



# Open & Pelvic Fractures & NV Injury

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## Objectives:

- To be able to identify and diagnose patients with an open fracture, a fracture with nerve or vascular injury and poly-trauma patients with pelvic injuries.
- To be knowledgeable about the pathophysiology and morbidity associated with these injuries.
- To be able to apply the principles of management of these injuries at the site of accident and In the emergency room.

## Color Index:

Original text | **Doctor's notes** | Text book  
**Important** | **Golden notes** | Extra

# Open Fractures:

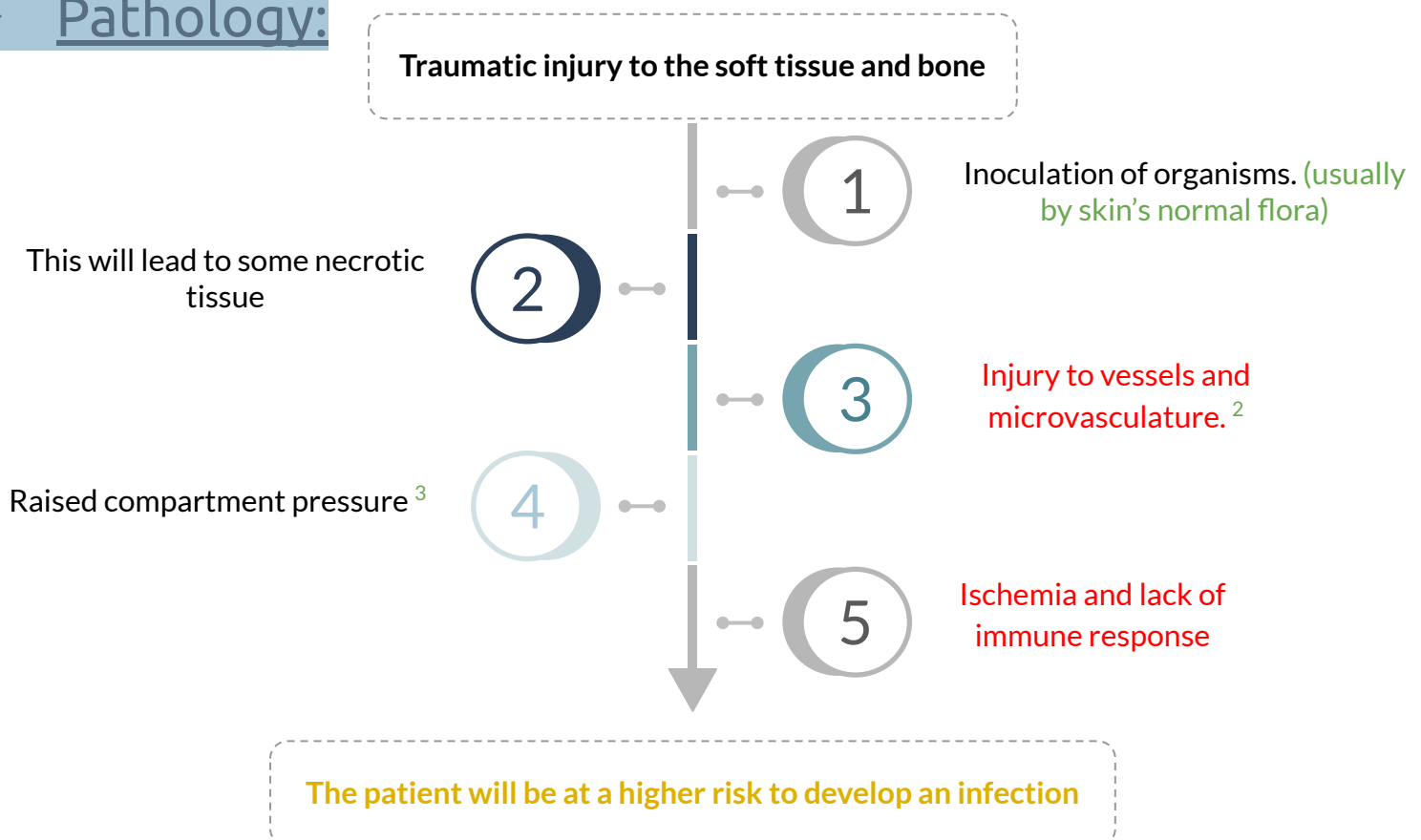
- **Open fractures** are defined as: "fractures that at some point communicated with the environment.
- An open joint is managed similarly.

## ❖ Etiology

- Open fracture usually requires high-energy injuries. (**not always**)<sup>1</sup>
- **Sometimes it can be easily missed**, look at the image on the right
- Commonly occurs in bones with minimal soft tissue coverage. e.g. **anterior tibia, distal radius and ankle**
- The deeper the bone (ex: femur) the higher the energy required.



## ❖ Pathology:



## ❖ Infections in the presence of Fractures:

- 1 ➤ Difficult to eradicate.
- 2 ➤ Need prolonged use of antibiotics
- 3 ➤ Requires multiple surgeries.
- 4 ➤ Lead to significant morbidity.
- 5 ➤ Significant costs.

1- e.g. a 90-year-old thin osteoporotic lady with very delicate skin who just got tripped she might easily break her bone and since her skin is not elastic the result will be an open fracture

2- Less blood delivered to the tissue > decreased O<sub>2</sub> transfusion and nutrient > ischemia and lack of immune response > good media for the bacteria to grow > infection.

3- This might lead to compartment syndrome as a result of the swelling. In compartment syndrome the skin is not affected because it has its own blood supply.

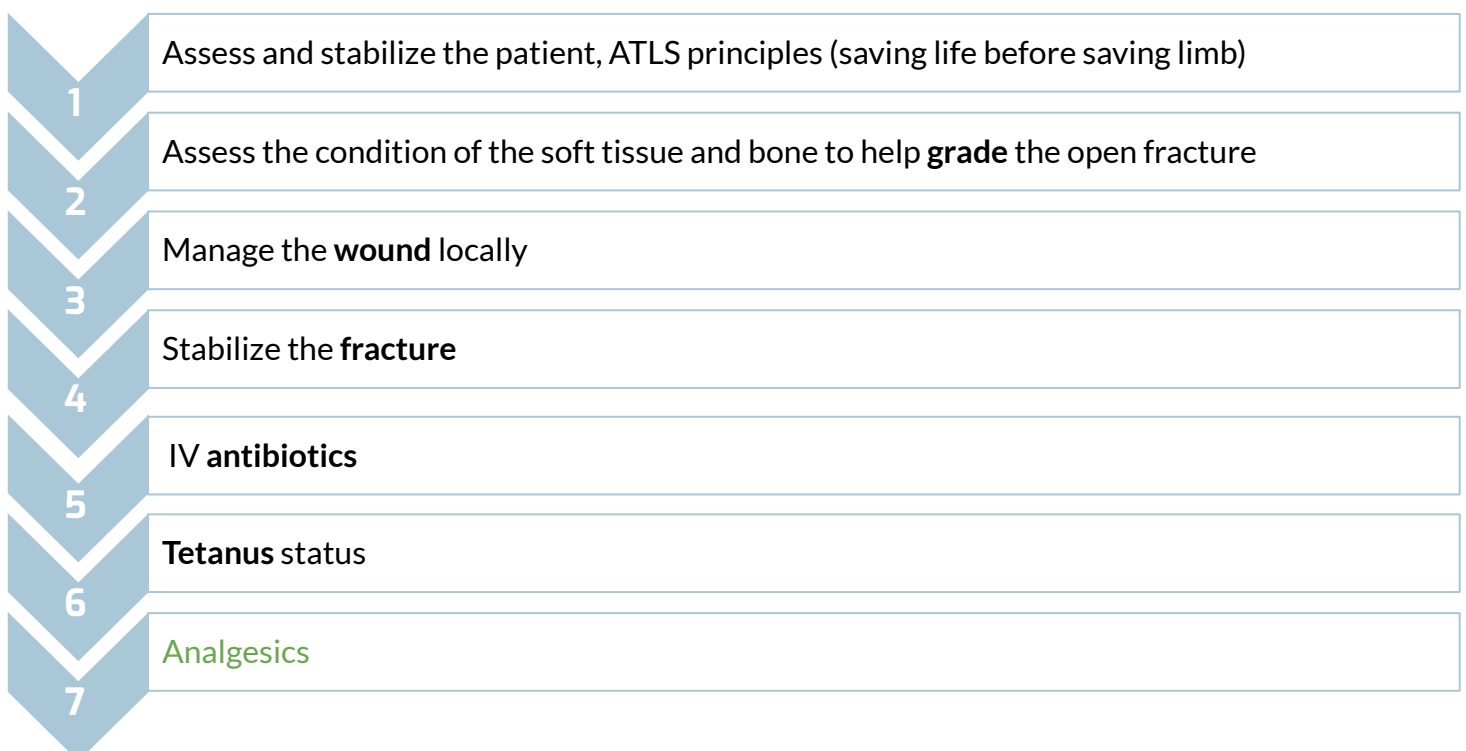
# Open Fractures:

- An open fracture is usually a “**red flag**” warning of significant trauma so **detailed assessment of the patient is necessary**.
- An open fracture is associated with significant morbidity so must act quickly.
- **A delay in management is proven to increase the likelihood of complications like infection.** So give urgent priority while triaging, provide initial management and consult urgently.

## ❖ Diagnosis:

- Sometimes it's obvious. Other times, settle; be observant
- A wound close to a fracture is an open fracture until proven otherwise= (the wound is very small, usually **oozing blood** and sometimes fat droplets from the intramedullary canal, needs high suspicion from the doctor)
- **Any wound/small opening in close proximity to a fracture, even if it is a small laceration, is potentially an open fracture until proven otherwise.** Whenever a fracture is diagnosed, go back and **check the skin**.
- **Small wound continuously oozing blood, even after applying pressure with a gauze it keeps bleeding, especially if you see fat droplets within the blood** like oil within the blood, it is diagnostic, but rarely seen, is an open fracture. **Where did the fat come from? from the bone marrow.** **The most indicative thing of open fracture is wound near fracture site with oozing blood.**
- Not always close to the fracture.
- Don't probe **any small opening!!** Because you might turn a closed fracture into an open fracture (probe: slender surgical instrument for exploring the depth or direction of a wound).
- If in doubt, use good light, if there is a break in the dermis or fat is seen, call it an open fracture.
- **Better to overcall than miss it.**

## ❖ Open Fractures Algorithm:



# Open Fractures Algorithm:

## 1- Assessment:

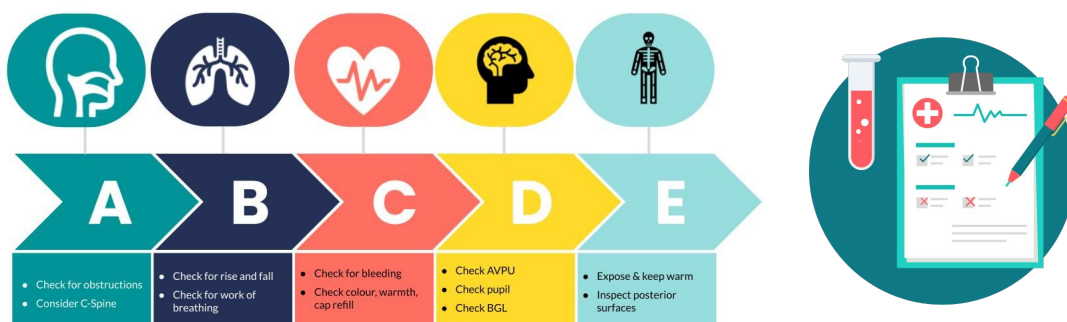
- Whenever you have a polytrauma cause → apply ATLS principles.<sup>1</sup>
- If you have an isolated injury, take a brief history about the following:
  - Mechanism and circumstances of injury?
  - Time since injury?<sup>2</sup>
  - PMH, PSH, allergies, drugs and smoking status (AMPLE)<sup>3</sup>
  - **Tetanus vaccination status**



- After stabilizing the patient and taking history, we need to examine the affected region for:
- **Soft Tissue:**
  - Degree of contamination (clean cut or bulldozer in a farm)
  - Size of wound
  - Necrotic and devitalized tissue
  - Coverage loss
  - Compartment syndrome
- **Bone:**
  - Comminution (simple vs. fragmented)
  - Stripping of bone periosteum<sup>4</sup>
  - Assess away from injury to joint above and below
  - X-rays to joint above and below
- **Neurovascular:**
  - Assess on arrival, post reduction and after splinting later



- Assess the condition of the soft tissue and bone to **help grade the open fracture.**



1- ATLS principles include primary survey which are the ABCDE (airway → breathing → circulation → disability → exposure)

2-The management differs between an open fracture since 1 hour and an open fracture since 12 hours.





3- AMPLE is a quick history : A: allergy / M: medication / P: past med/surgical / L: last meal / E: event surrounding the injury

4- Can indicates high energy trauma. Blood supply is affected which increases the incidence of infection.

# Open Fractures Algorithm:

## 2- Grading Open Fractures:

- We classify open fractures using "**Gustilo Classification**".

Gustilo Classification		
Grade	Description	Image
Grade 1	<ul style="list-style-type: none"> <li>Less or equal to 1 cm</li> <li>Clean, non-segmental nor severely comminuted fracture</li> <li>Less than 6 hours since injury.</li> </ul>	
Grade 2	<ul style="list-style-type: none"> <li>&gt; 1 cm (usually less than 10 cm)</li> <li>No extensive soft tissue injury or contamination</li> <li>Non-segmental nor severely comminuted fracture</li> <li>No bone stripping with adequate soft tissue coverage</li> </ul>	
Grade 3	3A <ul style="list-style-type: none"> <li>Any size (usually more than 10 cm)</li> <li>Extensive soft tissue contamination</li> <li>Segmental or severely comminuted</li> <li>Late presentation more than 6 hours</li> </ul>	
	3B <ul style="list-style-type: none"> <li>Any open fracture that <b>requires soft tissue coverage</b> procedure <sup>1</sup></li> </ul>	
	3C <ul style="list-style-type: none"> <li>Any open fracture that <b>requires vascular repair</b>.</li> <li>Patient comes with pulseless limb</li> </ul>	



It is more than 1 cm and it **requires soft tissue coverage**. So, it is either grade 3B or 3C. How to know? if there is a **pulse** then it is 3B, if there is **No pulse** then it is 3C (You take the higher grade)

Differ depending on the scenario:

- If the injury occurred <6h ago, it's 2
- If the injury occurred >6h ago, it's 3A
- If there is a **vascular injury**, it's 3C

<sup>1</sup>-What are the difference between skin graft and flap ? A graft is a piece of healthy skin that is removed from one part of the body and used to cover a wound elsewhere and it's does not have its own blood supply. At first, the graft survives because nutrients pass (diffuse) from the wound site into the graft. Soon, blood vessels grow into the graft. The blood vessels supply the graft with nutrients. A flap is a section of healthy skin that is partially detached and moved to cover a nearby wound. The flap has its own blood supply and usually heal faster than grafts. In the flab you have to take skin, subcutaneous tissue and muscle and it's used in severe soft tissue damage.

# Open Fractures Algorithm:

## 3- Management:

There are 4 phases in management

### Local Management

- Take a picture for documentation
- If dirty, irrigate with normal saline (warm) to remove gross contamination. **Do not use water even if it was sterile.**<sup>1</sup>
- If bone sticking out, try to reduce gently then immobilize and re-check neurovascular status.
- Cover with sterile wet gauze. **Wet because a dry gauze will stick to the wound and cause more injury when removing it.**
- If bleeding apply **direct pressure** on wound. **Never use a tourniquet.**<sup>2</sup>
- No culture swabs in ER. **you might contaminate the swab and you may induce an infection.**

### Antibiotics Management

- **Most important in managing open fracture grade 3A.**
- First generation **cephalosporin** for gram **positives** (Ex: Cefazolin or clindamycin if allergic) in **all open fractures.** (all grades)
- Aminoglycoside to cover gram **negatives** (Ex: Gentamicin) sometimes required in grade 2 if you suspect gram negative, **but generally give in all grade 3 cases.**
- Add penicillin or ampicillin or clindamycin (for **anaerobes**) for clostridium in grade 3 open fractures and all **farm and soaked wounds.**
- **Metronidazole can also be used for grade 3.**



Antibiotics based on Gustilo Classification			
	Grade I and II	Grade IIIA, IIIB and IIIC	Special considerations
Antibiotics	<ul style="list-style-type: none"> <li>• 1st generation cephalosporin (e.g. cefazolin)</li> </ul>	<ul style="list-style-type: none"> <li>• 1st generation cephalosporin for gram positive coverage</li> <li>• Aminoglycoside (such as gentamicin) for gram negative coverage</li> </ul>	<ul style="list-style-type: none"> <li>• Penicillin should be added if concern for anaerobic organism (farm injury)</li> <li>• Flouroquinolones (e.g. ciprofloxacin) should be used for fresh water wounds or salt water wounds (can be used if allergic to cephalosporins or clindamycin)</li> <li>• Doxycycline and 3rd or 4th-generation cephalosporin (e.g. ceftazidime) can be used for salt water wounds</li> </ul>

1- Because osmolality of the water is more so the tissue will loss fluid due to the concentration gradient. Just irrigate, if there is a big piece you can remove it by sterile equipment.

2-it will compromise the blood supply. We apply direct pressure for 5-10 minutes, if bleeding stops it's a venous which is more common to be injured, if doesn't stop, this is arterial injury.

# Open Fractures Algorithm:

Tetanus Management					
Clean Wounds			Other Wounds		
Clean wound criteria: (Any wound that doesn't meet all 5 criteria should be dealt with as other wounds)					
<ul style="list-style-type: none"> <li>&lt;6 hours from injury</li> <li>Not a farm injury</li> <li>No significant devitalized tissue</li> </ul>			<ul style="list-style-type: none"> <li>Non immersed wound</li> <li>Non contaminated wound.</li> </ul>		
Completed vaccination		Not Completed or Unknown	Completed vaccination		Not Completed or Unknown
Last Booster <10 years	Last Booster >10 years	Td 0.5 ml IM	Last Booster <5 years	Last Booster > 5 years	TIG 250 U and Td 0.5 ml IM
nothing	Td 0.5 ml IM		nothing	Td 0.5 ml IM	

Td: tetanus toxoid (vaccine)

TIG: Immunoglobulin

## Surgical Management and Plan

As soon as patient is stable and ready, **alert the OR**, and get consent from the patient for surgery

- Irrigation, **debridement of necrotic tissue** (source of infection) and fracture stabilization.
- The sooner the surgery the less risk of further morbidity.

### In the OR:

- Extend wound if necessary. (small wound → extend wound until you can reach the bone)
- Thorough irrigation.
- Debride all necrotic tissue.**
- Remove bone fragments without soft tissue attachment (dead bone) except articular fragments (except the part of bone that have cartilage over it). **Cartilage is precious**
- Usually requires second look or more every 48-72 hours.
- Generally, do not close open wounds on first look.

### Fracture management:

- Generally, avoid internal fixation (plate and screw).
- Generally external fixator is used.
- Femur and tibia fractures can usually be treated immediately with intramedullary nail** except severe injuries and contamination in the intramedullary canal.
- Observe for compartment syndrome post-operatively.

### If all principles were applied



In grade 1  
→ 2 % complication rate



In grade 2  
→ 10 % complication rate



In grade 3  
→ **≤50 %** complication rate

# Fractures with vascular injury

- Don't miss it.
- Always perform an accurate assessment at presentation, post manipulation and reduction, postsurgical fixation, **serially until condition stabilizes.**
- Serial examination helpful in deciding line of treatment and avoiding confusion because **sometimes the arterial injury is delayed so you have to check frequently.**
- High correlation between vascular injury and nerve injury (proximity)
  - e.g. if a patient injured the brachial artery suspect a median nerve injury.

## Mechanism

- Penetrating trauma
- High-energy blunt trauma
- Significant fracture displacement.
- Keep in mind tissue recoil at presentation.<sup>1</sup>
- Direct laceration (vascular) **usually from blunt injury or a gunshot**
- Traction and shearing. (vascular). **Clotting if only injury in intima**



## Assessment of Vascular Injury

- **Always check for:**
  - **Pulse, color, capillary refill, temperature, compartment pressure**
- **Keep high index of suspicion in case of the following:**
  1. High energy trauma.
  2. Associated nerve injuries.
  3. **Fractures/ Dislocations around the knee (injury to popliteal artery)<sup>2</sup>**
- **Hard signs (ALARMING SIGNS)**
  - Realignment of limb → If persistent → Vascular intervention
  - Realignment of limb → If Improved → Close observation (**with serial examination every 2 hrs**)

### Very Important !

#### Hard and Soft Signs of Vascular Injury Associated With Extremity Trauma

##### Hard signs

Pulselessness  
Pallor  
Paresthesia  
Pain  
Paralysis  
Rapidly expanding hematoma  
Massive bleeding  
Palpable or audible bruit

##### Soft signs

History of bleeding in transit  
Proximity-related injury  
Neurologic finding from a nerve adjacent to a named artery  
Hematoma over a named artery

Why do we perform a realignment?

Realignment results in uninking of vessel, lowering compartment pressure, relaxing arterial spasm

- **Always measure ABI** (<0.9 → vascular pathology) normal 0.9-1.4
  - Rarely gives false negatives (except profunda femoris injury)
  - Always used in high risk fractures (e.g. around the knee? PA)
- Angiography and CT angiography are gold standard
  - Comes with risk especially patients with renal failure

$$\text{ABI} = \frac{\text{Ankle Systolic Pressure}}{\text{Brachial Systolic Pressure}}$$

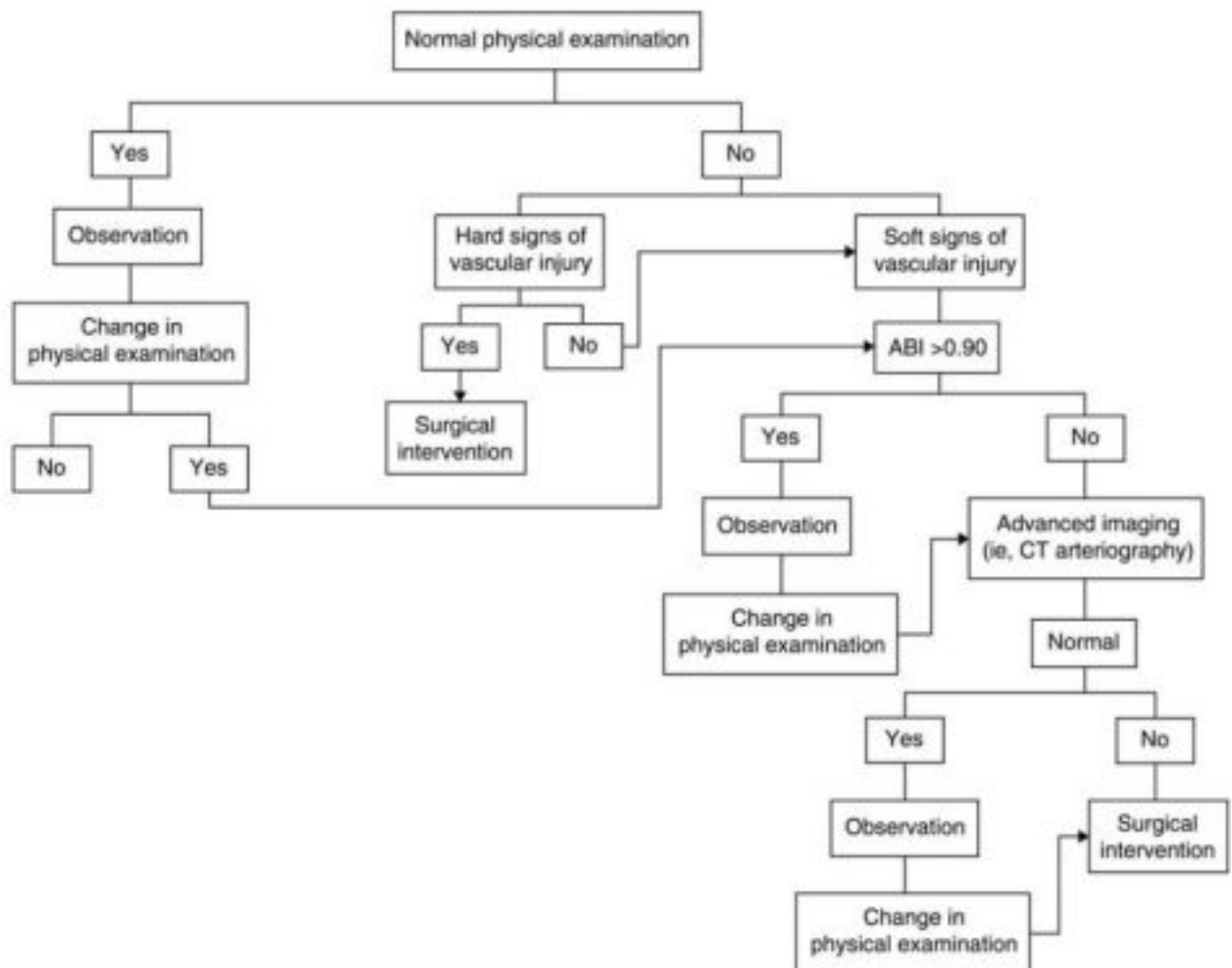
1- The injury might get displaced then the soft tissue might recoil it back to place; however, the injury still happened (be careful)  
2- The popliteal artery is tethered by both ends proximally and distally (so it's very tense)



# Fractures with vascular injury

## Management of Vascular Injury

- Once a vascular injury is confirmed, coordination between the following must be done:
  - Vascular Surgeon
  - Orthopedic Surgeon
  - General Surgeon
- To emergently re-establish perfusion, protect, repair and stabilize the bones.<sup>1</sup>
- **Warm ischemia time dictates treatment.**
  - Warm means the limb is still attached to the body,
  - Cold ischemia is when the amputated part was in an ice bag.
  - In cold ischemia it can wait longer because the metabolism is decreased in the amputated part.
- Most times, a quick external fixator is applied, followed by vascular repair.
- **Avoid prolonging warm ischemia time.**
  - Warm ischemia time is the amount of time from accident to when you intervene/ the time from injury till the limb is really ischemic and not warm anymore.
- **Prolonged warm ischemia > 6 hours**
  - You have to do prophylactic fasciotomy due to reperfusion injury which might cause CS
- Grade 3C open fractures have the worst outcome.
- Amputation may be necessary in severe cases.



1- We should stabilize the bone by an external fixator FIRST in 5 minutes then let the vascular surgeon repair the vessel

# Fractures with Nerve Injury:

- Cause of medico-legal concern.
- Accurate assessment and documentation at presentation, post reduction, post-surgery is essential.
- Remember to examine for motor and sensation prior to sedation.
- The most common type of nerve injury in bone fracture is **Neuropraxia**.

## Management of Nerve Injury

- Closed fractures with nerve injuries usually doesn't require surgery: why?**

  - Usually good outcome >80%
  - Usually managed conservatively in the early stages
  - Recovery may take more than 6 months. **most of the time it will recover spontaneously**
- Intact Nerve Before Reduction, absent after reduction:**

  - Controversial management.
  - Usually observe (because most of the time it's neuropraxia)
- Fracture requiring surgery with nerve injury: what dictates the need for surgery is the fracture not the nerve injury**

  - Limited exploration.
  - Do not perform another incision especially for fixing the nerve itself, we do surgery for fixation of bone only if the nerve is in our way we fix it if not we don't do it..
- Open Fracture With Nerve Injury:(gunshot +laceration)**

  - Explore, tag nerve ends for later repair.
  - We do suture like a tube between the two ends of the nerve ends)

## Follow up for Nerve Injury

- Follow up is usually clinical
- We need to perform an electrodiagnostic assessment starting at 6 weeks (then every 6 weeks)
- If there's no improvement:
  - Nerve exploration: neurolysis, repair or grafting
  - Tendon transfers to preserve function: **use a tendon supplied by a different nerve (last option)**

## Common Sites of Nerve Injury

Shoulder fracture/ dislocation  
 Distal humeral shaft fracture  
 Elbow fracture/ dislocation  
 Hip fracture/ dislocation  
 Knee fracture/ dislocation

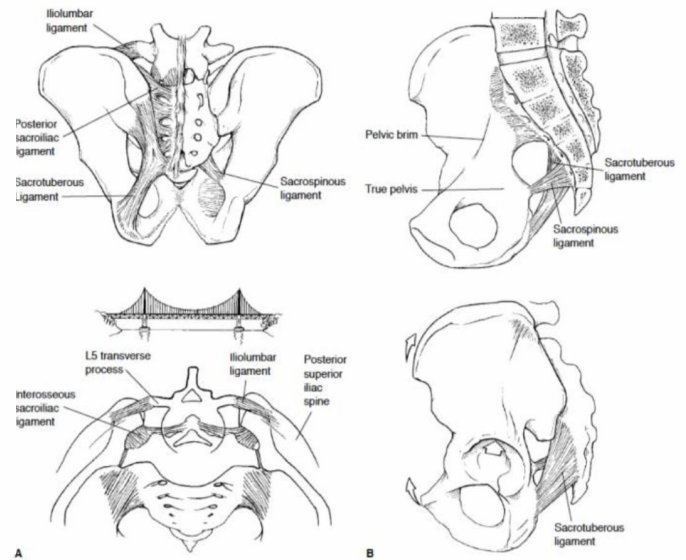
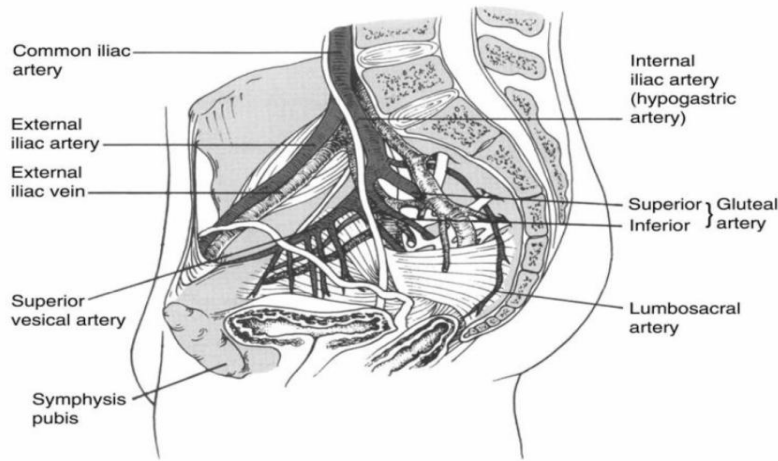


**Very Important !**

Axillary nerve  
 Radial nerve  
 Median, radial and ulnar nerves  
 Sciatic nerve  
 Peroneal nerve

# Pelvic Trauma:

## Pelvic anatomy



What makes the pelvis stable? 3 vertebropelvic ligaments.

1. **Iliolumbar ligament:** from tip of transverse process of L5 to posterior aspect of inner lip of iliac crest
2. **Sacrospinous ligament:** from ischial spine to lateral margins of the sacrum
3. **Sacrospinous ligament:** from sacrum to tuberosity of the ischium.

The sacroiliac joint is an important joint, composed of:

- Anterior Sacroiliac ligament.
- Posterior sacroiliac ligament (the strongest and most important)
- Accessory ligaments (sacrospinous and sacrotuberous)

These ligaments, amongst others, provide critical, structural support and connection of various tissues in and around the pelvis.

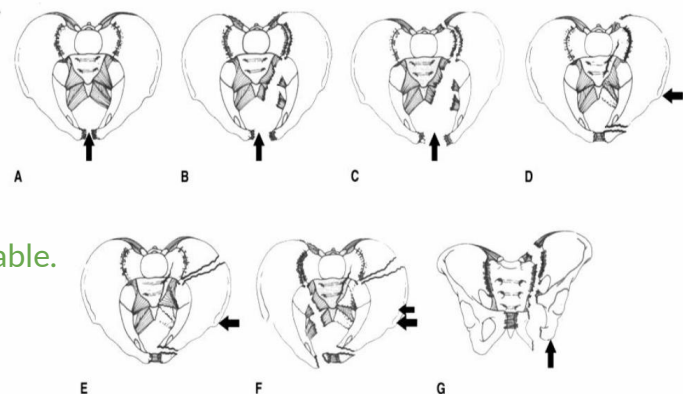
## Pathology

How the fracture causes instability to the patient's pelvis?

We have three mechanisms:

1. Anterior force causing open book. (A, B, C).
2. Lateral compression, e.g. car accident (figure D, E, F).
3. Vertical shears pelvic fracture (figure G). extremely unstable.

Survival is best in no. 1 and worst in no. 3



- Figure A: Anterior force causing a little opening in the sacro-iliac joint.
- Figure B: Anterior force causing a little opening in the sacro-iliac joint and instability.
- Figure C: more force caused open book pelvis. In this kind of injury, the left and right halves of the pelvis are separated at front and rear, the front opening more than the rear, i.e. like opening a book.
- Figure D, E, F: lateral compression.
- Figure G: vertical shears pelvic fracture. (falling on one's leg)

# Pelvic Trauma in the polytrauma patient

- Pelvic fractures, instability may cause life threatening bleeding. <sup>1</sup>
- Diagnosing pelvic instability early and stabilizing it can save lives <sup>2</sup>



## Diagnosis



- History: High vs. Low energy trauma.
- Mechanism of injury: Anterior vs. Lateral vs. Axial force
- Pelvic skin contusion, bruising.
- Short extremity (in vertical shears)
- Careful neurologic assessment.
- Primary survey (pelvic assessment falls under circulation)
  - Assess stability by gentle compression on the ASIS
  - Traction on the leg and assess pelvic instability, if unstable/painful:
    - Apply sheet around hips and close the pelvis gently
    - This results in decreased intra-pelvic volume (tamponade the bleeding) works if venous
    - Traction on the leg to stabilize vertical instability
    - This minimizes ongoing vasculature injury and bleeding
- Rectal exam, check for the following:
  - Bone fragments (be careful because it's usually sharp)
  - High riding prostate
  - Bleeding
  - Blood at the meatus, labia, or scrotum
- Vaginal exam (if a fractured bone penetrate a hollow viscus (bowel, vagina) → OPEN fracture



RIGHT

WRONG



## Management

- Stabilize pelvis with binder.
  - To control the volume, you may need an external fixator (leave it until the patient becomes stable)
  - Pay attention, putting the binder for long time can cause skin necrosis (always follow up)
- If vertically unstable apply traction
- IV resuscitation
- Look for other injuries
- Check response (make sure they are responding to fluid)
- If partial response, may require angiography for embolization of bleeders (arterial bleeding)
- May require external fixator and/or pelvic clamp.

1- The bleeding will be from the venous plexus of internal iliac vein and it will be retroperitoneal that's why it cannot be seen in US (FAST). So a patient comes after a high energy trauma we give him blood his blood pressure will increase then after a while it will go down, so what to do? Give him fluid again the patient will respond then the pressure will go down again this will tell you it is a matter of volume problem not cardiac or something else. So where is the fluid we are giving is going? You have to suspect an internal bleeding.

2- The idea of closing down and stabilizing the pelvis, is to try to close down the volume and allow less blood to accumulate till you have a tamponade effect, which can happen with venous bleeding or bleeding from the bone ends, arterial bleeding is less likely to stop.

# Extra:

## Open Fractures

- fractured bone and hematoma in communication with the external or contaminated environment

### Emergency Measures

- ABCs, primary survey, and resuscitate as needed
- remove obvious foreign material
- irrigate with normal saline if grossly contaminated
- cover wound with sterile dressings
- immediate IV antibiotics
- tetanus toxoid or immunoglobulin as needed ([see Plastic Surgery, PL27](#))
- NPO and prepare for OR (blood work, consent, ECG, CXR)
  - operative irrigation and debridement within 6-8 h to decrease risk of infection
  - ORIF
  - traumatic wound may be left open to drain with vacuum-assisted closure if necessary
  - re-examine with repeat irrigation and debridement in 48 h if necessary

**Table 6. Gustilo Classification of Open Fractures**

Gustilo Grade	Length of Open Wound	Description	Prophylactic Antibiotic Regimen
I	<1 cm	Minimal contamination and soft tissue injury Simple or minimally comminuted fracture	First generation cephalosporin (cefazolin) 2 g IV q8 h for 2 d If allergy use clindamycin 900 mg IV q8 h If MRSA positive use vancomycin 15 mg/kg IV q12 h
II	1-10 cm	Moderate contamination Moderate soft tissue injury	As per Grade I
III*	>10 cm	IIIA: Extensive soft tissue injury with adequate ability of soft tissue to cover wound IIIB: Extensive soft tissue injury with periosteal stripping and bone exposure; inadequate soft tissue to cover wound IIIC: Vascular injury/compromise	First generation cephalosporin (cefazolin) for 2 d plus Gram-negative coverage (gentamicin or ceftriaxone) for at least 3 d For soil or fecal contamination, metronidazole is added for anaerobic coverage ± penicillin G If MRSA positive use vancomycin 15 mg/kg IV q12 h

\*Any high energy, comminuted fracture, shot gun, farmyard/soil/water contamination, exposure to oral flora, or fracture >8 h old is immediately classified as Grade III



33% of patients with open fractures have multiple injuries



### Antibiotics for Preventing Infection in Open Limb Fractures

Cochrane DB Syst Rev 2004;1:CD003764

**Purpose:** To review the evidence regarding the effectiveness of antibiotics in the initial treatment of open fractures of the limbs.

**Methods:** Randomized or quasi-randomized controlled trials comparing antibiotic treatment with placebo or no treatment in preventing acute wound infection were identified and reviewed. Data were extracted and pooled for analysis.

**Results:** Eight studies (n=1106) were reviewed. The use of antibiotics had a protective effect against early infection compared with no antibiotics or placebo (RRR 0.43, 95% CI: 0.29-0.65; ARR 0.07, 95% CI: 0.03-0.10).

**Conclusions:** Antibiotics reduce the incidence of early infections in open fractures of the limbs.

### Gustilo Classification

	I	II	IIIA	IIIB	IIIC
Images					
Energy	Low	Moderate	High	High	High
Wound size	≤ 1 cm	1-10 cm	usually >10 cm	usually >10 cm	usually >10 cm
Soft tissue damage	Minimal	Moderate	Extensive	Extensive	Extensive
Contamination	Clean	Moderate	Extensive	Extensive	Extensive
Fracture Comminution	Minimal	Moderate	Severe	Severe	Severe
Periosteal Stripping	No	No	Yes	Yes	Yes
Skin Coverage	Local coverage	Local coverage	Local coverage	Free tissue flap or rotational flap coverage	Typically requires flap coverage
Neurovascular Injury	Normal	Normal	Normal	Normal	Exposed fracture with arterial damage that requires repair

## Extra:

## Pelvis

## Pelvic Fracture

## Mechanism

- young: high energy trauma, either direct or by force transmitted longitudinally through the femur
- elderly: fall from standing height, low energy trauma
- lateral compression, vertical shear, or anteroposterior compression fractures

## Clinical Features

- pain, inability to bear weight
- local swelling, tenderness
- abnormal lower extremity positioning: external rotation of one or both extremities, limb-length discrepancy
- pelvic instability

## Investigations

- x-ray: AP pelvis, inlet and outlet views, Judet views (visualizes obturator and iliac oblique when acetabular fracture suspected)
  - 6 cardinal radiographic landmarks of the acetabulum: ilioischial line, iliopectineal line, teardrop, weight bearing roof, posterior rim, anterior rim
- CT scan useful for evaluating posterior pelvic injury and acetabular fracture
- assess genitourinary injury (rectal exam, vaginal exam, hematuria, blood at urethral meatus)
  - if involved, the fracture is considered an open fracture

## Classification

Table 19. Tile Classification of Pelvic Fractures

Type	Stability	Description
<b>A</b>	Rotationally stable Vertically stable	A1: fracture not involving pelvic ring (i.e. avulsion or iliac wing fracture) A2: minimally displaced fracture of pelvic ring (e.g. ramus fracture) A3: transverse sacral or coccygeal fracture
<b>B</b>	Rotationally unstable Vertically stable	B1: open book (external rotation) B2: lateral compression – ipsilateral B2-1: with anterior ring rotation/displacement through ipsilateral rami B2-2: with anterior ring rotation/displacement through non-ipsilateral rami (bucket-handle) B3: bilateral
<b>C</b>	Rotationally unstable Vertically unstable	C1: unilateral C1-1: iliac fracture, C1-2: sacroiliac fracture-dislocation C1-3: sacral fracture C2: bilateral with 1 side type B and 1 side type C C3: bilateral both sides type C

## Treatment

- ABCDEs
- emergency management
  - IV fluids/blood
  - pelvic binder/sheet
  - external fixation vs. emergent angiography/embolization
  - ± laparotomy (if FAST/DPL positive)
- non-operative treatment: protected weight bearing
  - indication: stable fracture (e.g. elderly patient with fracture sustained in fall from standing)
- operative treatment: ORIF
- indications
  - unstable pelvic ring injury
  - symphysis diastasis >2.5 cm
  - open fracture

Specific Complications (see [General Fracture Complications, OR7](#))

- hemorrhage (**life-threatening**)
- injury to rectum or urogenital structures
- obstetrical difficulties, sexual and voiding dysfunctions
- persistent SI joint pain
- post-traumatic arthritis of the hip with acetabular fractures
- high-risk of DVT/PE

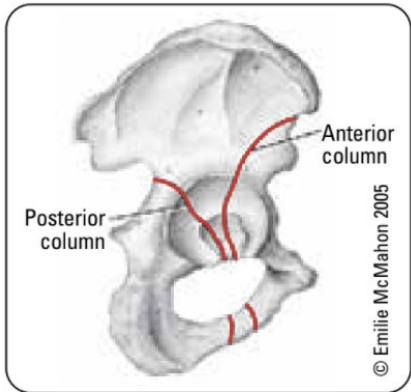


Figure 32. Pelvic columns



## Possible Radiological Findings

- Pubic rami fractures: superior/inferior
- Pubic symphysis diastasis: common in AP compression (N=5 mm)
- Sacral fractures: common in lateral compression
- SI joint diastasis: common in AP compression (N=1-4 mm)
- Disrupted anterior column (iliopectineal line) or posterior column (ilioischial line)
- “Teardrop” displacement: acetabular fracture
- Iliac, ischial avulsion fractures
- Displacement of the major fragment: superior (VS), open book (APC), bucket handle (LC)

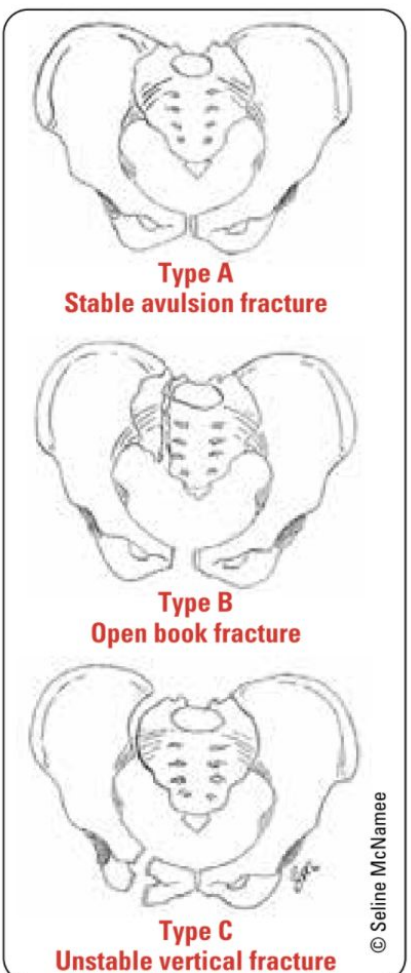


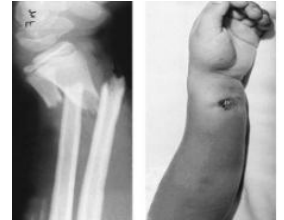
Figure 33. Tile classification of pelvic fractures

# Quiz

## MCQ

Q1: A 9-year-old boy sustained left forearm trauma after a fall. He presented to the emergency room with pain, tenderness and inability to move his hand. Clinical and radiological pictures are shown on the figures below. What is the diagnosis?

- A. Superficial wound laceration with spiral fracture of both radius and ulna
- B. Open fracture with Salter Harris type 1 distal radius and ulna
- C. Open fracture with transverse fractures of radius and ulna
- D. A simple both forearm fracture of radius and ulna



Q2: A 20-year-old male was involved in a motorcycle accident. On arrival to ER, patient was hypotensive and didn't respond well to fluid resuscitation. Examination revealed soft abdomen, clear chest, very unstable pelvis and no external bleeding. The AP pelvis X-ray is shown in the figure below. Which of the following is the most appropriate next step?

- A. U/S pelvis
- B. CT pelvis
- C. MRI pelvis
- D. Angiogram pelvis



Q3: According to Gustilo Classification of open fractures, a pulseless patient is graded as:

- A. Grade 2
- B. Grade 3C
- C. Grade 3B
- D. Grade 3A

Q4: A twenty-five-year-old male patient sustained an isolated injury shown below following a car accident. He underwent emergency debridement and intramedullary fixation of the fracture. Which of the following post-operative orders would be most appropriate to avoid further morbidity in the early post-op period?

- A. Close observation of thigh tightness and increasing pain
- B. Weekly X-rays to observe for malunion
- C. Daily blood work to observe for infection
- D. Observation of distal pulses to identify early compartment syndrome



## SAQs

A 45-year-old patient presented to the ER with an open fracture. Picture of the site of injury is shown below.

1. Mention 4 criteria to classify this fracture.  
Size, degree of contamination, bone fragmentation and time
2. Mention two long-term complications of this condition.  
Bone infection and poor bone healing



## Answers

Q1	Q2	Q3	Q4
C	D	B	A

# THANK YOU

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