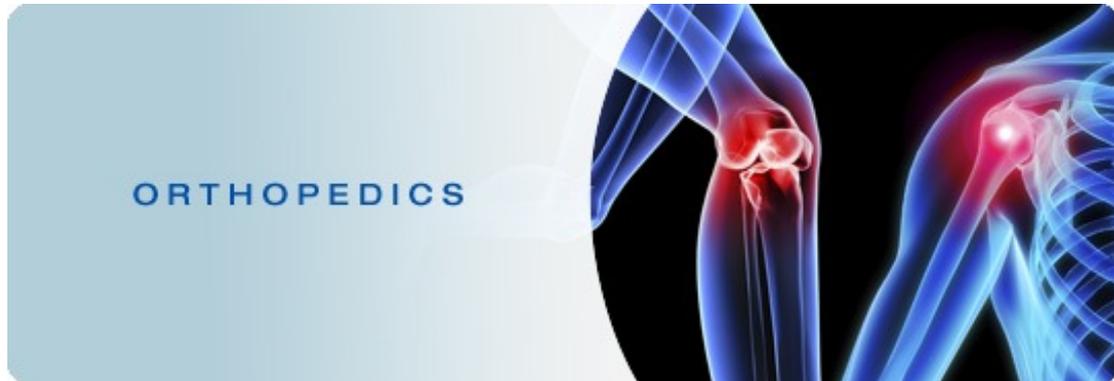


Isn't it funny how someone can say "I believe in Allah " but still follow the Satan who by the way also, " believes " in Allah...

430 ORTHOPAEDICS TEAM



7- Orthopaedic Emergencies 2/ Red Flags (Open fracture, Fracture with Neurovascular compromise, Pelvic fracture)

Team Members:

Hissah Alballa

Team Leader:

Ayedah Al-Ruhaimi.

Sources:

- **Dr.Ahmad Bin Nasser's slides.**
- **Lecture's recording.**
- **429 team work (group A1).**
- **Wikipedia**
- **Notes from clinical skills: Management of Open Fracture with Dr.Zaheer**

Open Fractures:

● Definition:

- A fracture that at some point communicated with the environment (Even if it's not shown at the time of presentation, the bone might go back inside) (Not necessarily bone coming out. For example, if a nail get inserted into the knee<<open joint)
- An open joint is managed similarly
- Usually requires higher injure (energy) (Not always! e.g. an old osteoporotic patient with thin skin, who just tripped and as a result had an open fracture)
- Sometimes can be missed
- Commonly occurs in bones with minimal soft tissue coverage (tibia)
- Usually higher energy is required in deep bones (femur).



● Pathology:

- Traumatic energy to the soft tissue and bone.
- Inoculation of organisms (normal flora of the skin contaminate the bone>>infection)
- Necrotic tissue (source of infection)
- Injury to vessels and microvasculature (less blood delivered to the tissue -decrease of transfusion of O2 and nutrient- ischemia and lack of immune response)
- Raised compartment pressure. The pressure will increase as a result of the swelling (less blood delivered to the tissue>>bone necrosis)
- Over all there will be ischemia and lack of immune response
- INFECTION:
 - Difficult to eradicate
 - Prolonged antibiotics
 - Multiple surgeries
 - Significant morbidity
 - Significant costs on the hospital and the country
 - infection will slow healing of the bone.

- Atrophy of the muscles

the patient will be depressed because of the long stay at the hospital

- An open fracture is usually a “red flag” warning of significant trauma. Detailed assessment of the patient is necessary
- An open fracture is associated with significant morbidity. Must act quickly **take fast detailed history.**
- **A delay in management is proven to increase the likelihood of complications.** Give urgent priority while triaging (open fracture is code 1 while closed 3) , provide initial management and consult urgently. **patient must be seen at least with in 20 min, if surgery is needed best with in 1 h maximum.**

● Diagnosis:

- Sometimes obvious!
- Other times, settle,, be observant. **The wound could be very small (need high suspicion)**
- **A wound close to a fracture is an open fracture until proven otherwise.**
- Whenever a fracture is diagnosed, go back and check the skin.
- **A small wound continuously oozing blood bones are very vascular, especially, if you see fat droplets within the blood (diagnostic), is an open fracture!**
- Not always close to the fracture, it may be around it. **Especially the femur (the deeper the bone more coverage of soft tissue around the bone the far the opening)**
- Don't probe!!
- If in doubt, use good light, if there is a break in the dermis or fat is seen, call it an open fracture
- **If unsure that the fracture is open consider it open. Better to overcall than miss it!**



● Algorithm:

- **Assess and stabilize the patient, ATLS principles**
- Assess the condition of the soft tissue and bone to help grade the open fracture. **Look for other injuries.**
- Manage the wound locally

- Stabilize the fracture
- IV antibiotics
- Tetanus status

● **Assessment:**

- if polytrauma, apply ATLS principles
- if isolated injury:

- **Hx:**

- Mechanism and circumstances of injury. Detailed Hx must be taken. If it was a RTA u need to know where was the patient sitting (front or back), wearing belt?, or pedestrian.

- **Time since injury**

- PMH/PSH/Allergy/Drugs/Smoking
- Tetanus vaccination status

- Examine the affected region for:

- Soft tissue: skin loss may require skin grafting

- Degree of contamination (look for dirt)
- Necrotic and devitalized tissue
- Size of wound
- Coverage loss, muscle and skin
- Compartment syndrome

- Bone:

- Comminution
- Stripping of bone periosteum
- Examine away from injury to joint above and below
- X-rays to joint above and below

- **Neurovascular status distally:**

- **On arrival and post reduction and splinting later.**



Fig. 28-40 Fasciocutaneous closure device being used to close a large femoral wound over a period of 1 week. (a) musculocutaneous flap; (b) 4 days later, and (c) after fixation.

- You need to document everything the patient came with to avoid any medico legal problems

● Open fracture grade: (take full Hx to grade correctly)

Grade 1: all those conditions have to apply

- Less or equal to 1 cm, it has to be : Clean wound (no direct, not swimming in the time of injury), Non-segmental NOR severely comminuted fracture, less than 6 hours since injury
Grade I has low incidence of infection



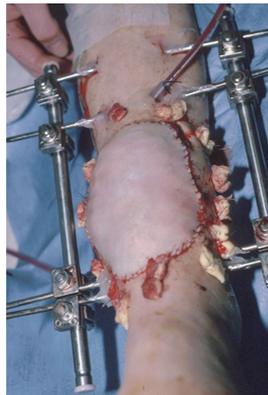
Grade 2: same as grade 1 but the wound is >1 cm but no need for soft tissue coverage procedure

- >1cm wound, not extensive soft tissue injury or contamination, non segmental nor severely comminuted fracture, no bone stripping and with adequate soft tissue coverage



Grade 3:

- 3A: (if not 1 or 2) 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
- 3C: Any open fracture that requires vascular repair



if there is pulse it's grad 3B. Because the soft tissue loss is big, requiring soft tissue coverage procedure

if there is pulse it's grad 3B. Because the soft tissue loss is big, requiring soft tissue coverage procedure

Differ depending on the scenario:
if the injury occurred >6 h ago, it's 3A
if the injury occurred <6 h ago, it's 2
if vascular injury, it's 3c
the idea is that u can't decide based on the pic alone

● **Management:**

I. Local: **1st step : Analgesics**

- Take a picture. you don't want to open it every time another doctor (intern, registrar, consultant, ortho team) wants to examine
- If dirty, irrigate with normal saline to remove gross contamination. Don't use water even if sterile, the osmolarity of the water is more so the tissue will lose fluid due to the concentration gradient. Just irrigate, if there is a big piece u can remove it by sterile equipment.
- If bone sticking out try to reduce gently then immobilize and **re-check neurovascular status**. **Realignment in the ER to: decrease further damage. decrease pain, decrease fat emboli.**
- Cover with sterile wet gauze. If it becomes bloody use another one above it. Wet because u don't want to cause any injury when removing it.
- If bleeding apply direct pressure on wound. Never use a tourniquet, it will compromise the blood supply.
- No culture swabs in ER. There are studies that say it's useless.

II. **Antibiotics:**

- First generation Cephalosporin for gram positives (Ex: Cefazolin) in all open fractures
- Aminoglycoside to cover gram negatives (Ex: Gentamicin) sometimes not required in grade 1 but in general it is safer to give in all grades, **gram + is most common but u can't guarantee it's only gram +**. If it's grade 1 and u said I will only cover gram +, or u said I'll cover both + -, both answers are considered correct.
- Add penicillin or ampicillin or clindamycin for clostridium (**will cause gangrene**) in grade 3 open fractures and all farm and soaked wounds. **Also, if >6 h**

III. **Tetanus prevention:** Tetanus vaccine is a vaccine composed of deactivated tetanus toxins. **Passive immunity**

Wound types:

- Clean wounds:
 1. <6 hours from injury

2. Not a farm injury
 3. No significant devitalized tissue
 4. Non immersed (soaked, e.g. if the injury accrued while swimming) wound
 5. Non contaminated wound
- Other wounds

Clean wounds		Other wounds			
Completed vaccination		Not completed or unknown (pt doesn't know or unconscious)	Completed vaccination		Not completed or unknown
Booster < 10	Booster > 10	Td 0.5ml IM	Booster < 5years	Booster > 5	TIG 250U And Td 0.5ml IM
nothing	Td 0.5 ml IM		nothing	Td 0.5ml IM	

- As soon as patient is stable and ready, alert the OR, and talk to the pt get consent for surgery
- Plan: Irrigation w normal saline, debridement and fracture stabilization
- The sooner the less risk of further morbidity (more time>>more complications)

IV. In the OR: move to the OR as soon as the pt is stable enough.

- Extend wound if necessary. If small wound & the surgeon is unable to reach the bone.
- Thorough irrigation to the bone.
- Debride all necrotic tissue (source of infection). start layer by layer from the skin, subcutaneous tissue then muscle. How will you know the muscle is dead? from the difference in colour, the muscle will not contract with mechanical or electrical stimulation .
- Remove bone fragments without soft tissue attachment (it will die>>source of infection) except articular fragments. Deal with it later, the most imp thing now is to stabilize the fracture and prevent infection.
- Usually requires second look or more every 48-72 hours. Necrotic tissue may not appear the first time.

- Generally do not close open wounds (Except clean wound with <6 h) on first look. Only approximate it to allow drainage so there won't be a sudden infection. But actually most of the time pts will come <6 h, the wound will be clean properly, so the doctors will close the wound. Safe answer is to not close the wound completely.

V. Fracture management:

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

● Results:

If all principles applied, in ideal scenario where the pt was transferred immediately to the hospital, the management was immediate and proper:

- 2% complication rate in grade 1
- 10% complication rate in grade 2
- Up to 50% complication rate in grade 3

Fractures with nerve or vascular injuries

- Don't miss it !!!!
- Always perform an accurate (distal to the fracture) assessment at presentation, post manipulation and reduction, post surgical fixation, serially until condition stabilizes
- Serial examination helpful in deciding line of treatment
- Serial examination helps avoid confusion
- High correlation between vascular injury and nerve injury. Proximity (anatomically near each other)

● Mechanisms:

- Penetrating trauma

- High energy blunt trauma
- Significant fracture displacement
- Keep in mind tissue recoil at presentation

● **Vascular injuries:**

- Direct laceration
- Traction and shearing

● **Assessment:**

- Always check serially until 48 h later (there might be an injury to the intima which usually take time): Pulse, Color, Capillary refill, Temperature, compartment pressure. Compare it to the other side.
- Keep high index of suspicion: High energy trauma
- Associated nerve injuries
- Fractures/ Dislocations around the knee
- Hard signs > realignment of limb > if persistent > vascular intervention
- Hard signs > realignment of limb > improved > Close observation every 1-2 h
- Realignment can result in unkincking of vessels, lowering compartment pressure, relaxation of arterial spasm
- ABI: The Ankle Brachial Index (ABI) is the ratio of the blood pressure in the lower legs to the blood pressure in the arms. Normal range 1.0 - 1.2. We do it because the presence of a pulse doesn't exclude vascular injury.
 - = or < 0.9 associated with vascular pathology. If .8 in the fractured limb and in the normal side 1, consider it vascular injury even if there is no pallor, no parasthesia, pulse present, warm.
 - Rarely can give false negative result (Ex. Profunda femoris)
 - Always used in high risk fractures (knee)
 - If positive > Urgent vascular intervention
- Angiography, CT angiography: Gold standard **But always**



Blunt trauma. Fracture of the proximal tibia, the popliteal artery is cut. Common site of vascular injury.



Penetrating trauma. Gun shot. Sudden interruption of the artery.

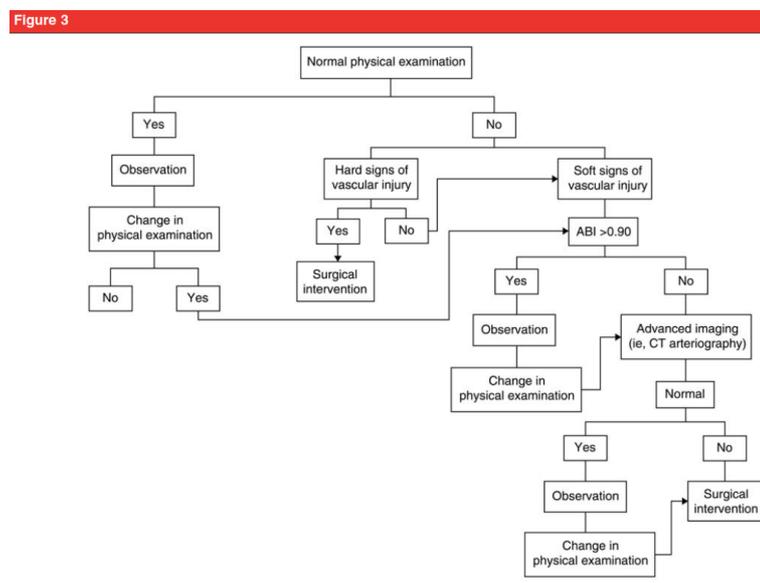
Table 1
Hard and Soft Signs of Vascular Injury Associated With Extremity Trauma
Hard signs
Pulselessness
Pallor
Paresthesia
Pain
Paralysis
Rapidly expanding hematoma
Massive bleeding
Palpable or audible bruit
Soft signs
History of bleeding in transit
Proximity-related injury
Neurologic finding from a nerve adjacent to a named artery
Hematoma over a named artery

start with simple tests

- Not without risks
- Vascular surgeon to arrange with interventional radiologist

● **Management:**

- Once vascular injury is confirmed:
 - Coordination between: Vascular surgeon, Orthopedic surgeon, General surgeon. (All AIM to save the Limb)The principle is that fixing the artery should be first. But what if after after fixing the artery the bone moves (it's unstable) and damage it again? so there should be collaboration between the surgeons. most of the time the orthopaedic surgeon will quickly stabilise the fracture fast by an general fixator.
- To emergently re-establish perfusion and protect repair with skeletal stabilization
- Warm ischemia (the hand is still attached to the body. cold ishemia is when the amputated part was in a bag ice. In cold ishemia can wait longer)time dictates treatment (Ex, the injury was 30 min ago, the orthopaedic surgeon can start before the vascular)
- Most times, a quick external fixator is applied, followed by vascular repair
- Avoid prolonging warm ischemia to do
- Prolonged warm ischemia >6 hours —>Prophylactic fasciotomy. Sometime after vascular repeat there will be re perfusion reaction>> edema in the muscle>> compartment syndrome.
- Grade 3C open fractures have the worst outcome



- Amputation may be necessary in severe cases

● Nerve Injury:

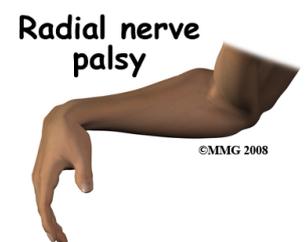
- Cause of medico-legal concern
- Accurate assessment and documentation at presentation, post reduction, post surgery is essential
- Remember to examine for motor and sensation prior to sedation
- **Closed fractures not requiring surgery with nerve injuries** high chance that the nerve injury will be reversed without intervention:
 - Usually good outcome >80%
 - Usually managed conservatively in the early stages
 - Recovery may take more than 6 months. If not, do something.
- Intact nerve before reduction, absent after reduction:
 - Controversial management
 - Usually observe
 - It's acceptable if u say u will redisplace the fracture. But it been proven that it's not always useful, just leave it. For us, go with redisplacement.
- Fracture requiring surgery with nerve injury, what dictate the need of surgery is the fracture not the nerve injury:
 - Limited exploration. Don't perform another incision.
- Open fracture with nerve injury:
 - Here we have to explore the nerve, tag nerve ends for later repair.



Radial nerve run in the spiral groove



Distal radial fracture, cause radial nerve palsy(common)



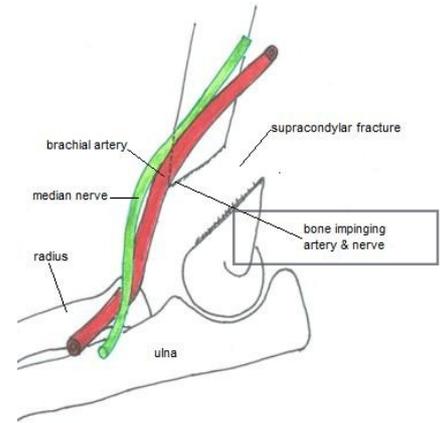
● Follow up:

- If no surgery was done.
- Clinically

- Electrodiagnostic assessment start at 6 weeks (base line) then serially every 6 weeks during this time give Splint to hold the limb in its position

- If no improvement:

- Nerve exploration: neurolysis / repair / grafting
- Tendon transfers with an intact nerve function to preserve function. Done when the nerve grafting is expected to not succeed or if it already failed. Ex, if foot drop we take a tendon from one of the planter flexors.

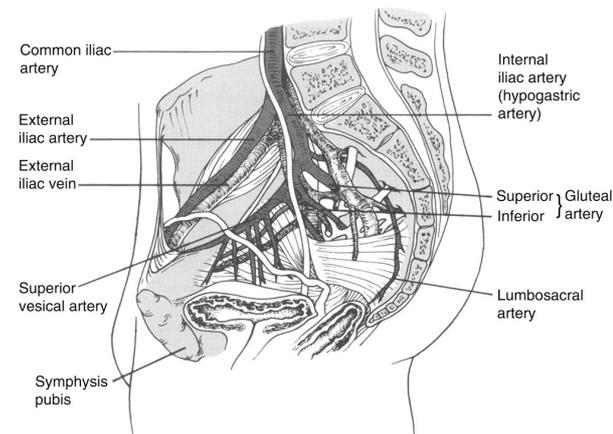
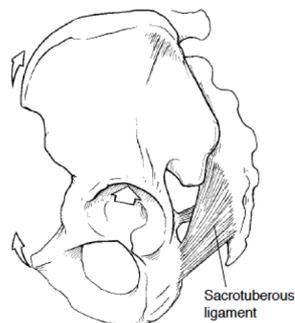
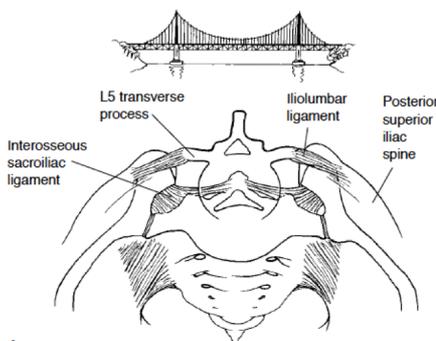
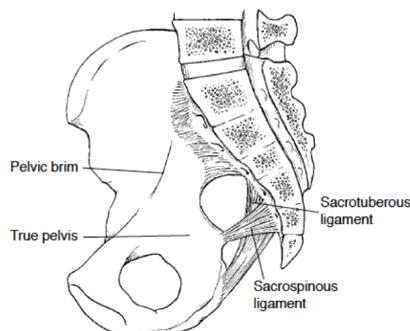
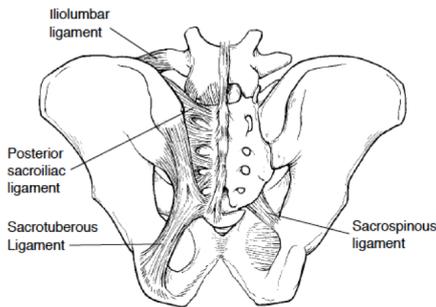


● Common Sites:

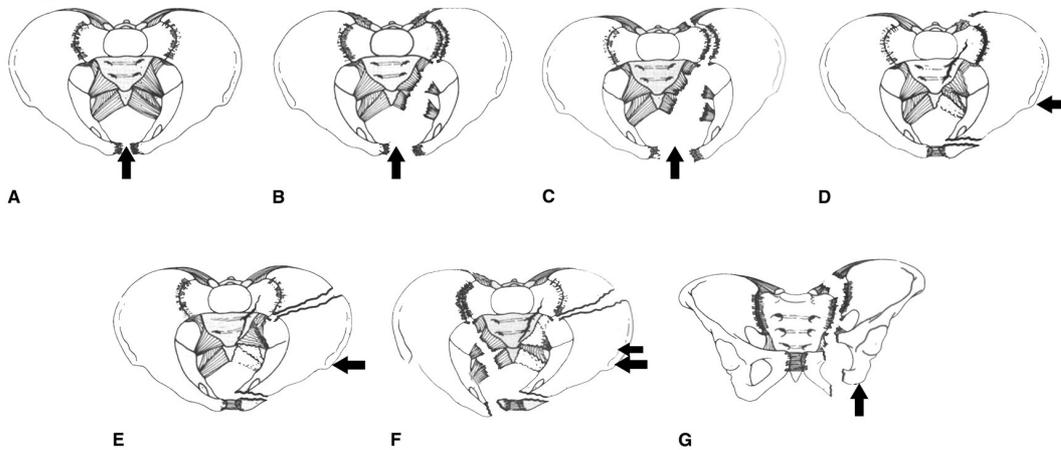
- Shoulder fracture / dislocation > Axillary nerve
- Distal humeral shaft fracture > Radial nerve
- Elbow fracture / dislocation > Median>>radial>>ulnar
- Hip fracture / dislocation > Sciatic nerve
- Knee fracture / dislocation > Peroneal nerve

● Pelvic trauma In the poly trauma patient

● PELVIS ANATOMY:



● Pathology:



A- anterior force causing a little opening in the sacro-iliac joint.

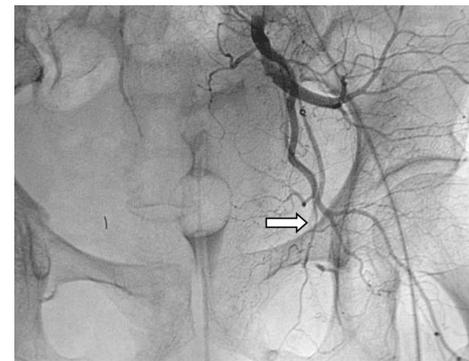
B- anterior force causing opening in the sacro-iliac joint and instability

C- More force cause 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.

D, E and F lateral compression. e.g. car accident

G- Vertical shears pelvic fracture. Extremely unstable.

- Pelvic fractures / instability may cause life threatening bleeding. The bleeding will be from the internal iliac artery and it will be retroperitoneal so it's hard to see in US. When given blood I.V the blood pressure will increase for a while then drop again.
- Diagnosing pelvic instability can save lives



External iliac

● Diagnosis:

- History: High vs. Low energy trauma
- Mechanism of injury: Anterior vs. Lateral vs. Axial force
- Pelvic skin contusion, bruising

- Short extremity
- Careful neurologic assessment
- Primary survey : part of “C”. **Circulation**. If the pt showing signs of shock (tachycardic, hypotension).
- Assess stability by gentle compression on the ASIS
- Traction on the leg and assess pelvic instability. **the pt in supine position.**
 - **traction in the leg while your hand in the iliac crest if it moves>>sheer.**
- If unstable or painful:(**pelvic binder**)
 - Apply sheet around hips and close the pelvis gently
 - This results in decreased intra-pelvic volume leading to tamponading the bleeding **by increasing the pressure around the injured vessel.>>BP will rise**
 - Traction on the leg to stabilize vertical instability.
 - This minimizes ongoing vasculature injury and bleeding
 - **When the pt is stable enough arrange with the radiologist for radiological studies.**
- Rectal exam:
 - Bone fragments (be careful)
 - High riding prostate
 - bleeding
- Blood at the meatus
- Labial or scrotal ecchymosis
- Vaginal exam

- **Management:**
 - Stabilize pelvis with binder
 - If vertically unstable apply traction
 - IV resuscitation
 - Look for other injuries
 - Check response
 - If partial response, may require angiography for embolization of bleeders

- May require external fixator and/or pelvic clamp

- **Early diagnosis:**

Aggressive resuscitation



Coordinated team effort >> Save lives

in the right pic, the binder is too tight that it may block the external iliac artery. the binder should be around the level of the femoral head