PELVIC FRACTURES

INTRO

- Severe pelvic injuries result from a wide range of situations, starting with low energy trauma that lead to stable fractures, up to complex life-threatening blunt trauma with hemodynamic instability.

INTRO

- 25% of pelvic ring fractures occur in polytraumatized patients.
- Consequently, death rate ranges from 8,5 to 19%.
- If both pelvic and hemodynamic instability occur, death rate increases up to 18-25%.

INTRO

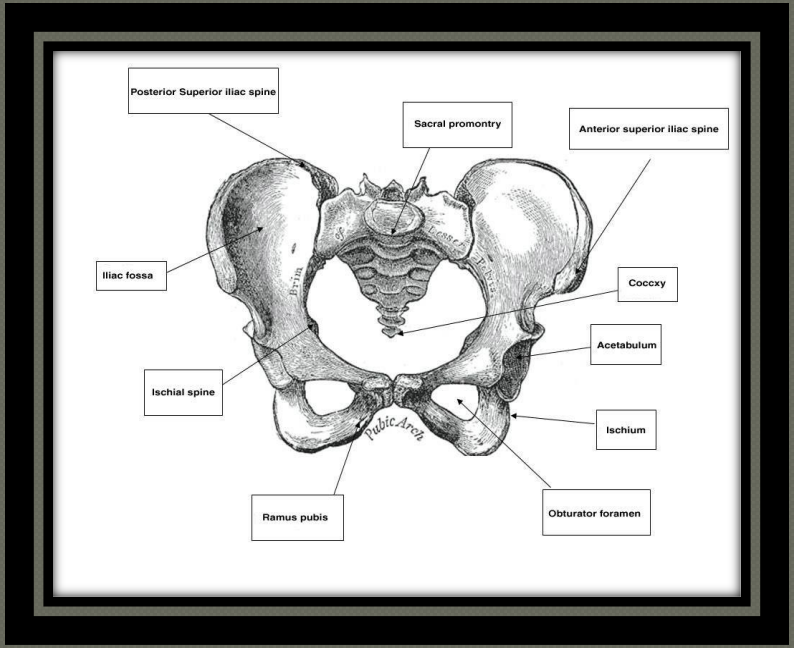
- Complex pelvic trauma requires immediate surgical intervention in order to stabilize the pelvis.
- Standardized protocols optimize treatment and subside death rate.

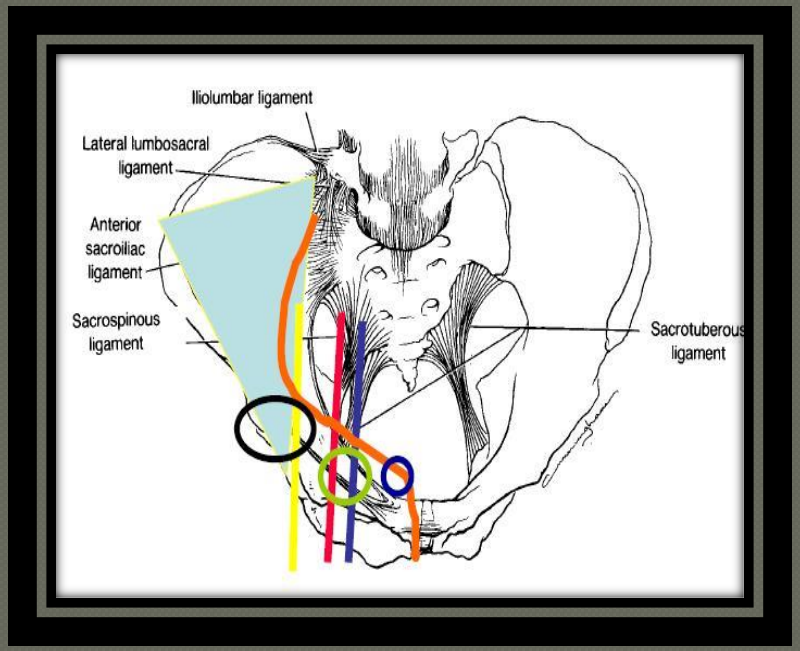
History

- Egypt, Ancient China
- Hipocrates
- Avicenna
- Joseph-François Malgaigne
  - Two classifications of vertical pelvic fractures (1834)
- Robert Judet
- Marvin Tile

Anatomy

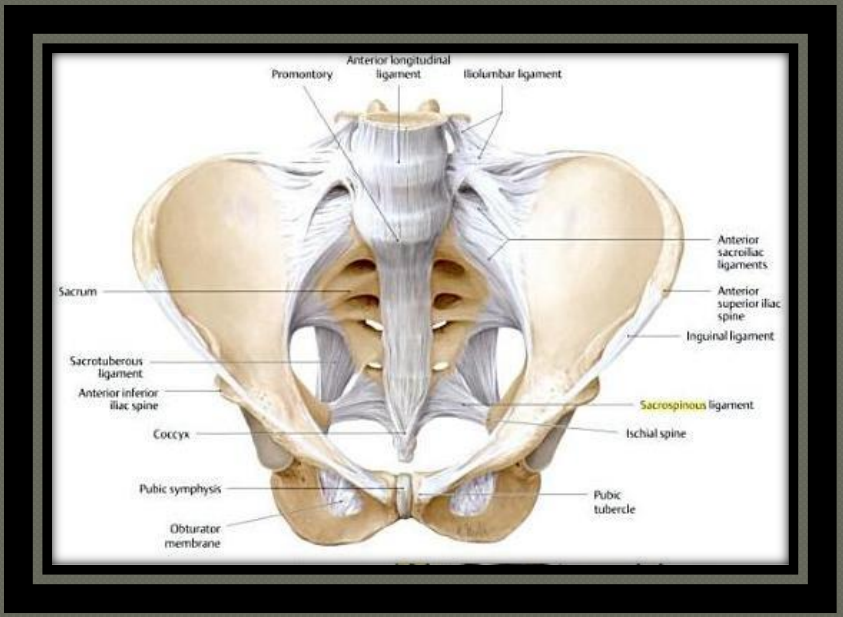
- Bones
- Blood vessels, Nerves and Ligaments

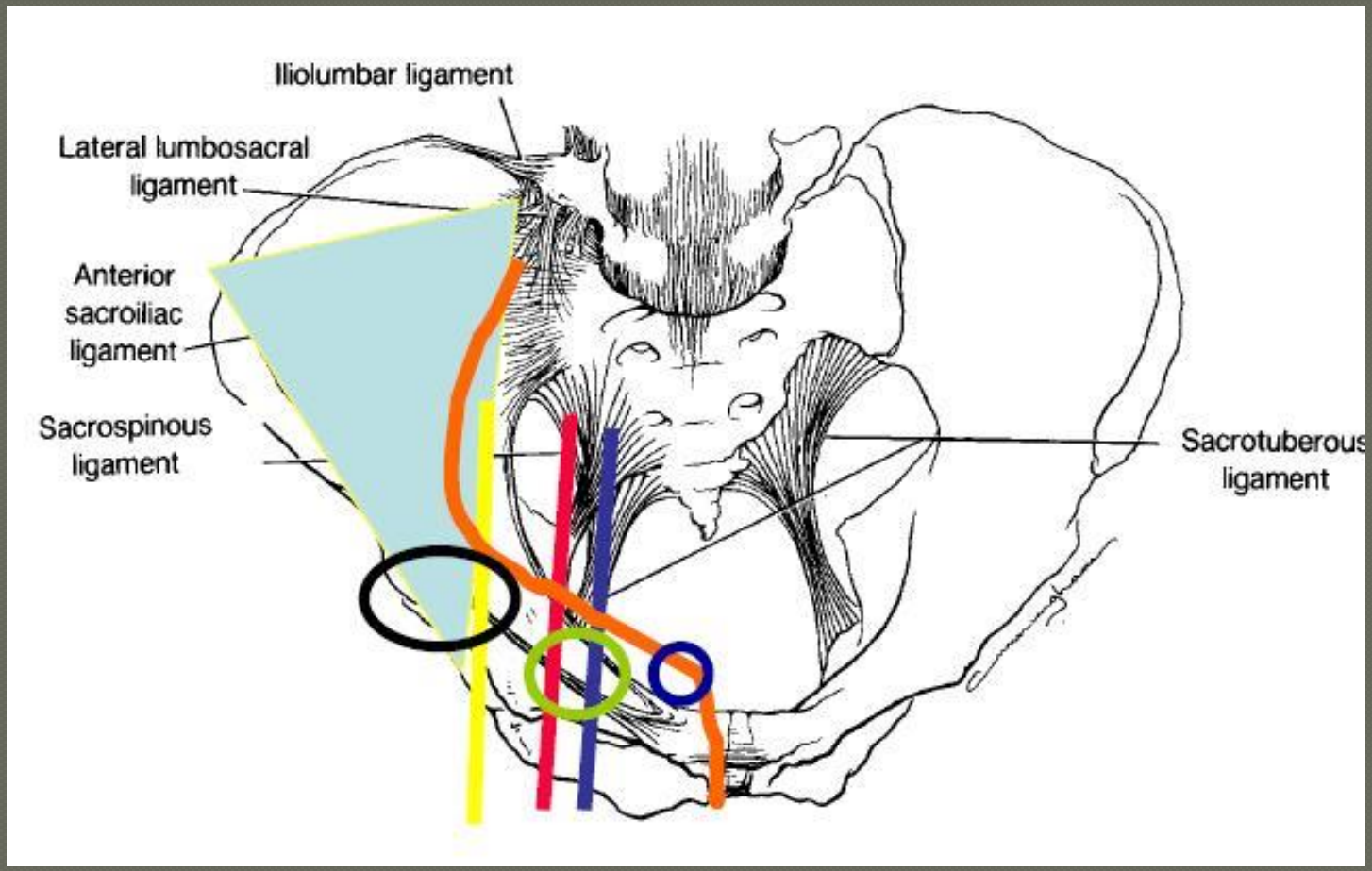




Biomechanics

- Biomechanics of coxo-femur
- Pelvis Biomechanics – ligaments role




Iliolumbar ligament
Lateral lumbosacral ligament
Anterior sacroiliac ligament
Sacrospinous ligament
Sacrotuberous ligament

- Tile's study is based on pelvic ligaments fracture pattern in order to assess stability of the pelvic ring.
- When pubic ramus fracture occurs with no ligament injuries, pubic diastasis remains below 2.5 cm – sacrospinous and SI stable.
- As long as both posterior and SI are stable, no shearing occurs in hemipelvis.

- Tile showed that avulsion of the symphyseal ligaments – sacrospinous, sacrotuberous and posterior SI, osseous included - leads to a severely unstable pelvis which allows backwards, upwards and rotational movement of the innominate bone in relation to the sacrum.

Radiological examination

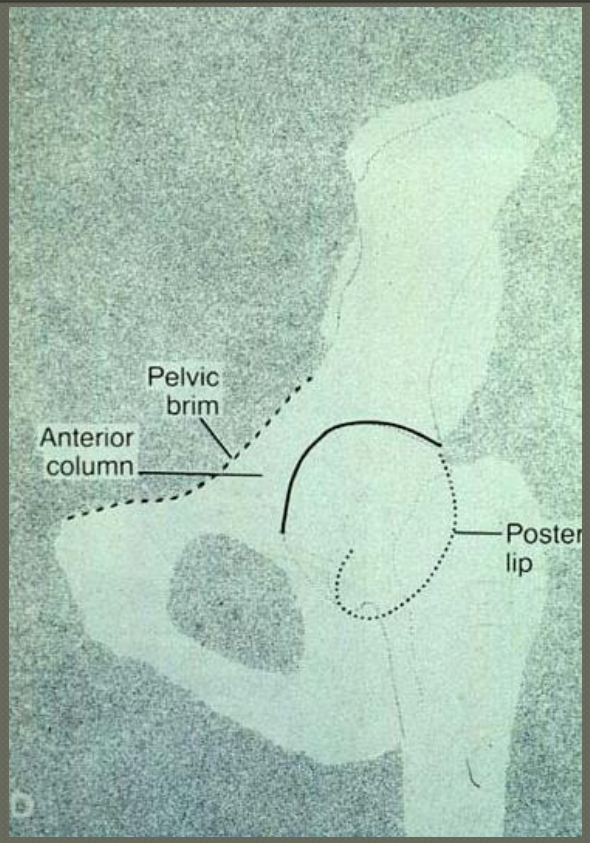
- Radiographic features:
  - AP standard;
  - inlet/outlet view;
  - Oblique
  - alar/obturator oblique;
- CT-scan;
- CT-3D;

ACETABULUM X-ray assessment

OBTURATOR VIEWS

- Obturator oblique view - 45° pelvis rotation towards uninjured part to get frontal view of the obturator foramen and a lateral view of the iliac wing.
- Anterior spine;
- Anterior acetabular lip;

ACETABULUM
Radiological examination

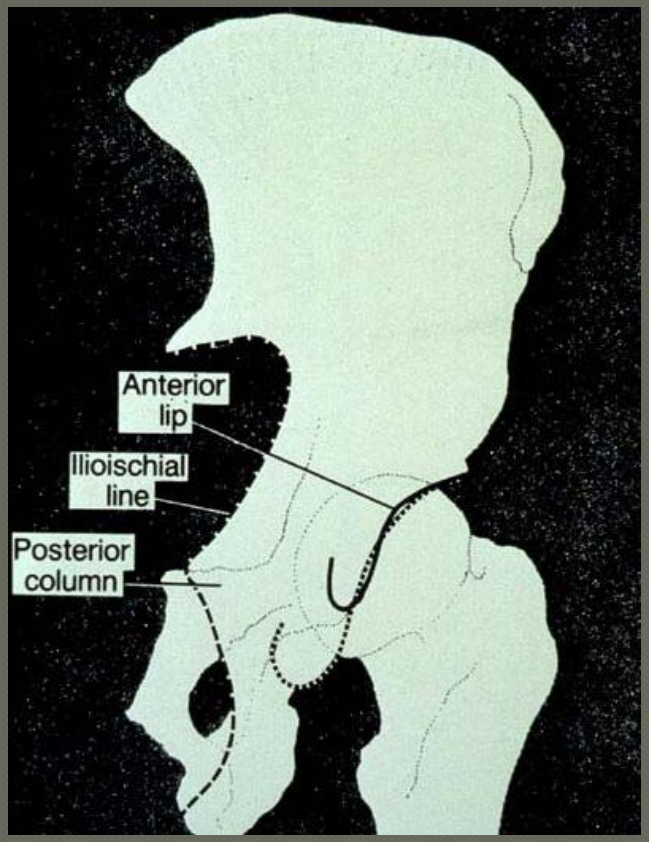


ACETABULUM
Radiological examination

ALAR VIEWS

- alar oblique (iliac) view is to be done by rotating the patient 45° on the injured part, to get frontal view of the iliac wing and lateral view of the obturator foramen.
- posterior edge of iliac bone;
- anterior acetabular lip

ACETABULUM
Radiological examination



ACETABULUM
Radiological examination

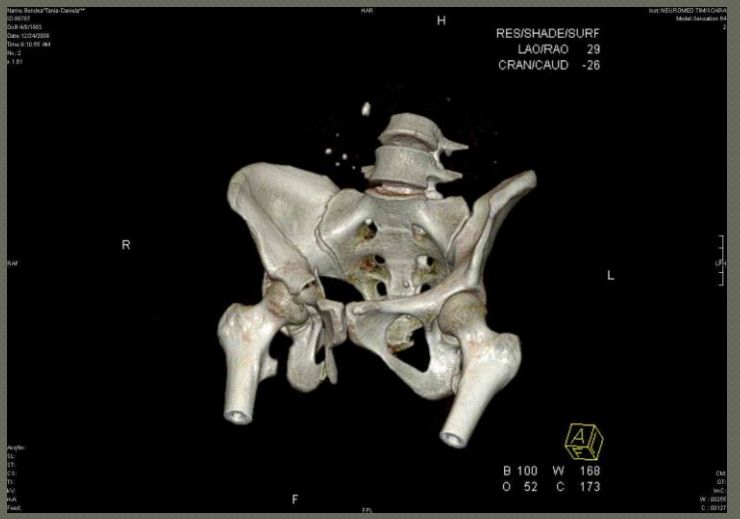
- CT helps assess joint disruption, number and dimension of fragments in posterior wall, crest damages, rotation and dislocation of ligaments, presence of intraarticular fragments and femur head injury.

ACETABULUM
Radiological examination

- 3D reconstruction imaging proves to be even more accurate.
- Intricated imaging that can project multiple angle views of the femur head offers a complete picture of the fracture pattern.

ACETABULUM

Radiological examination



Radiological examination of the pelvic ring

- X-ray standard consists of 3 plain views of the pelvic ring: one anteroposterior view and two oblique views (caudad – inlet view and cephalad – outlet view).

Radiological examination of the pelvic ring

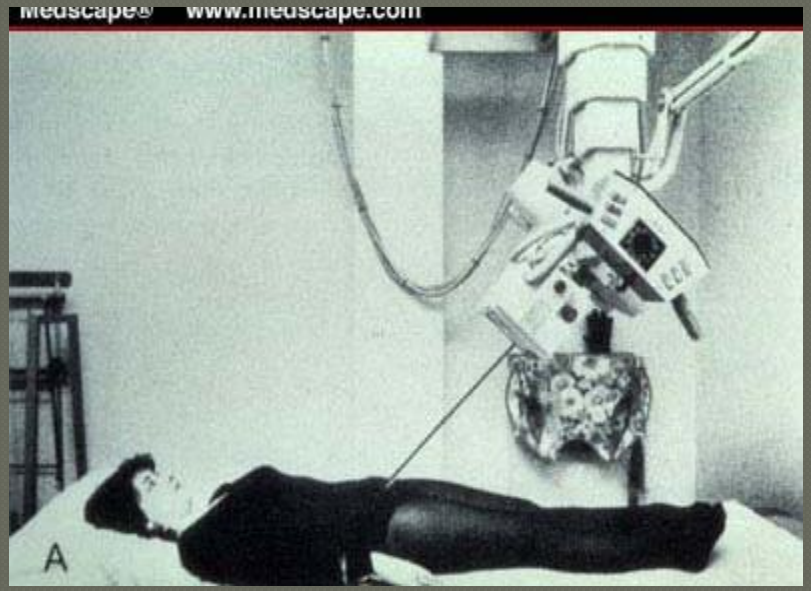
- Inlet view:

X ray beam is directed to get a view of the pelvis from above, along its longitudinal axis, approximately 40 degrees caudally.

Radiological examination of the pelvic ring

- Outlet view:

X ray beam is directed to get a view of the pelvis from above, along its longitudinal axis, approximately 40 degrees cephalad.



Radiological examination of the pelvic ring

- CT - the best method to assess the cause of posterior injury.
- It can accurately determine the type and location of an injury (sacral, SI joint, iliac wing) and it can also diagnose acetabular fractures.

Radiological examination of the pelvic ring

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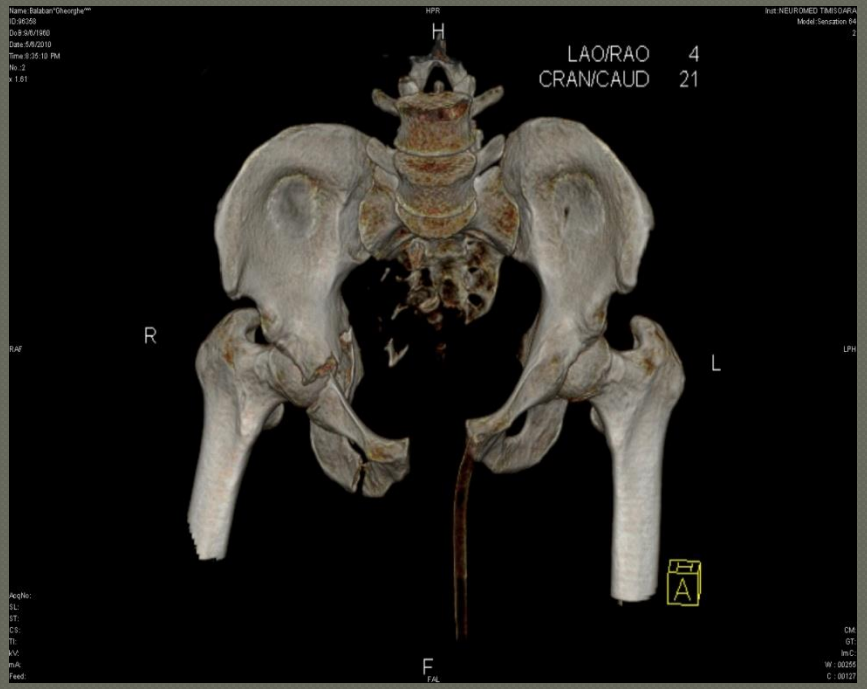
Radiological examination of the pelvic ring

- CT assesses SI joint instability.
- AP joint disruption reveals posterior intraosseous ligaments tear, whereas anterior sacroiliac disruption opposing the sacroiliac articulation, typically implies unstable rotational injury without vertical instability.



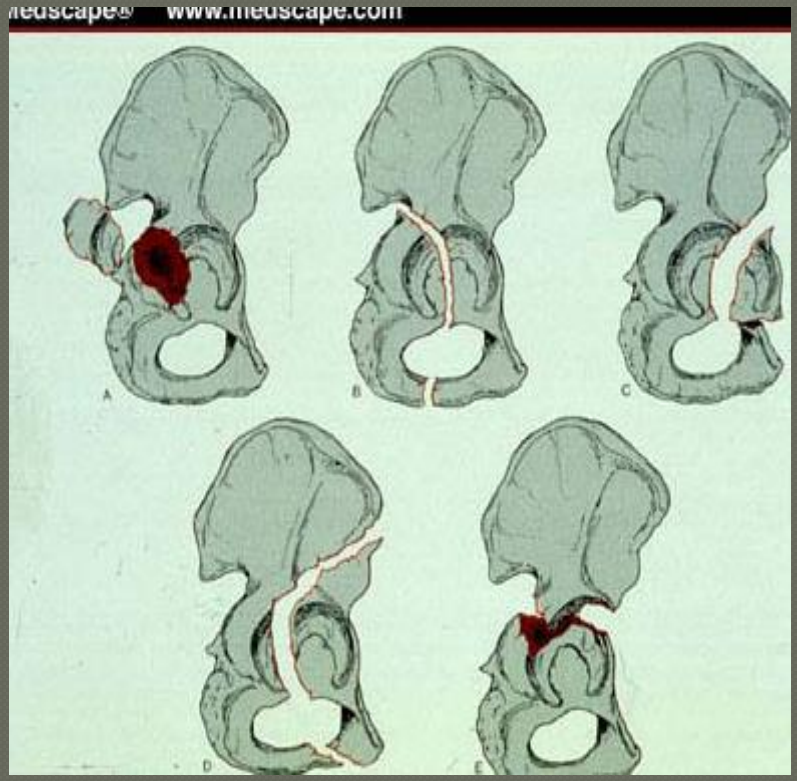
Acetabular fracture classification

- Basic classification was made by traumatologists R. Judet şi E. Letournel in 1964 - modified by E. Letournel in 1993, whereby the fracture pattern is made according to fracture morphology.
- Robert Judet and Emile Letournel divide cotil fractures în 2: elementary and mixed types.
- Elementary types involve the fracture of a single constitutive part of the acetabulum.
- Mixed type fractures associate two or more elementary fractures.

Acetabular fractures classification

- **Simple / elementary fractures:**

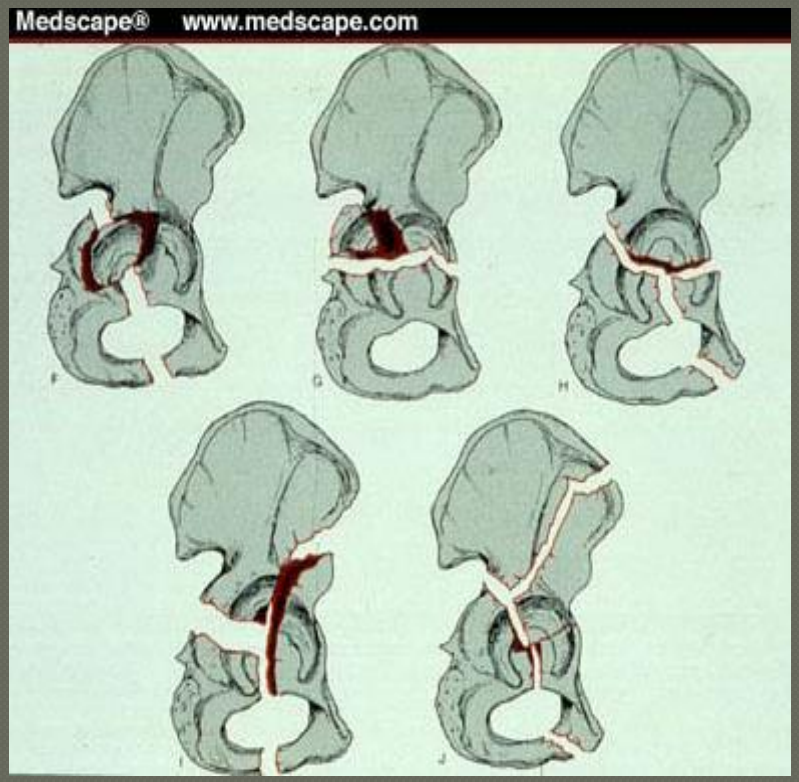
- 1. Anterior column fracture.
- 2. Anterior wall fracture.
- 3. Posterior column fracture.
- 4. Posterior wall fracture.
- 5. Transversal fracture.



Acetabular fracture classification

Mixed type fractures:

1. T-shape fracture
2. Transversal fracture + posterior wall fracture
3. Posterior column fracture + posterior wall fracture
4. Anterior column fracture + posterior hemitransverse fracture
5. Anterior column fracture + posterior column fracture.



CLASSIFICATION of CLOSED PELVIC INJURIES

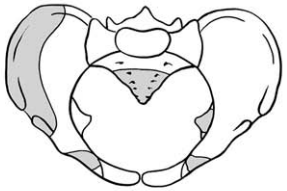
- In 1980 Pennal and Tile introduced the *stability factor* according to total or partial stability situations of the trauma mechanics.
- Defining unstable pelvic ring relies on gradual reduction of osteoligamentous integrity of posterior pelvic ring, ever since.

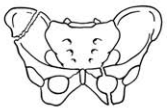
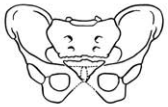
CLASSIFICATION of CLOSED PELVIC INJURIES

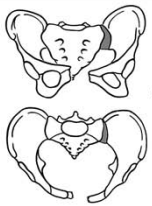
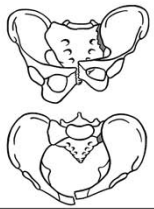
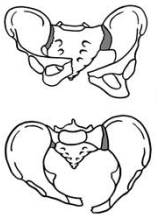
- Tile's alphabetic classification comprises 3 main groups, based on the instability of the pelvic ring [63,65,68,89-92]:

- Type A: stable
- Type B: partially unstable (unstable in rotation)
- Type C: instabile complet (unstable in rotation and vertically unstable)

CLASSIFICATION of CLOSED PELVIC INJURIES

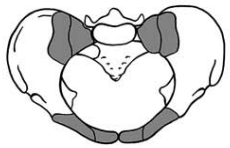


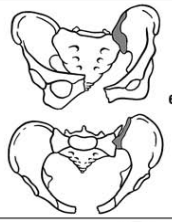
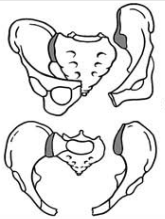
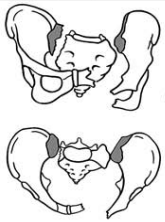
AO / OTA	Tile	Young & Burges
 61-A1	**A1** Avulsion of the innominate bone	**n/d**
 61-A2	**A2** Stable iliac wing fracture or stable, minimally displaced pelvic ring fracture	**(LC I/APC I)**
 61-A3	**A3** Transverse sacrum orcoccygeal fracture	**n/d**

AO / OTA	Tile	Young & Burgess
 61-B1	**B1** "Open book" injury - Anterior SI-ligament stretched	**APC I** - Pubic diastasis < 2.5 cm **APC II** - Pubic diastasis ≥ 2.5 cm - Anterior SI-ligament disrupte
 61-B2	**B2** "Lateral compression" injury (**B2-2:** contralateral "bucket handle" type)	**LC I** - Posterior injury: sacral impac **LC II** - Posterior injury: ▪ anterior sacral crush (**LC** ▪ iliac wing "crescent" injury (**LC IIB**)
 61-B3	**B3** Bilateral "B-type" injuries	**LC III** Unilateral "B1" with contralateral "B2" typ injuries ("windswept pelvis

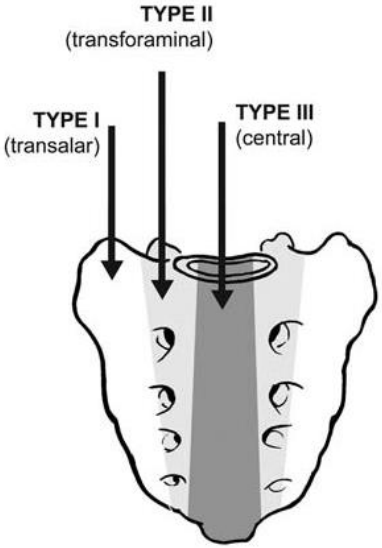
CLASSIFICATION of CLOSED PELVIC INJURIES

(rotationally and vertically unstable)



AO / OTA	Tile	Young & Burges
 61-C1	C1 - Unilateral	APC III - Pubic diastasis ≥ 2.5 c - Anterior and posterio SI-ligament disruption
 61-C2	C2 - Bilateral: ▪ one side "B-type" ▪ one side "C-type"	VS ("Vertical shear") -APC III with vertical displacement of hemipel
 61-C3	C3 Bilateral "C-type"	CM ("Combined mechanic Complex fractures wit combined elements of APC, LC, and/or VS

Vertical sacrum fractures (DENIS)



Therapy Management

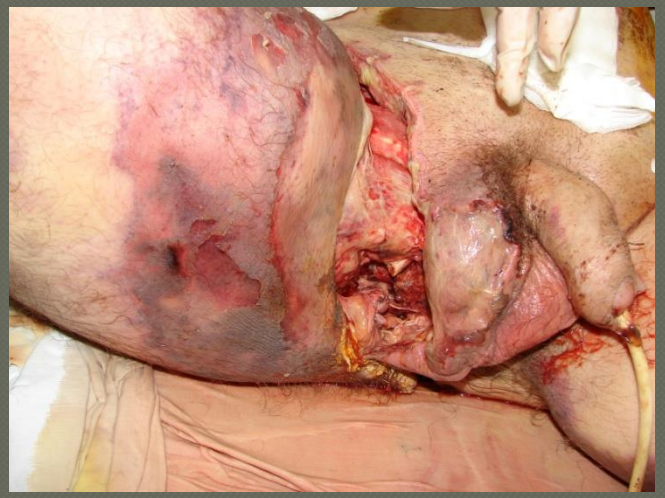
- Unstable injuries combined with hemodynamic instability - death is caused by hemorragic shock, the sequelae of the shock and massive transfusions.
- complex pelvic trauma- pelvic traumatism combined with soft tissue injuries in the pelvian area, such as urinary trac injury, complex rectum injuries, neurovascular and other serious integument injuries.
- Primary acute therapeutical management focuses on this category of patients.

Prehospital evaluation and treatment

- The severity of a pelvic fracture is often underestimated at the moment of the accident. Open pelvic fractures are easy to recognize, as they come with massive hemorrage and/or severe pelvic deformity. Closed injuries without integumental lesions are frequently left undiagnosed, despite their mechanical instability.

Prehospital evaluation and treatment

- Clinical examination investigates for:
  - open wounds
  - contusions in the pelvic region
  - Changes in shape
  - External or internal rotation deformity or of hemipelvis



Prehospital evaluation and treatment

- Spontaneous pain or pain on palpation is a major symptom in the case of conscious patients
- Pelvic stability is investigated by manual palpation of the pelvic ring

Prehospital evaluation and treatment

- Handling at the place of the accident is done according to the Advanced Trauma Life Suport (ATLS) protocol, maintainting vital functions as a priority.
- Patients with hemodynamic instability and pelvic trauma need prompt evaluation and simultaneous CPR
- Initial procedures include preserving the airways and the hemodynamic balance intensively with fluid administration via two venous routes simultaneously, considering even unstable closed fractures can cause a 2 to 5L blood loss

Prehospital evaluation and treatment

- In the case of a massive external hemorragia, external manual compression is required to reduce bleeding. In the case of mechanically unstable fractures such as open book, it's common practice to tie a sheet around the pelvic area, or to use military anti-shock garments or pneumatic splints.

Prehospital evaluation and treatment

In-hospital evaluation and treatment

- Immediate evaluation and intensive CPR required
- Fluid administration on two venous routes is maintained
- Clinical examination focuses on mechanical pelvic instability (shortening or rotation of hemipelvis, iliac spine assymetry, swelling or blood around genitourinary tract or perineum, ecchymosis around lower abdomen or pelvis).

In-hospital evaluation and treatment

- Slight manual pressure upon the iliac wings, from outside towards the middle can help distinguish a mobile hemipelvis and mechanical instability
- Neurological examination should focus on sensitivity and motor functions of the pelvic limbs.
- Rectal and vaginal examination can highlight any hidden bleedings or open fractures.

In-hospital evaluation and treatment

- An untreated fracture hematoma in contact with contaminated soft tissue can lead to an infection complicating patient evolution.
- ECHO-FAST or CT scan can be used to find any interperitoneal or retroperitoneal liquid.

In-hospital evaluation and treatment

- The emergency image results can reveal any radiological signs of pelvic instability:
  - A higher than 5mm displacement of the SI articulation on any level (inlet and outlet incidents improve diagnosis accuracy)
  - Posterior fracture line
  - Transverse process of the L5 lumbar vertebra avulsion or sacrospinal ligament injury

In-hospital evaluation and treatment

- Several studies have shown that associated hemorrage shock and intracranial lesions in polytraumatized patients are the main causes of mortality in the first 24h from traumatism.
- Damage Control surgical interventions such as hemorrage control, intracranial and intrathoracic decompression, contamination control following abdominal perforations, devitalized tissue debridement at extremity level and fixating associated fractures increase survival rate.

In-hospital evaluation and treatment

- A group of polytraumatized patients present no measurable vital signs, many of them requiring laparotomy, thoracotomy and/or abdominal parking (with or without aortic cross-clamp) in order to survive.
- While awaiting patient response to intensive resuscitation procedures, pelvic stabilization can be attempted by applying a C-clamp or an external pelvic fixator.
- This way, repeated abdominal or pelvic parking can become more efficient in stopping bleeding, when applied on a stabilized pelvis.

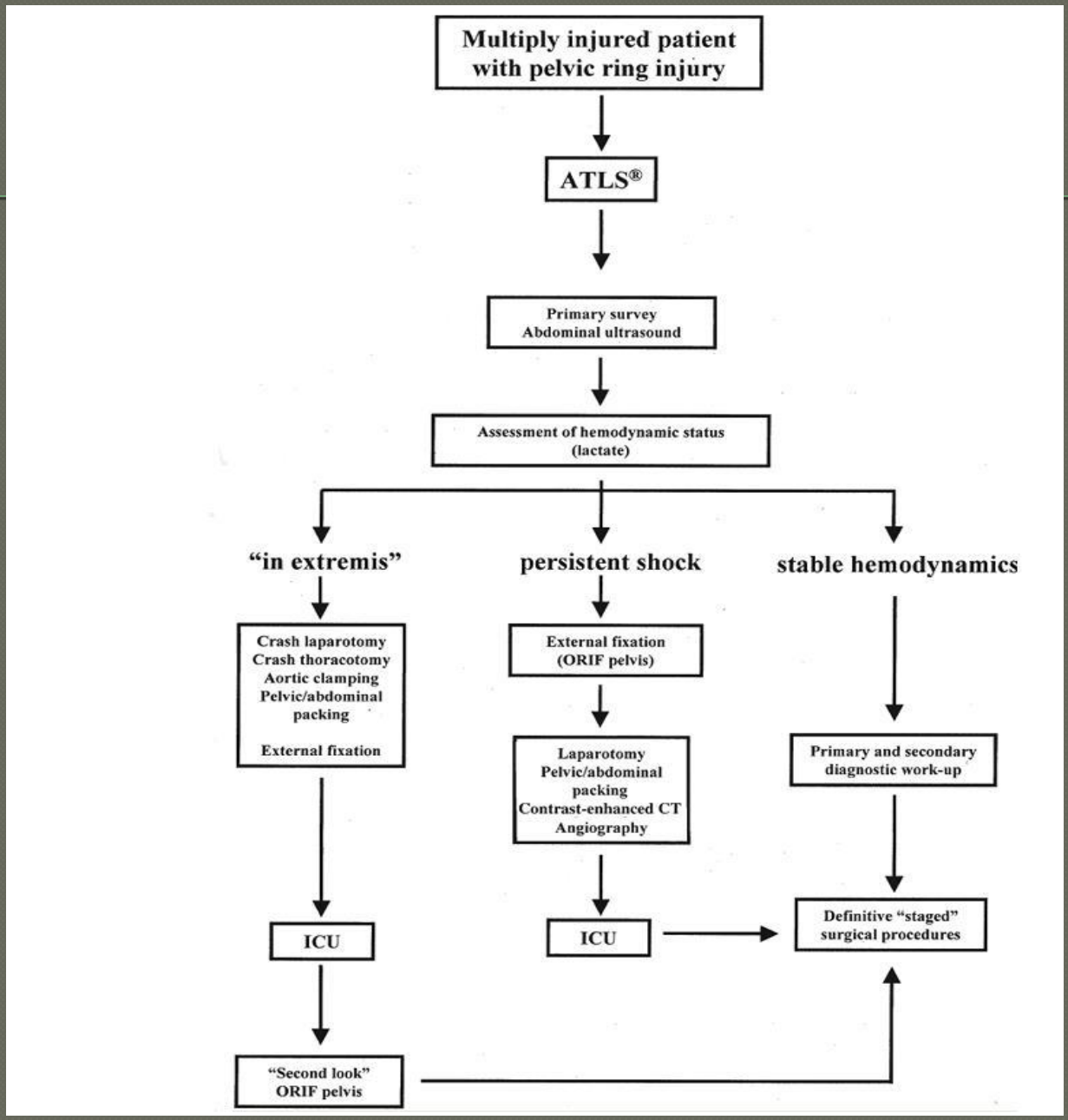
In-hospital evaluation and treatment

- Several studies show that auto-tamponade rarely works in patients with unstable pelvic injusties where ligaments and fascial planes supporting the pelvic floor have been torn.
- Huittinen and Slaxtis estimated that 80-90% post-fracture or dislocation bleeding comes from lumbo-sacral venous plexus tearing, while only 10% have arterial origin.

- The most common technique to stop diffuse hemorrage is tamponade. For patients requiring abdominal examination, laparotomy would lead to pelvic instability due to diminishing the iliac wing muscular strength. Therefore, applying an external fixator or a C-Clamp will lead to stabilization by allowing an efficient parking or the direct tackling of bleeding points.

In-hospital evaluation and treatment

- If hemodynamic instability persists despite all measures applied, an abdominal CT scan with contrast should be performed.
- In case of extravasation of contrast material occurs in a patient, angiography is recommended, together with the embolization of the concerned vessel.
- Angiography is not to be used for venous bleeding, because it is time consuming and can cause gluteal muscle necrosis.


Multiply injured patient with pelvic ring injury
ATLS®
Primary survey
Abdominal ultrasound
Assessment of hemodynamic status (lactate)
"in extremis"
persistent shock
stable hemodynamics
Crash laparotomy
Crash thoracotomy
Aortic clamping
Pelvic/abdominal packing
External fixation
External fixation (ORIF pelvis)
Laparotomy
Pelvic/abdominal packing
Contrast-enhanced CT
Angiography
Primary and secondary diagnostic work-up
ICU
ICU
Definitive "staged" surgical procedures
"Second look" ORIF pelvis

Pelvic stabilization

- Critical patients with unstable pelvic ring fractures need emergency pelvic stabilization in order to improve fracture stability, help the tamponade take effect and reduce pain.
- The swiftness and reliability of the pelvic stabilization are more important than the quality of ??? or the complexity of the fixating devices.
- Riemer et al.[127] reported a decrease in mortality rates from 26% la 6% after adding the external fixator to the resuscitation protocol.

Pelvic stabilization

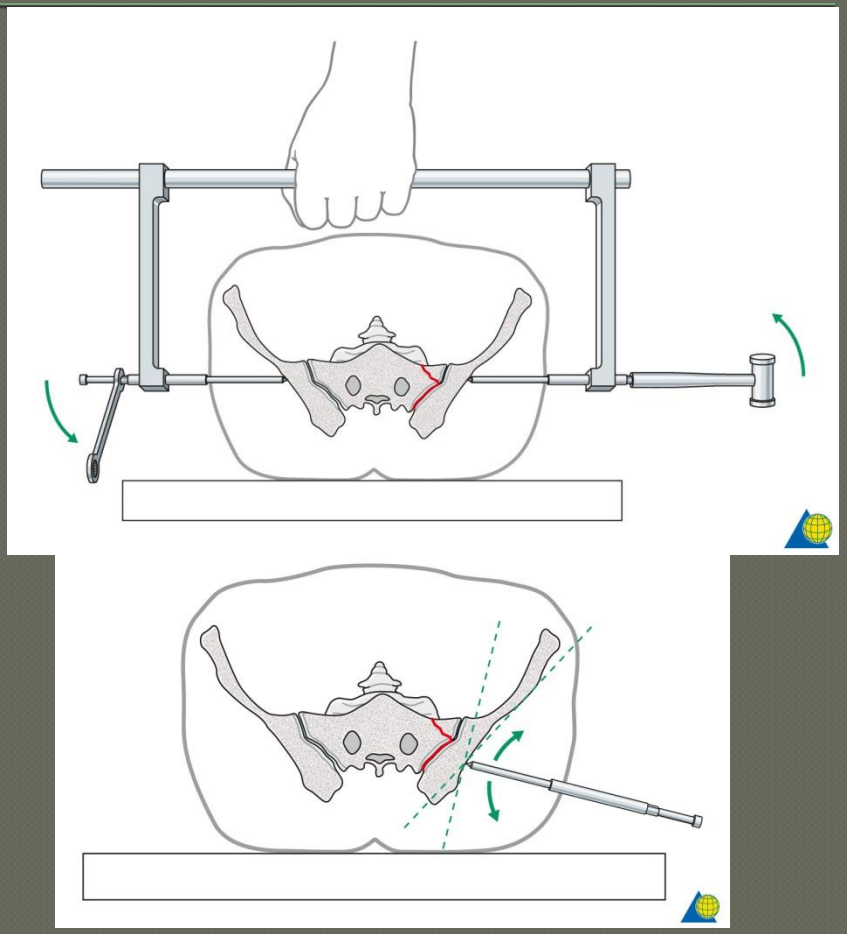
- External fixation:
  - Non-invasive techniques: easily accessible and can be used since pre-hospital phase: pelvic binder, bed sheet around the basin, anti-shock trouser.
  - Invasive techniques:
    - Continuous extension
    - anterior external fixator (with or without traction) with pins on iliac cortex or supraacetabular pins
    - Posterior external fixator (with or without anterior ExFix)
    - C-Clamp

Pelvic stabilization

- Internal fixation:
- percutaneous SIS
- ORIF fixation
- Internal fixation with ExFix.
- External fixation methods are defined based on the pelvic ring lesion classification:
  - Type A – conservatory treatment recommended
  - Type B - anterior fixation with external fixator recommended
  - Type C - posterior fixation with c-clamp recommended, with or without additional anterior ExFix fixation

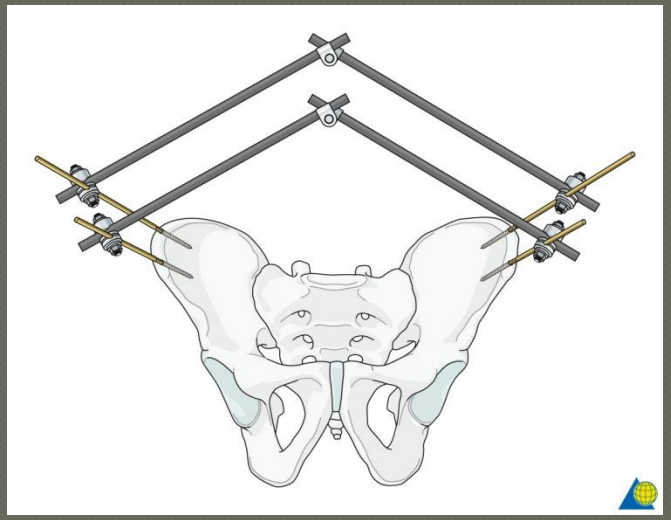
C-clamp – posterior fixation

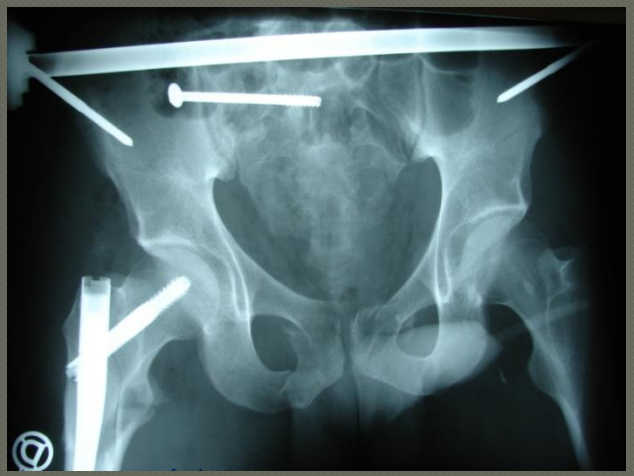
- Used in the acute phase
- Quick application
- The percutaneous pins ensure the biomechanical stability of the SI articulations
- Allows simultaneous or ulterior access to the abdominal
- Wrong pin positioning can lead to injuring the gluteal vascular area or the sciatic nerve



External fixator with iliac cortex pins

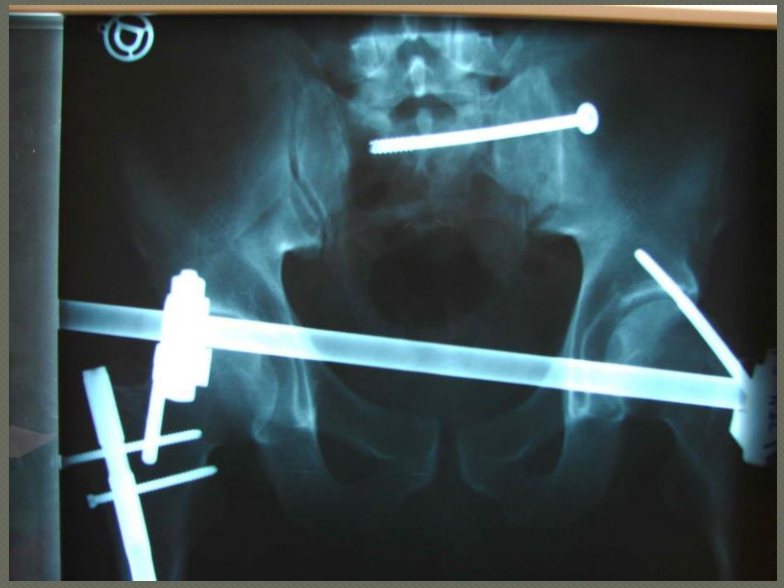
- Unanimously accepted in the acute phase
- Quick fitting
- Pins can be placed percutaneously or externally
- Chance of wrongly placing the pins on iliac cortex is 30%
- Relative stability
- Obstructs access to the abdominal area





External fixator with acetabular pins

- Has a more stable biomechanic fixation than the ExFix with pins in the iliac cortex
- Can interfere with hip flexion
- Higher infection rate at pin penetration spot
- High risk of intraarticular penetration when inserting pins



Acetabular fractures – principles of treatment

- Decision of treatment depends on the lesion type
- Patient incumbant factors are:
  - Age
  - Associated pathology
  - Patient mobility before traumatism
  - Treatment of associated visceral and skeletal injuries

Acetabular fractures – principles of treatment

- Surgical treatment indications rely on the fact that achieving an accuracy reduction on the articular surface will lead to a consistent articulation and will rebuild normal articulation mechanics.

Acetabular fractures – principles of treatment

- Surgical treatment instructions (ORIF)
- An acetabular fracture with a higher than 2mm (young patients) or higher than 5mm (senior patients) acetabular dome displacement
- A higher than 50% involvement of the articular surface of the posterior face
- Clinical instability of the hip at a 90^{0} flex flexion, when the posterior face is fractured
- Any subluxation of the femoral head due to an acetabular fracture is emerging on any of the three standard radiographies.

- Elderly patients with significant coxarthosis and intra-articular comminution, with lesions of the fenoral head, with more than 40% of the articular surface impacted are recommended coxofemoral arthroplasty as first choice.
- Severe osteoporosis represents a contraindication in the internal fixation of the acetabulum, as a stable fixation of the fracture focal point cannot be achieved.

Complications

- Regardless of the treatment method, the complication rate is very high
- Coxarthrosis and AVN of the femoral head can emerge in 44% of the cases following conservative treatment and in 22,2% of cases after surgical treatment
- Periarticular ossifications can develop at between 14 to 50% of cases.

- Postsurgical infections can develop in 1,3% - 5% of cases
- Sciatic and femoral nerve injury make up for 10-15% of cases as a result of the initial traumatism, and 2-6% of these are iatrogenic
- Thromboembolic complications are the most severe complications

Thank you!