

OPEN FRACTURES & FRACTURE WITH NERVE COMPROMISE & PELVIC FRACTURE



Lecture objectives:

1. 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.
2. To be knowledgeable about the pathophysiology and morbidity associated with these injuries.
3. To be able to apply the principles of management of these injuries at the site of accident and in the emergency room.

Done by: Bandar ALJammaz , Sulaiman Alzomia, Felwah Alsaawi

Team Leaders: Tareq AlAlwan, Elham AlAmi

Revised by: Sondos AlHawamdeh

References: Dr's slides & 436 team, Toronto Notes'2020'

OPEN FRACTURES

(TORONTO NOTES) (DR NABIL)

- A fracture that at some point **communicated with the environment** which is unsterile. The bone could be visible within the opening wound at the time of presentation or not, **Not necessarily bone coming out** i.e. all we can see is a small opening wound while the bone got back inside (see the pic). **The most important thing that we are concerned about in these cases is infection, because the bacteria now have a way to go inside the body.**
- An open joint is managed similarly. we consider it as emergency. In an open joint, it is enough to have an opening in the joint capsule without any fracture.



Etiology:

- Open fracture **usually** requires higher injury.
- **Not always** high energy (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).
- **Sometimes it can be missed.**
- Commonly occurs in bones with **minimal soft tissue coverage**. e.g. **anterior part of Tibia, distal radius.**
- Usually higher energy is required **in deep bones**. e.g. Femur, usually with this high energy look

Pathology:

Traumatic energy the soft tissue and bone which leads to:

- Inoculation of organisms. **Normal flora of the skin contaminates the exposed bone.**
- There will be some necrotic tissue.
- **Injury to vessels and microvasculature.** Less blood delivered to the tissue > decreased O₂ transfusion and nutrient > **ischemia** and lack of immune response > good media for the bacteria to grow > infection.
- Raised compartment pressure **will lead to compartment syndrome.** Due to swelling, in compartment syndrome the skin is not affected because it has its own blood supply.
- **Ischemia and lack of immune response.** As a result, **the patient at higher risk to develop an infection** because it's a good environment for bacteria to grow. When you already have an infection this is very hard to eradicate and treat and requires a lot of antibiotics and multiple surgeries, significant morbidities and very costly.
- Common scenario: A patient came with open fracture in femur in a developing region, initial management were done, and patient was taken to OR, fixation and immobilization using a plate were achieved. However, the patient wasn't managed properly with antibiotics. 2 years later, the patient came with chronic osteomyelitis (very complicated to manage at this stage, around 6 to 10 stages of operations are needed)

And then may end up with **infection**.

Infection in The Presence of a Fracture:

It is very important to manage the patient with **antibiotics**. When you already have an infection it's:

- Difficult to eradicate.
- **Need** prolonged antibiotics
- **Require** multiple surgeries.
- **Lead to** significant morbidity.
- Significant costs.

- 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 to **avoid infections.**
- **A delay in management is proven to increase the likelihood of complications like infection.** So give urgent priority while triaging, provide initial management (like antibiotics) and consult urgently. **The patient should be taken to OR preferably within 6 hours.**

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.** If we have like this picture and we are not sure if it is open fracture or wound, we consider it and deal with it as an open fracture until proven otherwise. Why? because if it’s open fracture and you didn't recognize it early, you may end up with infection.
- 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. From where the fat came? 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.**
 - Big wound but no fracture is not an open fracture, managed as soft tissue injury.
 - Fracture + skin abrasion "a superficial damage to the skin, no deeper than the epidermis" is not an open fracture.
 - **Fracture + a wound continuously oozing blood is an open fracture.**



Open Fracture Algorithm:

If you are **in an emergency** and a patient comes to you with an open fracture, this is what you have to do:

1. Assess and **stabilize** the patient, ATLS principles. **Saving life before saving limb**
2. Assess the condition of the soft tissue and bone to help **grade** the open fracture.
3. Manage the **wound** locally.
4. Stabilize the **fracture**.
5. **IV antibiotics.**
6. **Tetanus** status.
7. **Analgesics**

Assessment:

1. **Assess and stabilize the patient, ATLS principles:**

When the patient came to you and he is stable we start to assess him as usual by taking history, perform physical examination. etc. but sometimes the patient is not stable and we don’t have time to take the proper history, so we need to start with ATLS immediately.

- a. If **polytrauma** case, apply **ATLS** principles.
- b. If **isolated** injury, take brief **history** (AMPLE history) about the following:
- Mechanism and circumstances of injury. **What happen? how? is there any other injuries?**
 - Time since injury. **The management differs between an open fracture since 1 hour and an open fracture since 12 hours**
 - Past Medical/Surgical History/Allergy/Drugs/ Smoking.
 - **Tetanus vaccination status**
 - When was his last meal because the patient will go to OR, Recent last meal requires different type of intubation.

AMPLE is a quick history


- A: allergy
- M: medication
- P: past med/surgical
- L: last meal
- E: event surrounding the injury

2. Then **examine** the affected region for:

Soft tissue	<ul style="list-style-type: none"> ● Degree of contamination (clean cut or bulldozer in a farm) ● Size of wound ● Necrotic and devitalized tissue ● Coverage loss (the presence of a skin loss that might need a graft) ● Compartment syndrome
Bone	<ul style="list-style-type: none"> ● Comminution (simple vs. fragmented) ● Stripping of bone periosteum, which indicates high energy trauma. Blood supply is affected which increases the incidence of infection. ● Away from injury to joint above and below ● X-rays to joint above and below
Neurovascular Status	On arrival and post reduction and splinting later. Document everything to avoid any medico-legal issues

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

Very IMP: Open fracture grades (Gustilo classification): [ORTHO BULLETS](#)

Grade 1	<p>Less or equal to 1 cm, clean, non-segmental nor severely comminuted fracture, less than 6 hours since injury.</p> <p>What are the difference between segmental and comminuted fracture? Segmental fractures present two fracture lines both being complete, within the same anatomic location.</p> <p>Comminuted fractures involve multiple fracture lines in the same anatomic location resulting in multiple fragments of bone. If you have same picture but the fracture more than 24 hours what is the grade? 3, any fracture more than 24 hours its 3 even if the fracture is clear.</p>	
----------------	---	---

Grade 2

> 1 cm wound and usually less than 10 cm, not extensive soft tissue injury or contamination, non-segmental nor severely comminuted fracture, no bone stripping and with adequate soft tissue coverage. Same as Grade 1 but the wound is > 1 cm, (size of the wound is the main difference between grade 1&2). In this picture the wound is very big but if you clean it you will find enough soft tissue coverage.



Grade 3

3A: Any size with extensive soft tissue contamination or injury but not requiring soft tissue coverage procedure, or with a segmental or severely comminuted fracture, or late presentation more than 6 hours.



3B: Any open fracture that requires soft tissue coverage procedure like skin graft or flap.



What are the difference between skin graft ترفيع الجلد and flap سديلة ?

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.

3C: Any open fracture that requires vascular repair. (patient came with pulseless limb)

If combined conditions always take the worse which is 3C (e.g. patient came with an open fracture that needs both soft tissue coverage in addition to vascular repair so we consider it as 3C). You can't differentiate between 3A and 3B in the ER, we do it in the OR. To make it simple: if all the criteria for grade 1 and 2 are present then it is either grade 1 or 2 depending on the size. If something is missing it is a grade 3a except if it needs coverage (3b) or vascular repair (3c).

It's very important to take full Hx to grade correctly.



Examples on open fracture grading



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

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.

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**

Management:

Manage the wound locally: the management is divided into 3 parts: locally, antibiotics and in OR. First, you have to do what we said before from stabilization to grading.

1- Locally:

- Take a picture for documentation or to show it to your colleagues, so you don't need to reopen the wound every time another doctor wants to examine it to avoid contamination.
- If dirty, irrigate with normal saline to remove gross contamination make sure saline is warm. **Do not use water even if it was sterile**. Because osmolality of the water is more so the tissue will lose fluid due to the concentration gradient. Just irrigate, if there is a big piece you can remove it by sterile equipment.
- 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**; 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.
- No culture swabs in ER. Some studies said it is useless As the wound might be contaminated and you will induce the infection.

2- **IV antibiotics:** Most important in managing open fracture grade 3A.

I. First generation **Cephalosporin** for gram **positives** (Ex: Cefazolin or clindamycin if allergic) in all open fractures.

II. Aminoglycoside to cover gram **negatives** (Ex: Gentamicin) sometimes not required in grade 1 but in general it is safer to give in all grades.

III. Add penicillin or ampicillin or clindamycin (for **anaerobes**) for clostridium in grade 3 open fractures and all **farm and soaked** wounds. **Metronidazole** used also for grade 3

Grade 1: one antibiotic (Cefazolin), grade 2: two antibiotics (cefazolin+aminoglycosides), grade 3: three antibiotics.

Grade 3: give 1st generation cephalosporin + gentamicin + penicillin or ampicillin or give clindamycin if patient is allergic to penicillin.

3- Tetanus status (Very IMP): “you have to memorize this, because you can have scenarios in the Exam about patients with open fractures, and then you decide what kind of vaccination you should provide”.

Tetanus prevention is depending on the wound type:

a. Clean wounds criteria:

- <6 hours from injury
- Not a farm injury
- No significant devitalized tissue
- Non immersed wound
- Non contaminated wound.

b. Other wound criteria: Any wound does not apply to type A

Clean wounds		Other wounds					
Completed vaccination		Not Completed or Unknown Unconscious or doesn't remember		Completed vaccination		Not Completed or Unknown	
Last Booster <10 y	Last Booster >10 y	Td 0.5 ml IM		Last Booster <5 y	Last Booster > 5 y	TIG 250 U and Td 0.5 ml IM	
nothing	Td 0.5 ml IM			nothing	Td 0.5 ml IM		

Tetanus toxoid (Td) considered as **active** immunity.

While immunoglobulins (TIG) **passive** immunity. In KSA, most patients will be not completed or unknown.

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

- Plan: Irrigation, **debridement of necrotic tissue** because it is a source of infection and fracture stabilization.
- The sooner the less risk of further morbidity.
 - **In the OR:**
- Extend wound if necessary. If it was a small wound, we need to extend until we can reach the bone.
- Thorough irrigation.
- **Debride all necrotic tissue.**
- Remove bone fragments **without soft tissue attachment**, because it's dead bone i.e. floating except **articular fragments** (except the part of bone that have cartilage over it). Give it a chance to heal as it doesn't regenerate easily
- Usually requires second look or more every 48-72 hours.
- Generally, **do not close open wounds on first look**. Don't close it surgically, only cover it, and then put external fixation if it was dirty, look at it again in a day or 2 and then close it again. Newly, this is what they do: Irrigate, debridement, and close primarily.

In OR, if there were no necrotic tissue, no contamination & the cut was simple & clean (make sure) → stabilize the fracture & close the wound but if you find necrotic tissue → do debridement & leave the wound open (no suture yet only gauze & bandage) → recheck again in 48-72 hours for necrotic tissue.

Fracture management:

- Generally, avoid internal fixation (plate and screw). If it's clean we can do IM nail but in general try to avoid it
- 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. (studies showed it is ok to use internal fixation in these cases)
- Observe for compartment syndrome post-operatively.

If all principles applied you can still have infection: (in an ideal scenario)

- a. 2% complication rate in grade 1
- b. 10% complication rate in grade 2
- c. **Up to 50% complication rate in grade 3**



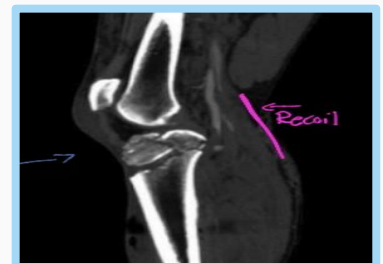
If there's any further assessment bring the patient later on. In some patients we can leave the wound open and put vacuum dress or regular wet dressing. **In general, if you have a question in the exam, that gives you external fixator as an option and internal fixation as an option and only tells you this is an open fracture (simple question with different methods of fixation, choose the safest one), it's always safer to go with the external fixator.**

FRACTURES WITH VASCULAR INJURY

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

Mechanism:

- Penetrating trauma (sharp object) e.g. stab wound.
- High-energy blunt trauma (pedestrian hit by car from the side).
- Significant fracture displacement.
- Keep in mind tissue recoil at presentation. (it means that it can go back to its normal place at the time of imaging after injuring the vessel). **Soft tissue recoiled the bone back to place make it seem normal.**
- Direct laceration (vascular) usually from blunt injury or a gunshot
- Traction and shearing. (vascular). **Clotting if only injury in intima**



All arteries and veins contain three layers. The innermost layer is called the tunica intima. The muscular middle layer is called the tunica media, and the outermost layer is called the tunica adventitia. The most layer to be affected if intima.

Assessment of vascular injury: **Important**

- **Always check for:**

- **Pulse, Color, Capillary refill, Temperature, Compartment pressure**
- Check both sides:
 - If vascular injury → one limb is affected
 - If shock → both limbs are affected

- **Keep high index of suspicion in case of the following:**

1. High energy trauma.
2. Associated nerve injuries.
3. **Fractures/ Dislocations around the knee** (Dangerous! **Measure ABI**) because of popliteal artery vascular injury sometimes occurs with intimal tear. In an intimal tear the intima of the vessel is injured but the blood flows normally early on. Later the blood pushes the tear and occludes the vessel in a valve like mechanism.

Algorithm: To help you know whether there is vascular injury or not, if you have one of them (hard signs), then you have to worry about having vascular injury.

hard signs—>Realignment of limb: (hard sign means dangerous or alarming sign)

- If persistent—> Vascular intervention

- If Improved—> Close observation with serial examination every 2 h. Why we do realignment? Because Realignment can result in unkinking of vessels, lowering compartment pressure, relaxation of arterial spasm. So, if you did your Vascular exam and you did not find the pulse, best thing to do is realignment of the fracture. In case of open fracture around the knee—>Hard signs—>realignment of limbs—>improved—>do ABI test.

IMP
ABI (the ankle brachial index): Normal range 1.0-1.2. we do it because the presence of a pulse alone does not exclude vascular injury.

$$ABI = \frac{\text{Ankle systolic pressure (dorsalis pedis or posterior tibial artery)}}{\text{Arm systolic pressure (brachial artery)}}$$

- **< 0.9 associated with vascular pathology.** Less than 0.9 vascular injury, above 1.2 calcified by atherosclerosis.
- Rarely can give false negative result (Ex. Profunda Femoris)
- Always used in high risk fractures (knee)
- If positive—>Urgent vascular intervention
- If vascular status didn't improve (<0.9) after limb realignment do CT angio. If there is a slight improvement do ankle brachial index.
- **Angiography** using a catheter through femoral line, **CT angiography** is a **gold standard**, but it has risks, so be careful with patient who have renal failure or pre renal failure. Needs vascular surgeon to arrange with interventional radiologist.

OSCE + MCQs

#الصورة مهمة#



Table 1

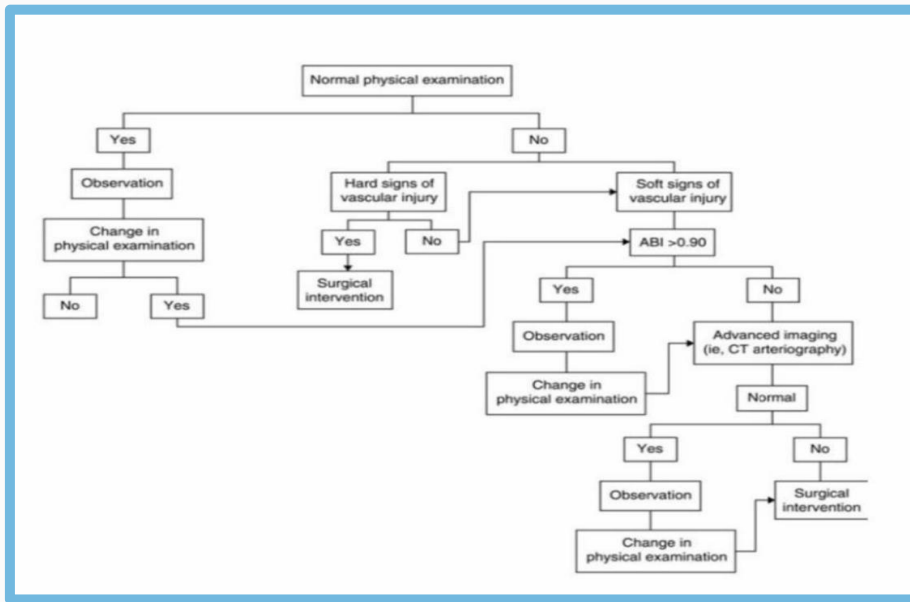
Hard and Soft Signs of Vascular Injury Associated With Extremity Trauma

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



-Angio is a certain artery and you puncture it. (diagnostic & therapeutic)
 -CT is systemic dye and then put them in CT machine to take pictures. (diagnostic)

Management:

- Once vascular injury is confirmed—>Coordination between: Vascular + Orthopedic + General surgeons.
- Aim: Emergently re-establish perfusion and protect repair with skeletal stabilization.

The principle is that fixing the artery should be first, but what if after fixing the artery the bone moves (since it is unstable) and damage the artery again? So most of the time the orthopedic surgeon will act quickly to stabilize the fracture by general fixator. Then we do the vascular repair. **In short: we fix the fracture first then the artery because fixing of fracture will move the artery again.**

- **Warm ischemia time dictates treatment.** Warm means the hand 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 metabolic rate is decreased in this amputated part.
- Most times, a quick external fixator is applied, followed by vascular repair.
- **Avoid prolonged warm ischemia time to do repair.** Warm ischemia time: 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 i.e. after repairing the vessel the reperfusion will cause edema in the muscle leading to increased pressure—>compartment syndrome.
- Grade 3C open fractures have the worst outcome. **50% infection.**
- Amputation may be necessary in severe cases.

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:

A. 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**

B. Intact Nerve Before Reduction, absent after reduction:

- Controversial management.
- Usually observe because most of the time it's neuropraxia.

C. 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 another incision.

D. 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:

Clinically:

- Electrodiagnostic assessment start at 6 weeks then serially every 6 weeks (**6 weeks because if done before 6 weeks it is useless and it cannot be read**)
- If no improvement:
 - A. Nerve exploration: neurolysis, repair, grafting
 - B. Tendon transfers to preserve function. **It's done when the nerve grafting is not expected to succeed or already failed.** E.g. we take one of the plantar flexor tendons in case of foot drop. In other words, some tendons are transferred in order to restore more normal movement to a foot and ankle that has lost function. Patient needs to get use to it.

■ Common sites of nerve injury: **Very IMP**

1. Shoulder fracture, dislocation—>Axillary nerve
2. Distal humeral shaft fracture—>Radial nerve
3. Elbow fracture, dislocation—>Median, radial, ulnar
4. Hip fracture, dislocation—>Sciatic nerve
5. Knee fracture, dislocation—>Peroneal nerve

PELVIC TRAUMA IN THE POLYTRAUMA PATIENT (TORONTO NOTES)

Pelvic anatomy:

What makes the pelvis stable? The bony pelvis is held together with the support of the 3 vertebropelvic ligaments.

1. **Iliolumbar ligament:** from tip of transverse process of L5 to posterior aspect of inner lip of iliac crest; strengthens the lumbo-sacral joint.
2. Sacrospinous ligament
3. Sacrotuberous ligament

The sacroiliac joint is an important joint, composed of:

- Anterior Sacroiliac ligament.
- **Posterior sacroiliac ligament (the strongest and most important).**
- **Accessory ligaments:**
 1. sacrotuberous ligament: from sacrum to tuberosity of the ischium.
 2. sacrospinous ligament: from ischial spine to lateral margins of the sacrum

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

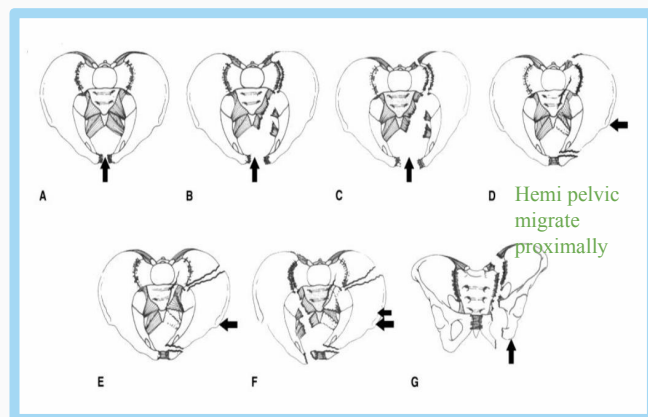
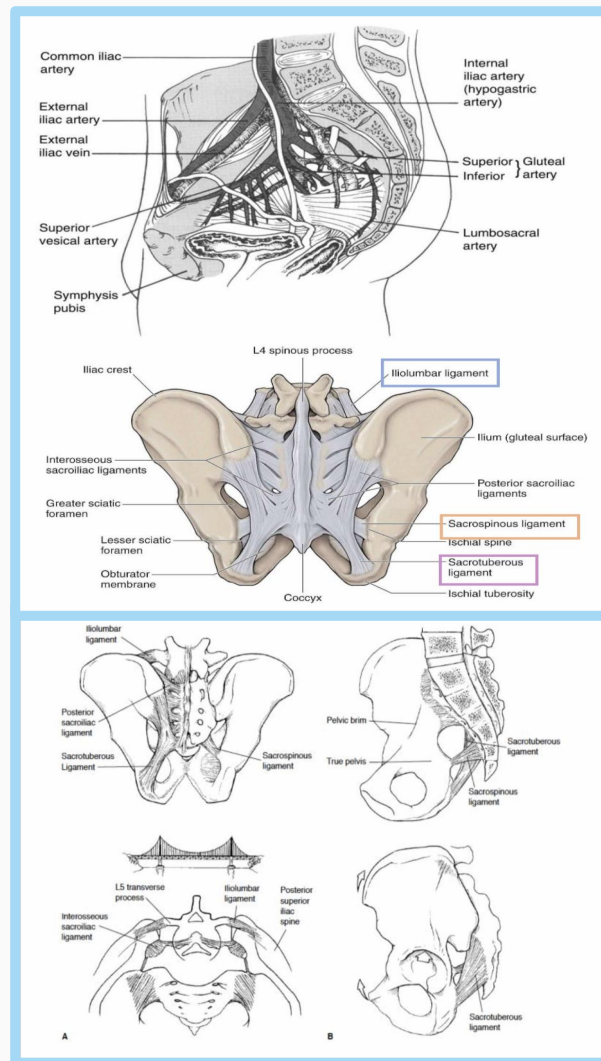
The doctor said: It is very important to understand how the pelvic ring fails, and what are the directions of instability, more commonly it's unstable rotation.

Pathology:

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

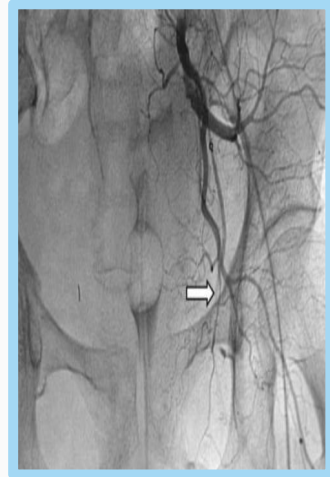
We have three mechanisms:

1. Fall on one leg causing vertical shears pelvic fracture (figure G). extremely unstable.
 2. Anterior force causing open book. (A, B, C).
 3. Lateral compression, e.g. car accident (figure D, E, F).
- There is more survival with open book then lateral compression and least is the vertical.



- 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.

- Pelvic fractures, instability may cause life threatening bleeding. 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.
- Diagnosing pelvic instability can save lives. 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.



Diagnosis: Investigation then if you find fracture apply binder or sheet.

- 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: part of (C) circulation.**
1. Assess stability by gentle compression on the ASIS.
 2. Traction on the leg and assess pelvic instability (traction on leg while your hand at the iliac crest if it moves then it is a vertical shear fracture).
- if unstable or painful (mostly fractured):



A- Apply sheet around hips and close the pelvis gently (around the trochanter used in case of compression fracture)

B- This results in decreased intra-pelvic volume leading to tamponade the bleeding (by increasing the pressure around the vessel the blood pressure will rise)

C- Traction on the leg to stabilize vertical instability

D- This minimizes ongoing vasculature injury and bleeding

- **Rectal exam:** it's very important to perform it to check if there is any:
 1. Bone fragments (a pelvic bone fragment got inside the rectum and it could be sharp so be careful).
 2. High riding prostate (a sign of pelvic fracture).
 3. Bleeding.
- Blood at the meatus, Labial or scrotal ecchymosis, Vaginal exam.

➤ **If the fractured bone penetrates the bowel or vagina or any hollow viscus—>it's an OPEN FRACTURE**

Management:

- **Stabilize pelvis with binder.** To control the volume, very unstable may. Need external fixator, leave the binder until the patient is stable. *Pay attention, putting the binder for long time can cause skin necrosis, so put it carefully and keep following 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 (to look for any active arterial bleeding).
- May require external fixator and/or pelvic clamp.

Early diagnosis: Aggressive resuscitation, Coordinated team effort, Save lives

Extra, Complications:

Thromboembolism, Sciatic nerve injury, Urogenital problems, Persistent sacroiliac pain.

Open Fractures

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

Emergency Measures

- ABCs, primary survey, and resuscitation as needed
- removal of 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, PL10](#))
- 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 q8h for 2 d If allergy use clindamycin 900 mg IV q8h If MRSA positive use vancomycin 15 mg/kg IV q12h
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 q12h

*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.

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
- deformity of lower extremity
- pelvic instability

Investigations

- X-ray: AP pelvis, inlet and outlet views, Judet views (obturator and iliac oblique for acetabular fracture)
 - 6 cardinal radiographic lines of the acetabulum: ilioischial line, iliopectineal line, teardrop, 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

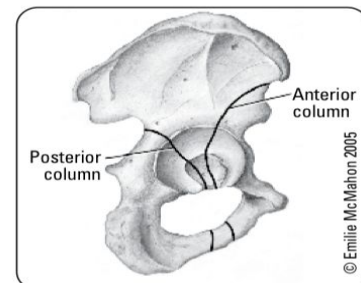


Figure 32. Pelvic columns

Classification

Table 19. Tile Classification of Pelvic Fractures

Type	Stability	Description
A	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 fracture
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
C	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
- non-operative treatment: protected weight bearing
 - indication: stable fracture (e.g. elderly patient with fracture sustained in fall from standing)
- emergency management
 - IV fluids/blood
 - pelvic binder/sheeting
 - external fixation vs. emergent angiography/embolization
 - ± laparotomy (if FAST/DPL positive)
- operative treatment: ORIF
 - indications
- unstable pelvic ring injury
- disruption of anterior and posterior SI ligament
- symphysis diastasis >2.5 cm
- vertical instability of the posterior pelvis
- open fracture

Specific Complications (see General Fracture Complications, OR7)

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



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)

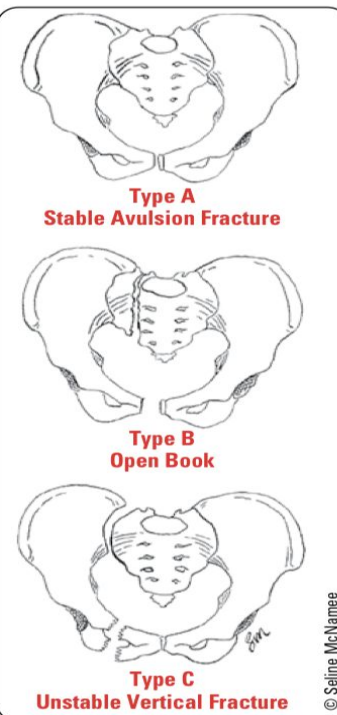


Figure 33. Tile classification of pelvic fractures

QUESTIONS

Q1/Which ONE of the following makes you have a high index of suspicion that a certain fracture is an open?

- A. Site of wound is near the fracture
- B. Inability to move the limb
- C. Not broken layer of dermis
- D. Wound active oozing blood

Ans:D



Q2/what grade of open fracture is this (No neurovascular involvement)?

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

Ans:C



Q3/Patient had an open fracture while swimming in a lake. He went to the ER after 2 hours of the fracture. What is the best dose of Tetanus vaccine for him (note: he doesn't know if he had Tetanus vaccine before).?

- A. Nothing
- B. Td 0.5 ml IM
- C. TIG 250 U
- D. Both B+C

Ans: D

Q4/A 22-year-old male presented to the emergency room, one hour after he fell off a motorbike. He sustained an injury to his right leg with exposed bone and bleeding. He is conscious and alert with stable vital signs. The clinical and x-ray images are shown in the below figures. Physical examination revealed soft compartment and palpable dorsalis pedis pulse. He is able to move his toes. Which of the following is the most appropriate initial step in management?

- A. Irrigation and debridement followed by external fixation
- B. Irrigation and debridement followed by external fixation and urgent vascular consultation
- C. Irrigation and debridement followed by external fixation and fasciotomy
- D. Irrigation and debridement followed by internal fixation and fasciotomy

Ans: A

