS 14 [E3,V5,M6]**
- Lt. upper and lower extremity motor/sensory decrease (Asymmetric movement)
- Irritability
- Steadily GCS drop
- > sedated by Fentanyl, perform intubation

#### <Plan>

**Bullet found in CT scout**

-> Galea hematoma, ICH, Brain hernia & mild midline shift (8mm)



=> NS consult, perform Rt. craniotomy

#### <Review>

Head shot scene often appeared in movies. In most movies, it is almost certain death when being a shot in the head. In fact, head trauma accounts for 35% of all traumatic brain injuries and 90% of patients die before reaching the hospital.

On the other hand, there are movies and dramas depicting people who have been shot in the head and miraculously survived. So I wanted to experience head GSW during this exercise. Brain is considered to be the most important organ for humans. Unlike other animals, we have a brain that allows us to think high -dimensionally. I was able to get a head GSW case during this exercise.

The patient was sitting in the passenger seat of the car. The sound of gunshot was heard, and the car clashed to a streetlight, and the driver was not there. The suspected location of the gunshot was Rt. parietal region. Fortunately, the GCS was 14, and cognition was normal except Lt. hemiplegia was observed. Until CT was taken, team members were suspicious of motor cycle collision (MCC), not gunshot.

However, the CT scan showed a bullet from the scout image. In addition, axial view showed that the bullet penetrated the skull and was located in the brain parenchyma. A midline shift of 8 mm was observed. Rt. craniotomy was performed. I have not been able to observe it because it was a NS operation, not a Trauma surgery. It is regretful that I did not do f/u after the operation.

Instead, I studied the principles of Head GSW and secondary injuries after surgery in textbooks.

#### \* Principle of surgery for GSW on the Head (GSWH)

- Evacuation of hematomas causing mass effect, meticulous hemostasis
- Thorough debridement of devitalized tissue and foreign debris
- Watertight layered closure to prevent cerebrospinal fluid (CSF)

#### \* GSWH prognosis

- GCS: 3~4 -> poor prognosis.
  - : 5 -> intermediate
  - : **6 and more -> opt for aggressive treatment**
- Poor prognosis factor: Self-infliction injury
  - : Presence of bilaterally fixed and dilated pupils, Development of coagulopathy
  - : Bullet passage across midline, through the geographic center of the brain, through the ventricles, or across more than one lobe of the brain

#### \* Secondary injury of GSWH

: brain edema, growth of contusions, abscess, traumatic aneurysm formation, seizures, etc.

## ② Neck

**Case:** Young male with GSW on **Midline neck**

### <Assessment>

- GCS 15
- Cooperative patient
- Voluntarily spit out blood by coughing
- **Found bullet on Chest X-ray**  
**: neck midline~Rt. side of Trachea**

### <Plan>

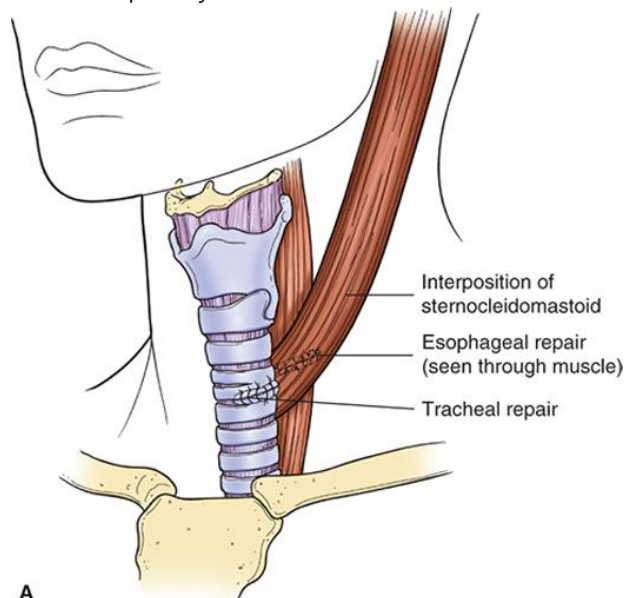
- Maintain sitting position because the patient felt asphyxiated when he lay down
- Horizontally long incision & observe
- > **partial injury to Trachea and esophagus**  
Intact Carotid artery!
- Use endoscopy to search for Esophageal injury
- Check esophageal leakage by injecting dyes through NG tube => Esophagus와 Trachea closure
- Remove Bullet

### <Review>

I thought that it is a marvelous and lucky case since the spinal cord, nerves, and carotid artery were intact despite of the GSW on neck. Surgical site was so small that the field was not well visible. What I saw sparsely was the scene that the bullet was removed and NG tubes and endoscopy were used to check the esophageal damage. I could not see the procedure repairing the damaged trachea, so I found the principle of trachea repair in the textbook.

### \* Principles or repair of the Trachea

- No debridement is necessary
- **One-layer repair with absorbable suture if small or moderate-sized hole**
- When there is loss of a portion of the anterior or lateral wall, a tracheostomy tube is inserted into the defect.  
The sternocleidomastoid muscle is then detached inferiorly, mobilized, and sewn in an airtight fashion to the defect after the tracheostomy tube is removed
- When there is loss of a portion of the membranous trachea, a three-sided rectangular longitudinal flap of pericardium based superiorly is sewn to the defect to create an airtight seal



Source: Ernest E. Moore, David V. Feliciano, Kenneth L. Mattox: Trauma, Eighth Edition  
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(Trauma, 8<sup>th</sup> ed, Figure 12 Repair of a combined injury to the trachea and esophagus)

: Following repair using interrupted absorbable sutures on the trachea, a vascularized muscle pedicle (such as the sternal head of the sternocleidomastoid muscle) is interposed between these two tubular structures to reduce the postrepair complication of fistula formation

### ③ Abdomen

**Case:** Young male with **GSW on belly**

**<Assessment>**

- A huge black male
- GCS 15, V/S stable
- small GSW found in **Lt. middle abdomen**
- Oozing type bleeding
- FAST(+): LUQ
- Cannot found Bullet exit
- Found bullet on Abdomen X-ray

**<Plan>**

- Exploratory laparotomy
- Penetration at 2 sites of small bowel, and 1 site of transverse colon
- **Bullet was thought to be embedded in the abdominal wall, not in the abdominal cavity.**
- => **Wasn't removed separately.**

**Case:** A young man found in a house with a GSW on belly

**<Assessment>**

- GSW at **Lt. flank**
- GSW 15 initially, GCS 3 on arrival
- **V/S unstable: HR 40, BP 60**
- Dorsalis pedis palpation (-)

**<Plan>**

- Performed **Lt. thoracotomy on Trauma bay** because HR dropped to 30 -> manual cardiac massage  
+ directly inject epi in heart 2 times
- Cardiac massage was performed for 10 minutes, but the circulation did not recover

**Death sentence**

(Thoracotomy showed elevated diaphragm and collapsed Aorta, suggesting that intra-abdominal hemorrhage was more common. There was no pericardial effusion)

**<Review>**

Abdominal gunshot wounds lead to intraperitoneal hemorrhage or risk of intestinal perforation. When FAST (+) or unstable V/S, or the estimated pathway crosses the abdominal cavity, they went to the operating room and performed laparotomy. It was fresh that the bullet was not removed, if the bullet was not detected through the intraperitoneal Exploration.

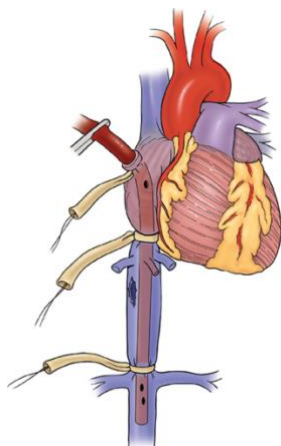
**\* Purpose of Laparotomy**

Hemostasis  
& Control of contamination

- Evacuate blood from the peritoneum
- Manual evacuation of clot, and direct and careful packing
- Liver hemorrhage: packing (laterally, superiorly , and inferiorly to the liver)
- Spleen & Kidney(pedicled organ) hemorrhage  
: vascular control – repair or resection of the involved organ
- Vessel injury: perform ligation, primary repair, vein patch, interposition grafting, and temporary intravascular shunting

※ **Damage control consideration**

- : For the patient in Shock,
- a modified, abbreviated operation course designed to control hemorrhage and control gross contamination
- > Shunting



(Reference: Trauma, 8<sup>th</sup> ed, Figure 50 Artrial caval shunt)

Exploring the peritoneal cavity

Structures appearing bruised of those located close to a missile trajectory should be fully mobilized and carefully examined for injury

- **Hollow viscus injury: repaired, or resected, with or without re-anastomosis**

I saw a case of death in abdominal gunshot that at the time of the discovery GCS was 15, but when he arrived at Trauma bay, the consciousness decreased and V/S unstable (SBP 60, HR40). I investigated more for the purpose and indication of resuscitative thoracotomy, and the anatomy of thoracotomy.

**\*Physiologic rationale of Resuscitative thoracotomy**

- Release pericardial tamponade and control cardiac hemorrhage
- Control intrathoracic hemorrhage
- **Perform open cardiac massage:** the ONLY potential to salvage the injured patient with ineffective circulatory status
- Achieve thoracic aortic cross-clamping
- Evacuate bronchovenous air embolism

**\* Resuscitative thoracotomy Indication & Contraindication**

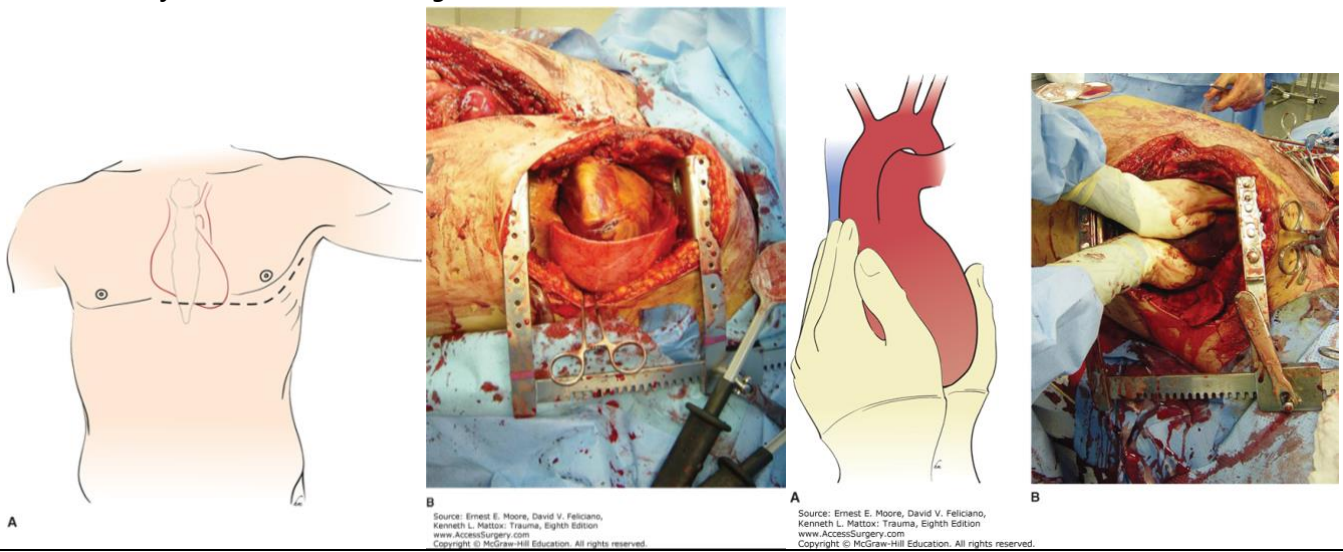
**- Indication**

Salvageable postinjury cardiac arrest due to:	<ul style="list-style-type: none"> <li>• Patient sustaining witnessed penetrating thoracic trauma with &lt; 15min of pre-hospital CPR</li> <li>• <b>Patient sustaining witnessed penetrating nonthoracic trauma with &lt; 5min of pre-hospital CPR</b></li> <li>• Patient sustaining witnessed blunt trauma with &lt; 10min of pre-hospital CPR</li> </ul>
Persistent severe postinjury hypotension due to: (SBP < 60mmHg)	<ul style="list-style-type: none"> <li>• Cardiac tamponade</li> <li>• Hemorrhage-intrathoracic, intra-abdominal, extremity, cervical</li> <li>• Air embolism</li> </ul>

**- Contraindication**

- CPR > 15min following penetrating injury and no sign of life (pupil response, respiratory effort, or motor activity)
- CPR > 10 min following blunt injury and no signs of life

**\* Thoracotomy (Trauma, 8<sup>th</sup> edition figure)**



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### <Review>

There are urinary organ such as bladder & ureter and Rectum in Pelvis. There were many cases with pelvic area injury requiring Urology consult. The severity varies from consciously clear patient with GCS 15 to death, from normal organs to injured organs requiring urinary surgery.

The surgeon who performed laparotomy for the operation was Trauma surgeon. During the operation of urology, one trauma surgeon remained and assisted the operation. It was also trauma surgeon that closed the abdominal cavity after the operation. Trauma surgeon was there from the beginning to end of the operation.

In addition, through the consult from ER, I was able to see a patient who had paraplegia due to spinal injury, RLQ ileal conduit urinary diversion due to bladder injury, and LLQ Ostomy due to rectum injury. I was sad because the patient was only about 30 years young.

### ⑤ Extremity

**Case:** s/p Popliteal arterial graft due to Lt. thigh GSW

#### <Assessment>

(OR case)

Lower extremity edema due to clot in vessel graft

#### <Plan>

Fasciotomy (Lt. calf, Med/Lat)

VAC dressing: The sponge was wrapped with vinyl tape on the fasciotomy site, made a hole in the vinyl tape to apply a negative pressure

**Case:** Teenager boy who shot his shin while playing with gun

#### <Assessment>

- 15cm GSW at Rt. medial calf  
(Not penetrating but graze)
- Limited primary closure; edema, wide legion
- Depth: can see the post. side of tibia (1 finger breadth)

#### <Plan>

Radical Debridement: remove veins and injured muscles

**Case:** Young male with Lt. thigh GSW

#### <Assessment>

- GCS 15, Clear Entry & exit
- Femur X-ray: remnant bullet (-)

#### <Plan>

GSW site irrigation and dressing

**Case:** Lt. tibia GSW

#### <Assessment>

- GCS 15, Severe pain in tibia
- Severe deformity
- Dorsalis pedis palpation -> Pulse (+)
- Motor & sensory normal

#### <Plan>

Tibia X-ray: fragmented bullet, multiple fracture -> Ortho c'



**Case:** Young male, Multiple GSW

#### <Assessment>

- GCS 15
- Multiple GSW: total 7 areas
  - : Rt. flank 1
  - : Lt. medial thigh 1
  - : Lt. lateral thigh (distal) 2
  - : Lt. ankle (media. Malleus) Entry 1
  - : Lt. plantar Exit 1
- Previous GSW found at Rt. leg

#### <Plan>

Remnant bullet on Abdomen X-ray

Access to Lt. knee med -> popliteal a. exploring,  
Injured vein ligation

-> Lt. Popliteal a. injury

Anastomosis with Rt. great saphenous vein harvest  
+ Med. & lat. Calf fasciotomy

IntraOP Doppler: PT(+)



Lt. foot Doppler: DP, PD (-) -> directly to OR

DPL<sup>2</sup>: to check intra-abdominal hemorrhage  
-> blood negative  
CT after surgery -> bullet found at Rt. flank  
embedded in the back muscles

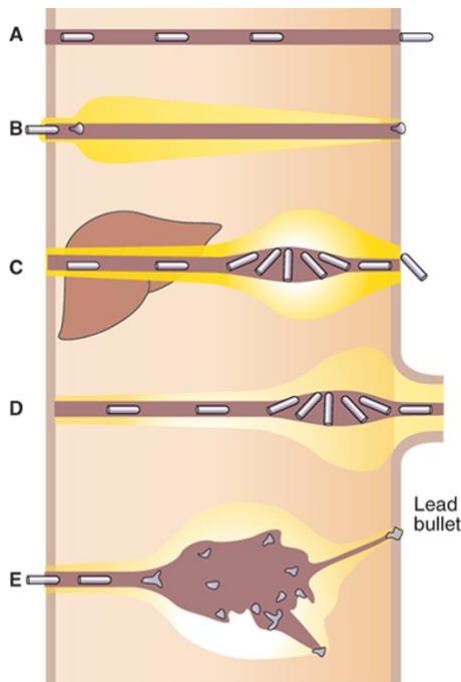
### <Review>

Extremity does not have critical organs, so prognosis seems to be good. Fasciotomy was performed directly by trauma surgeon. In the case of simple penetration without fragmentation, irrigation and dressing treatments were performed without additional suture.

Unlike other GSWs, the injured site made by the boy accidentally shot himself was very wide. The usual GSW leaves almost a hole, but this boy left a palm-sized GSW. I was once again thinking about the danger of carrying a gun that it could cause such a wound made by only mistake.

In addition, I witnessed the severe extremity GSW cases; multiple fracture with fragmented bullets, Doppler negative in both PT and DP that requires 7 hour-long surgery. **Saphenous vein interposition** is regarded as the best method to repair popliteal & tibial artery injury. In addition, the textbook recommends **empiric compartment calf fasciotomy when the ischemic time exceeds 3~4 hrs**. The patient arrived hospital after 30min of the accident and it took 2~3 hrs to explore popliteal a. in OR. Therefore, they did fasciotomy according to the recommendation.

I found the part of the textbook that deals with ballistics that explain the reactions that bullets cause in the human body.



#### \* Factors affecting Ballistics

- The force of the propellant
- The force of gravity pulling it down
- The resistance of the medium – Air, water, or tissue

=> The performance of a bullet in producing injury is reliant upon **velocity**, **construction of a bullet**, and the **composition of the target**.

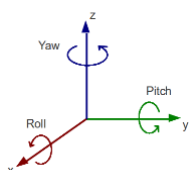
(Figure 1-2)

A	<b>Nonfragmenting bullet through tissue with minimal yaw<sup>3</sup></b>
B	Mushrooming bullet
C	Bullet tumbling <sup>4</sup> through solid organ
D	Bullet tumbling with large exit skin flaps due to hydrostatic pressure wave
E	<b>Bullet fragmenting</b> : Bullets breaks up into smaller pieces that will each produce separate injury tracks and patterns -> The most extreme form of change in sectional density

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<sup>2</sup> Diagnostic Peritoneal Lavage

<sup>3</sup> **Yaw**: rotation in Z-axis



(The X-axis is the direction of the trajectory)

<sup>4</sup> **Tumbling**: extreme yaw and flip on its axis as it slows -> immediate decrease in sectional density

-> increasing drag and thus releasing more kinetic energy into the surrounding tissue