Pelvic Trauma

Pikula R., Ira D.
Department of Trauma Suregry
University Hospital Brno

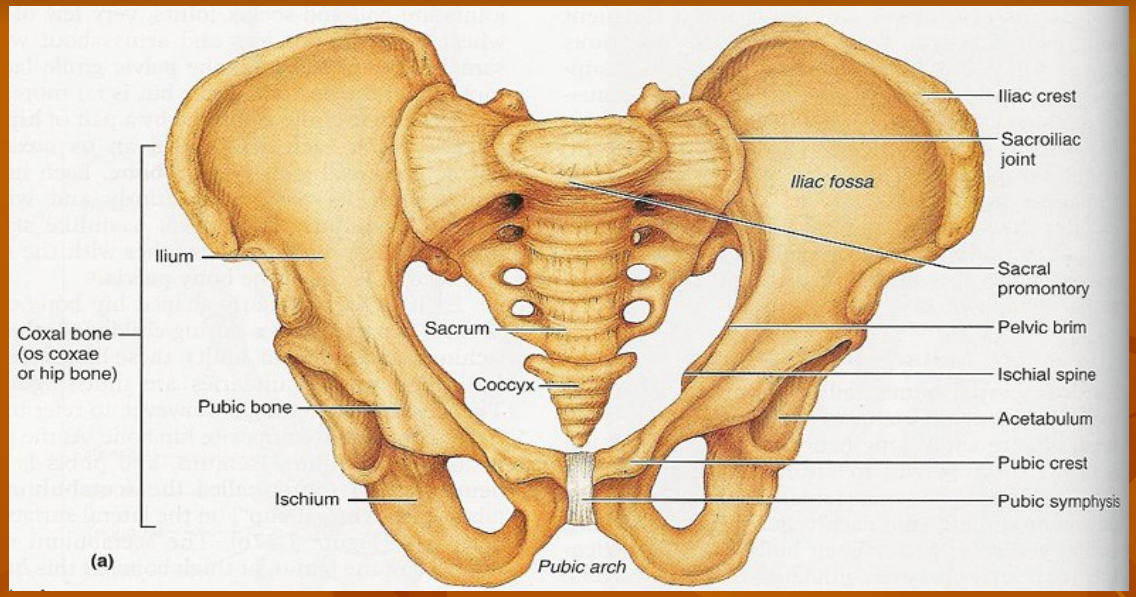
PELVIS: TRAUMA

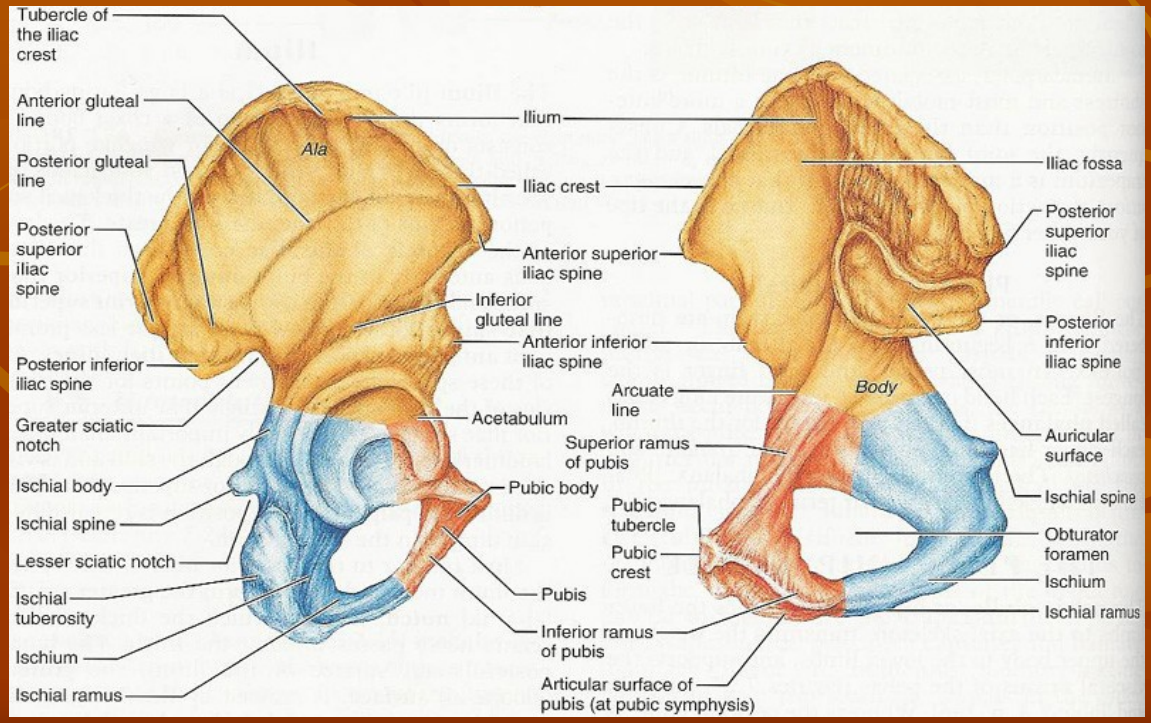
- Fractures
- Hemodynamic consequences
- Associated injuries
  - connected with pelvis fracture
  - polytrauma

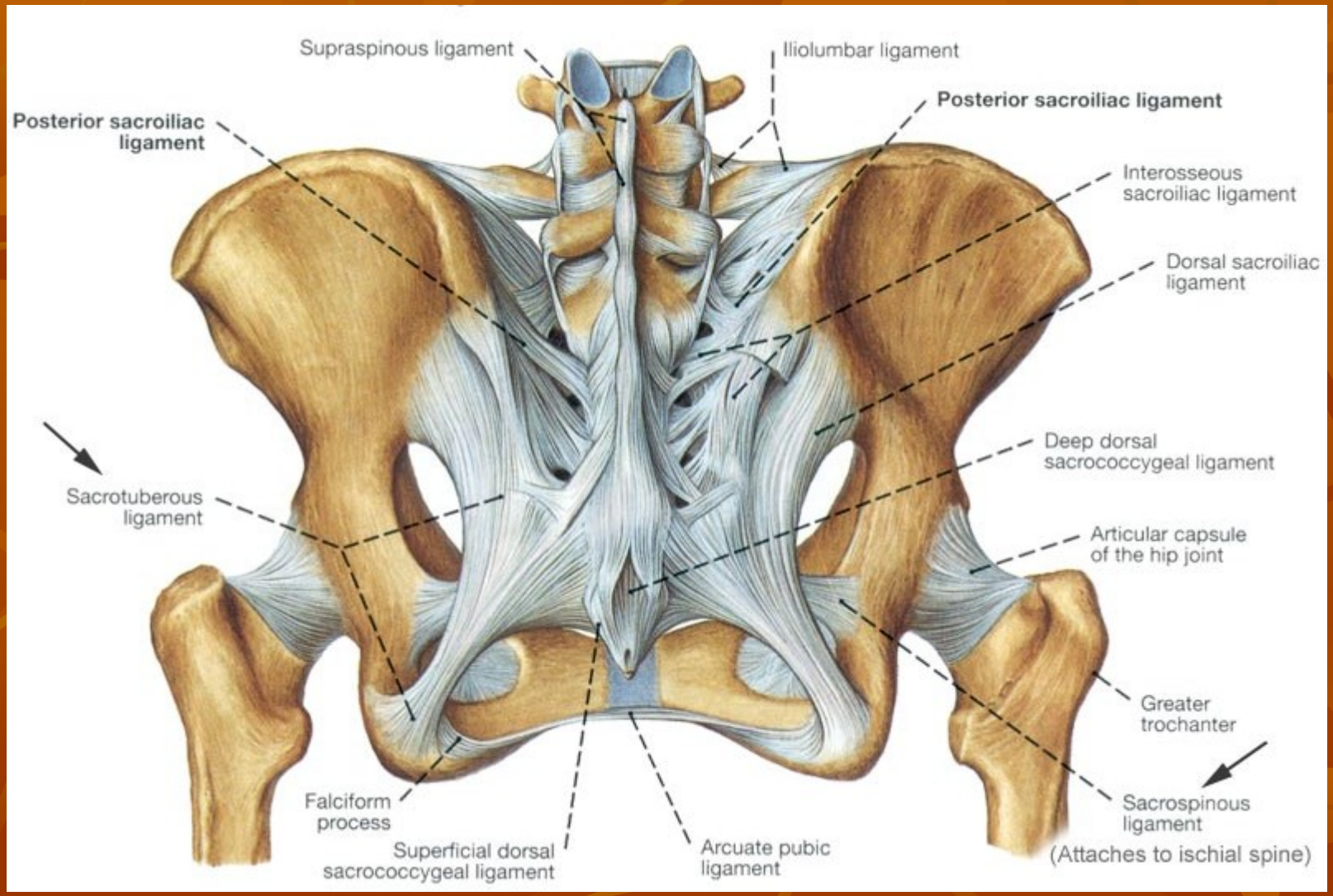
ANATOMY

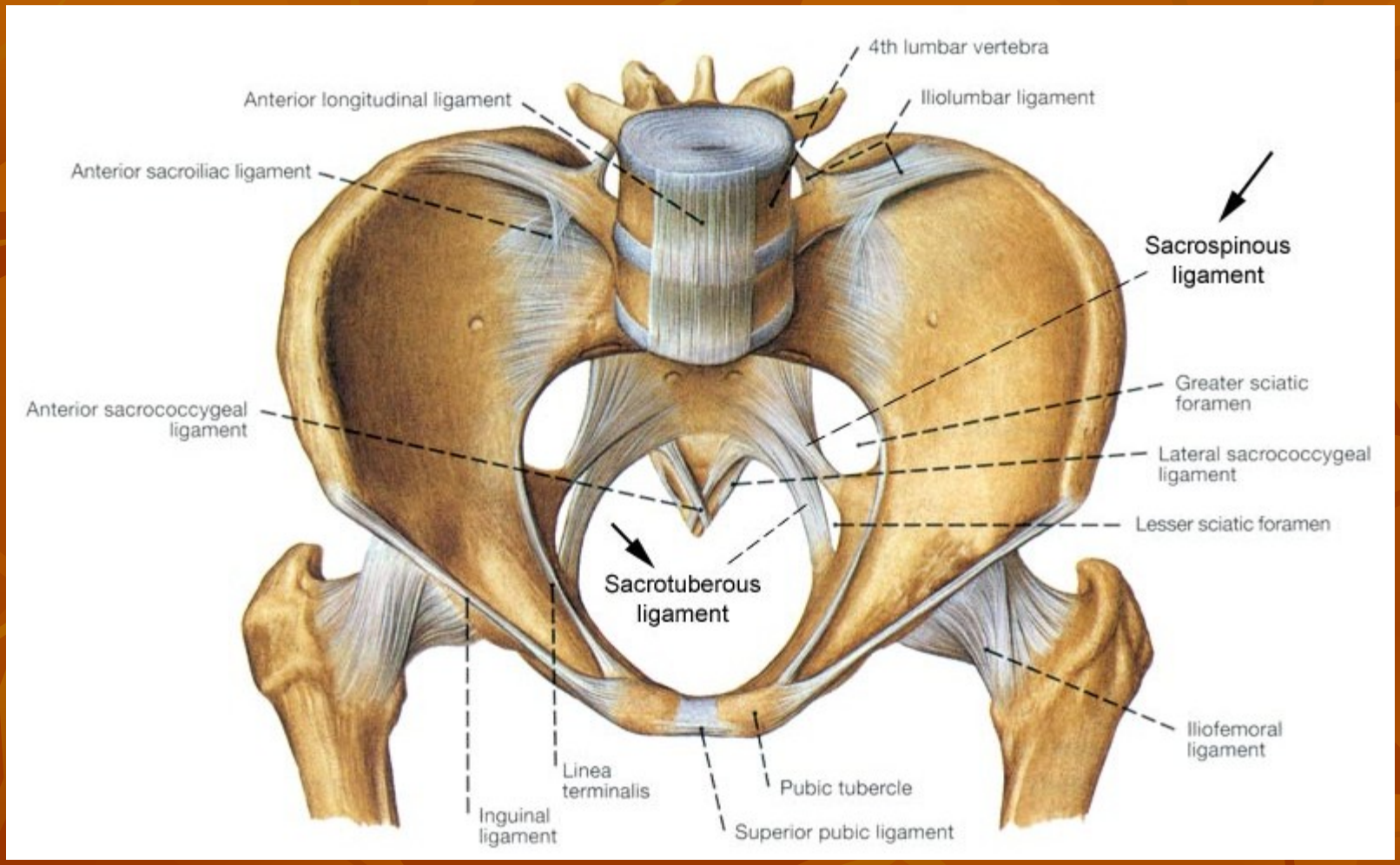
- Rami
- Symphysis pubis
- Sacrum
- Sacroiliac joints
- Ilium
- Ischium
- Hip & Femur
- Lumbar spine
- Soft tissues

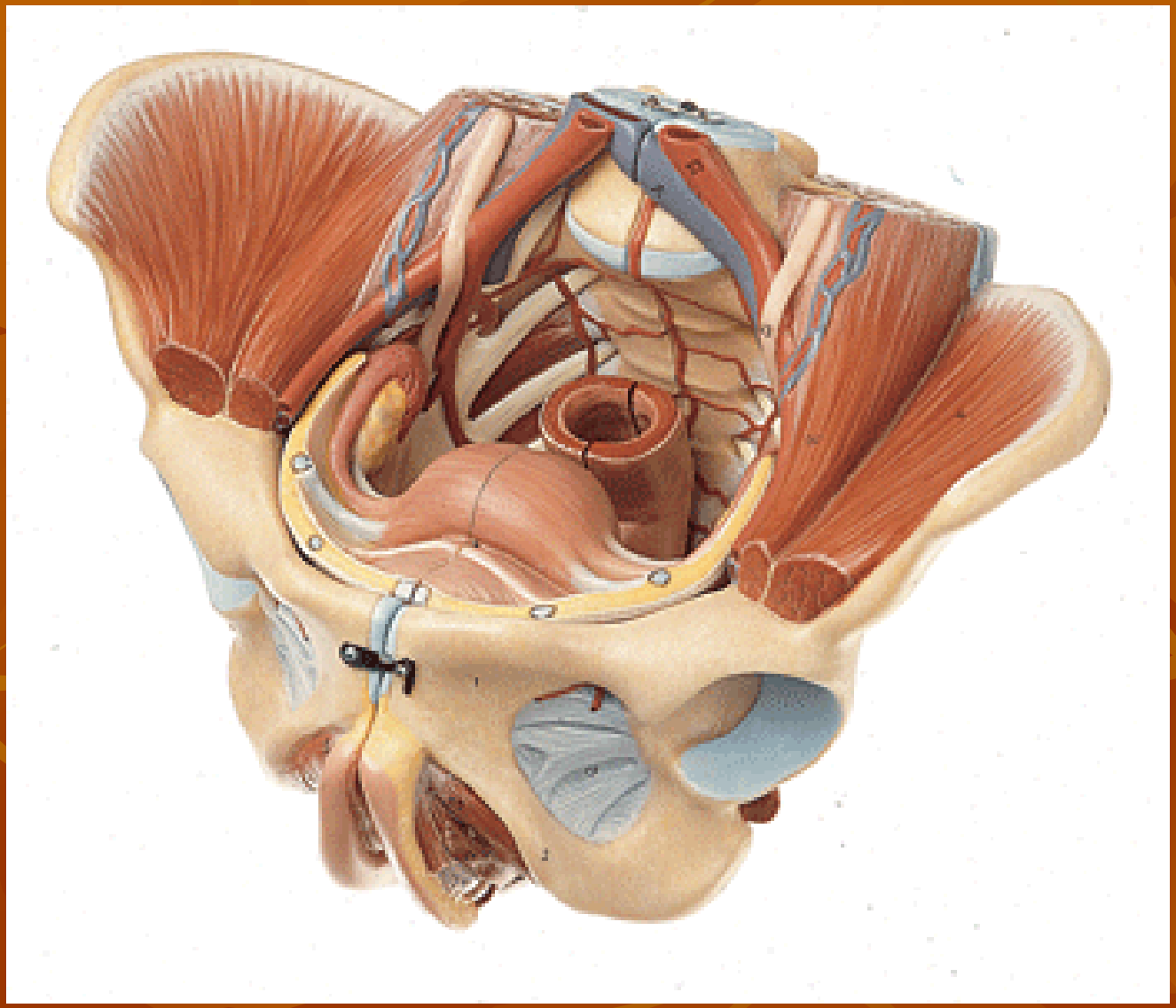
- Closed head injury — 51%
- Long bone fracture — 48%
- Peripheral nerve injury — 26%
- Thoracic injury — 20%
- Urethra (male) — 15%
- Bladder — 10%
- Spleen — 10%
- Liver — 7%
- GI tract — 7%
- Kidney — 7%
- Urethra (female) — 6%
- Mesentery — 4%
- Diaphragm — 2%


Iliac crest
Sacroiliac joint
Iliac fossa
Sacral promontory
Ilium
Coxal bone (os coxae or hip bone)
Sacrum
Pelvic brim
Coccyx
Ischial spine
Pubic bone
Acetabulum
Pubic crest
Ischium
Pubic symphysis
(a)
Pubic arch


Tubercle of the iliac crest
Anterior gluteal line
Posterior gluteal line
Posterior superior iliac spine
Posterior inferior iliac spine
Greater sciatic notch
Ischial body
Ischial spine
Lesser sciatic notch
Ischial tuberosity
Ischium
Ischial ramus
Ala
Ilium
Iliac crest
Anterior superior iliac spine
Inferior gluteal line
Anterior inferior iliac spine
Acetabulum
Pubic body
Pubis
Inferior ramus of pubis
Articular surface of pubis (at pubic symphysis)
Iliac fossa
Posterior superior iliac spine
Posterior inferior iliac spine
Body
Arcuate line
Auricular surface
Superior ramus of pubis
Ischial spine
Pubic tubercle
Obturator foramen
Pubic crest
Ischium
Ischial ramus

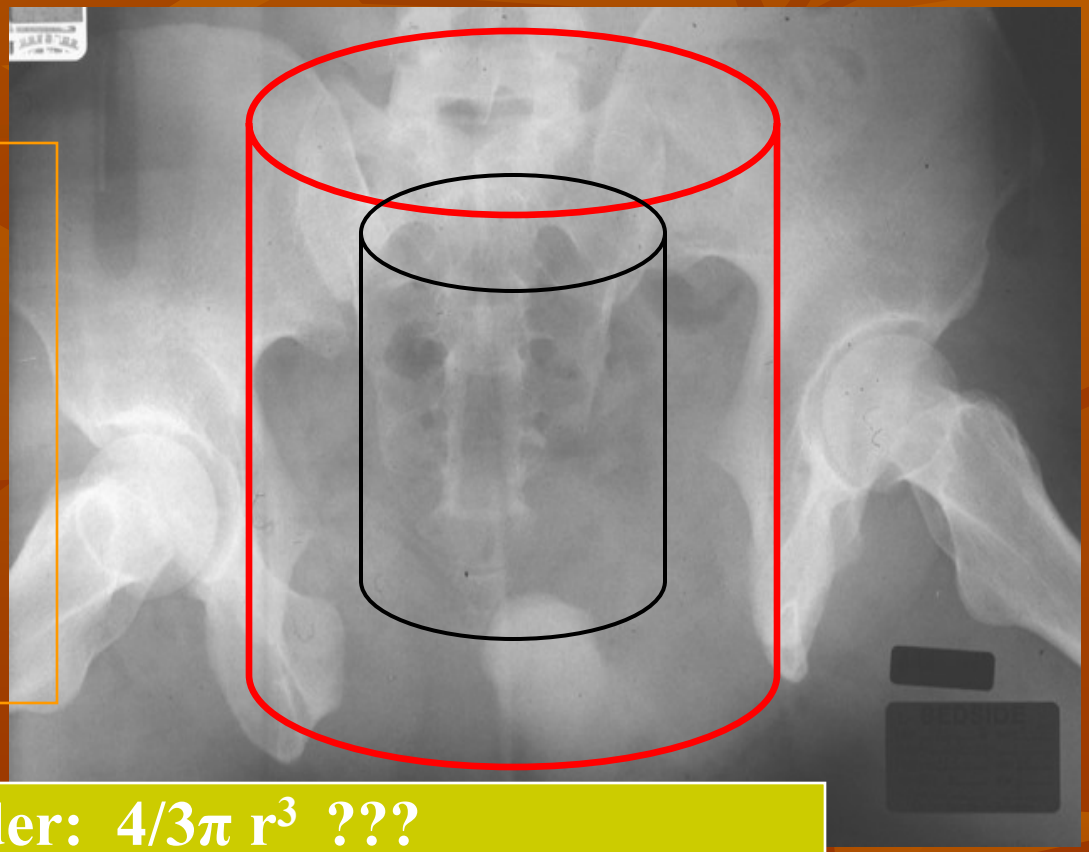

Supraspinous ligament
Iliolumbar ligament
Posterior sacroiliac ligament
Posterior sacroiliac ligament
Interosseous sacroiliac ligament
Dorsal sacroiliac ligament
Deep dorsal sacrococcygeal ligament
Sacrotuberous ligament
Articular capsule of the hip joint
Greater trochanter
Sacrospinous ligament
(Attaches to ischial spine)
Falciform process
Superficial dorsal sacrococcygeal ligament
Arcuate pubic ligament


4th lumbar vertebra
Anterior longitudinal ligament
Iliolumbar ligament
Anterior sacroiliac ligament
Sacrospinous ligament
Greater sciatic foramen
Anterior sacrococcygeal ligament
Lateral sacrococcygeal ligament
Lesser sciatic foramen
Sacrotuberous ligament
Iliofemoral ligament
Linea terminalis
Pubic tubercle
Inguinal ligament
Superior pubic ligament



Pelvic Ring Injuries

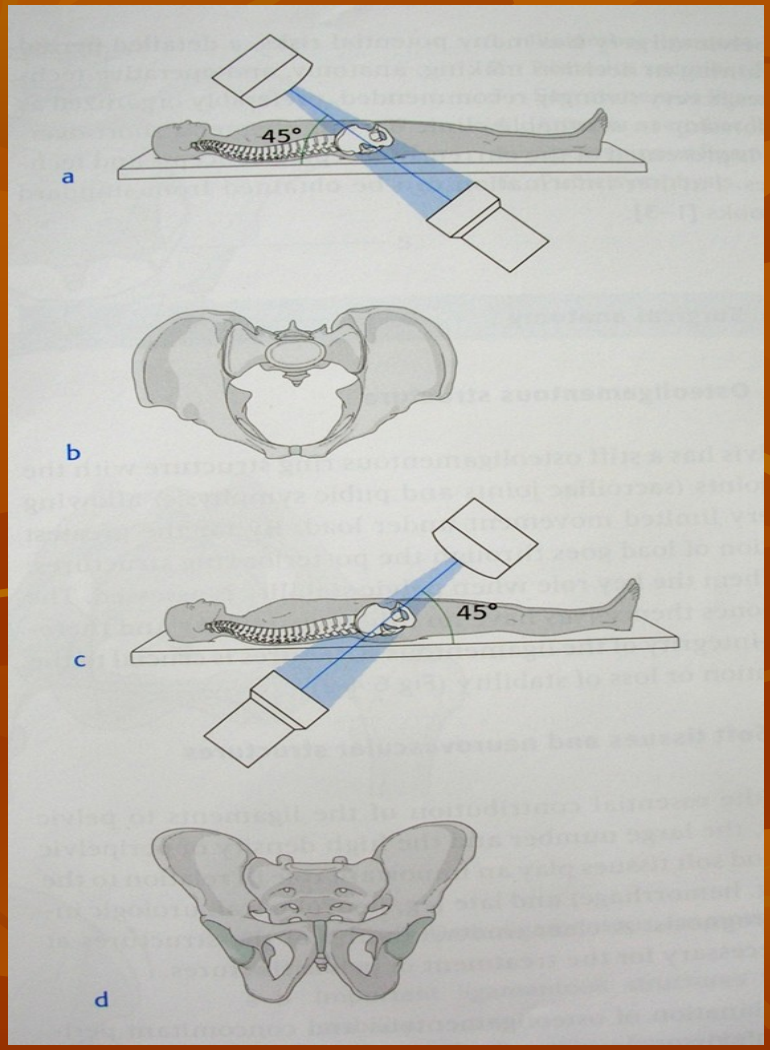
- High energy
- Morbidity/Mortality
- Hemorrhage



Cylinder: $4/3\pi\ r^3$???
Best estimated by a hemi-elliptical sphere

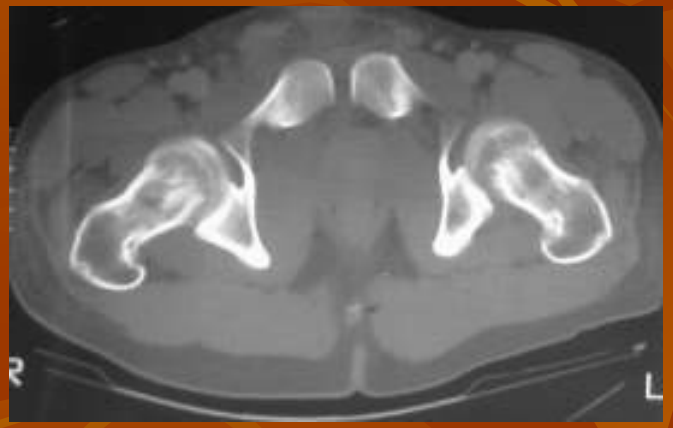
(Stover et al, J Trauma, 2006)

X - ray



CT

- More sensitive, more specific, more accurate
- Pelvis is part of CT trauma protocol
- More detailed CT examination can be performed if needed for orthopedic planning




H
F

Primary Survey: ABC's

- Airway maintenance with cervical spine protection
- Breathing and ventilation
- Circulation with hemorrhage control
- Disability: Neurologic status
- Exposure/environment control: undress patient but prevent hypothemia

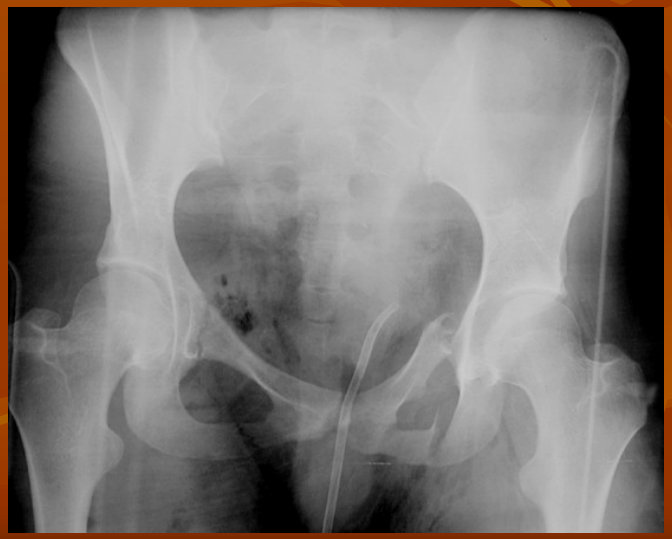
Physical Exam

- Degloving injuries
- Limb shortening
- Limb rotation
- Open wounds
- Swelling & hematoma

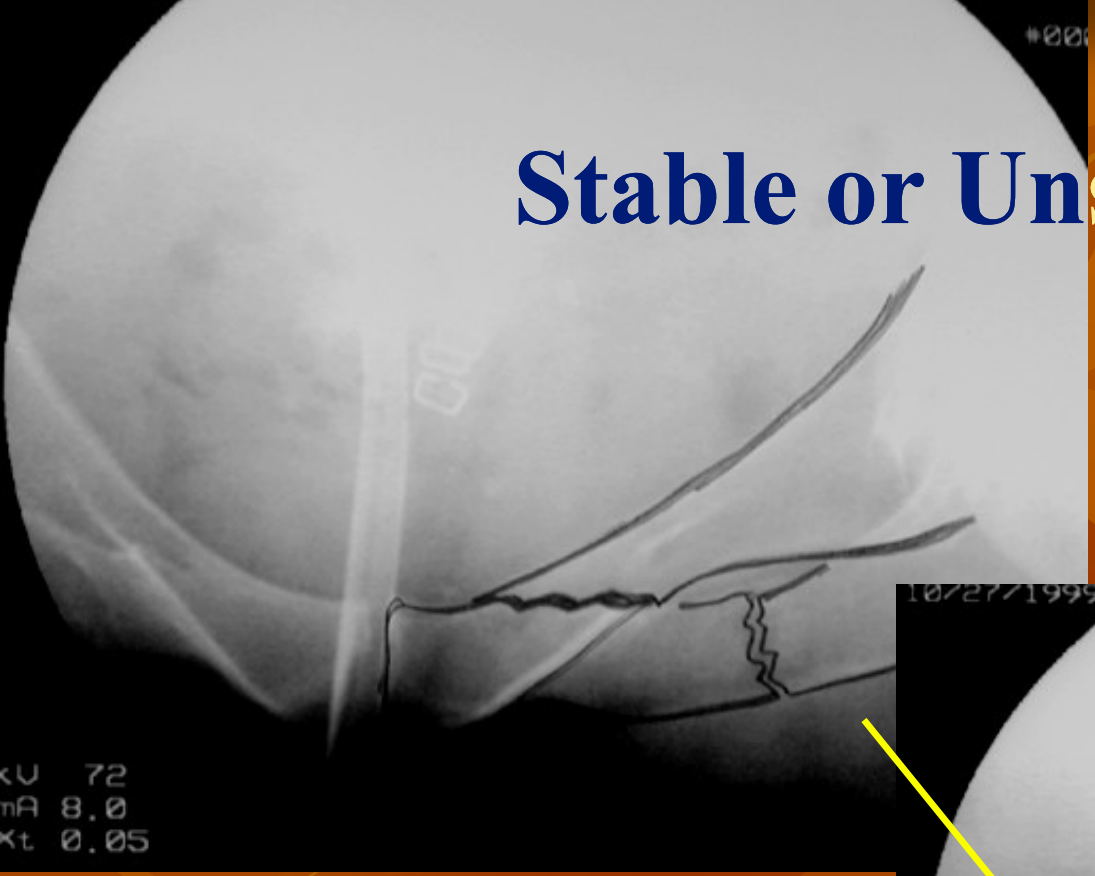
Pelvic Stability x Instability

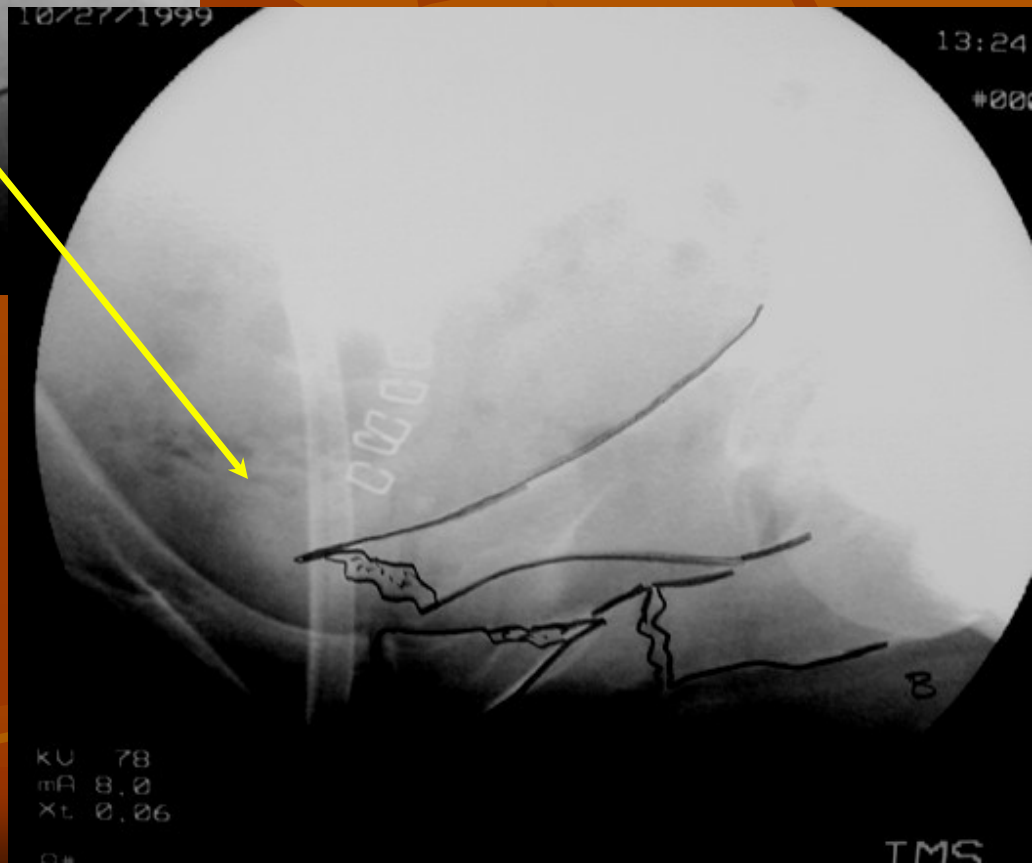
- Radiographic
- Hemodynamic
- Biomechanical (Tile & Hearn)
- Mechanical

- "Able to withstand normal physiological forces without abnormal deformation"



Stable or Unstable?





- Single examiner
- Use fluoro if available
- Best in experienced hands

Radiographic Signs of Instability

- Sacroiliac displacement of 5 mm in any plane
- Posterior fracture gap (rather than impaction)
- Avulsion of fifth lumbar transverse process, lateral border of sacrum (sacrotuberous ligament), or ischial spine (sacrospinous ligament)

Shock vs Hemodynamic Instability

- Definitions Confusing
- Potentially based on multiple factors & measures

- Lactate
- Base Deficit
- SBP < 90 mmHg
- Ongoing drop in Hct
- Response to fluid challenge

Open Pelvic Injuries

- Open wounds extending to the colon, rectum, or perineum: strongly consider early diverting colostomy
- Soft-tissue wounds should be aggressively debrided
- Early repair of vaginal lacerations to minimize subsequent pelvic abscess

Urologic Injuries

- 15% incidence
- Blood at meatus or high riding prostate
- Eventual swelling of scrotum and labia (occasional arterial bleeder requiring surgery)
- Retrograde urethrogram indicated in pelvic injured patients

Urologic Injuries

- Intraperitoneal & extraperitoneal bladder ruptures are usually repaired
- A foley catheter is preferred
- If a supra-pubic catheter it used, it should be tunneled to prevent anterior wound contamination
- Urethral injuries are usually repaired on a delayed basis

Sources of Hemorrhage

- External (open wounds)
- Internal:
- Chest
- Long bones
- Abdominal
- Retroperitoneal

Sources of Hemorrhage

- External (open wounds)
- Internal:
- Chest
- Long bones
- Abdominal
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→ Chest x-ray

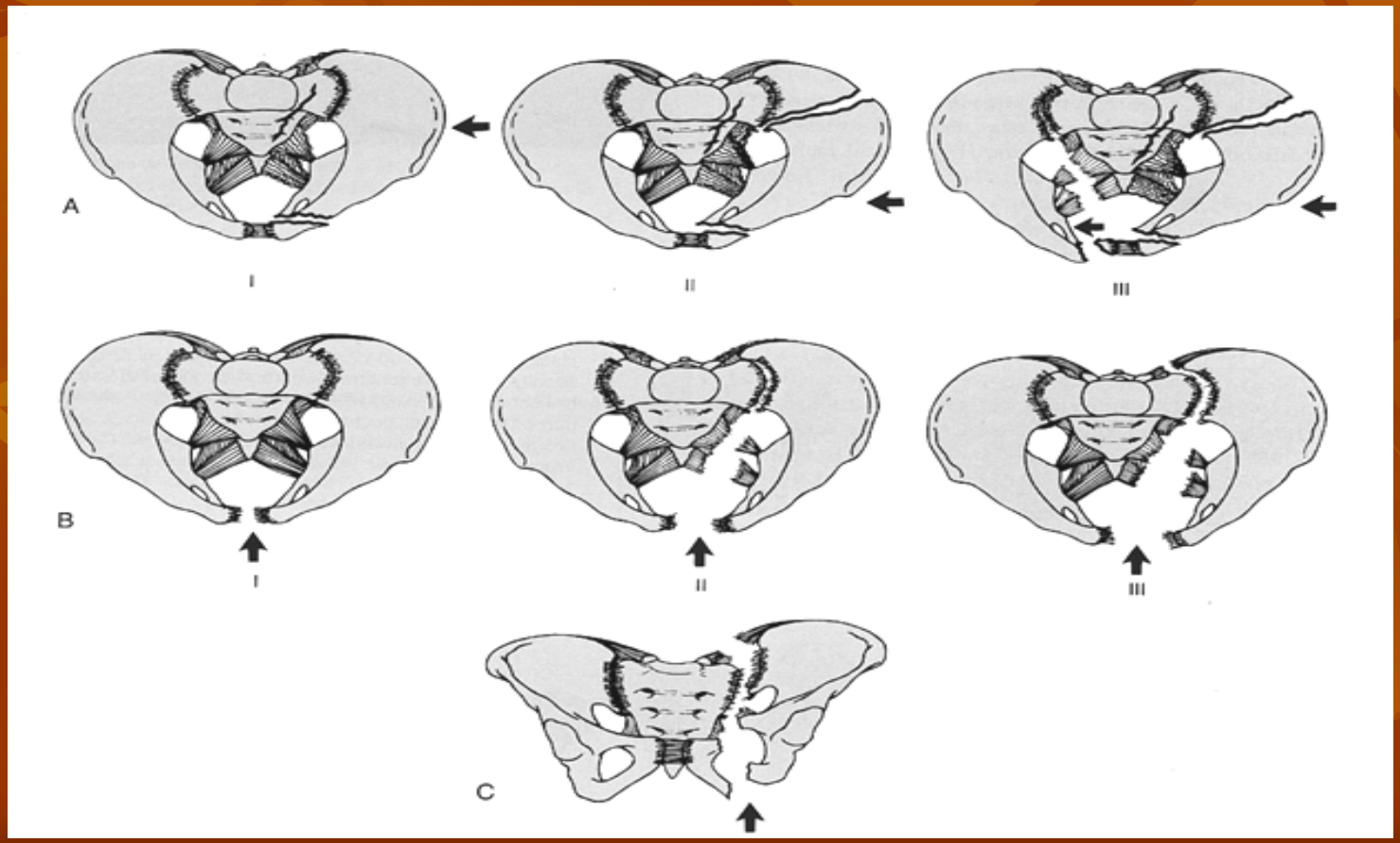
→ Physical exam, swelling

→ DPL, ultrasound, FAST

→ CT scan, direct look

Pelvic Fractures & Hemorrhage

- ER & VS > IR
- APC & VS at increased risk

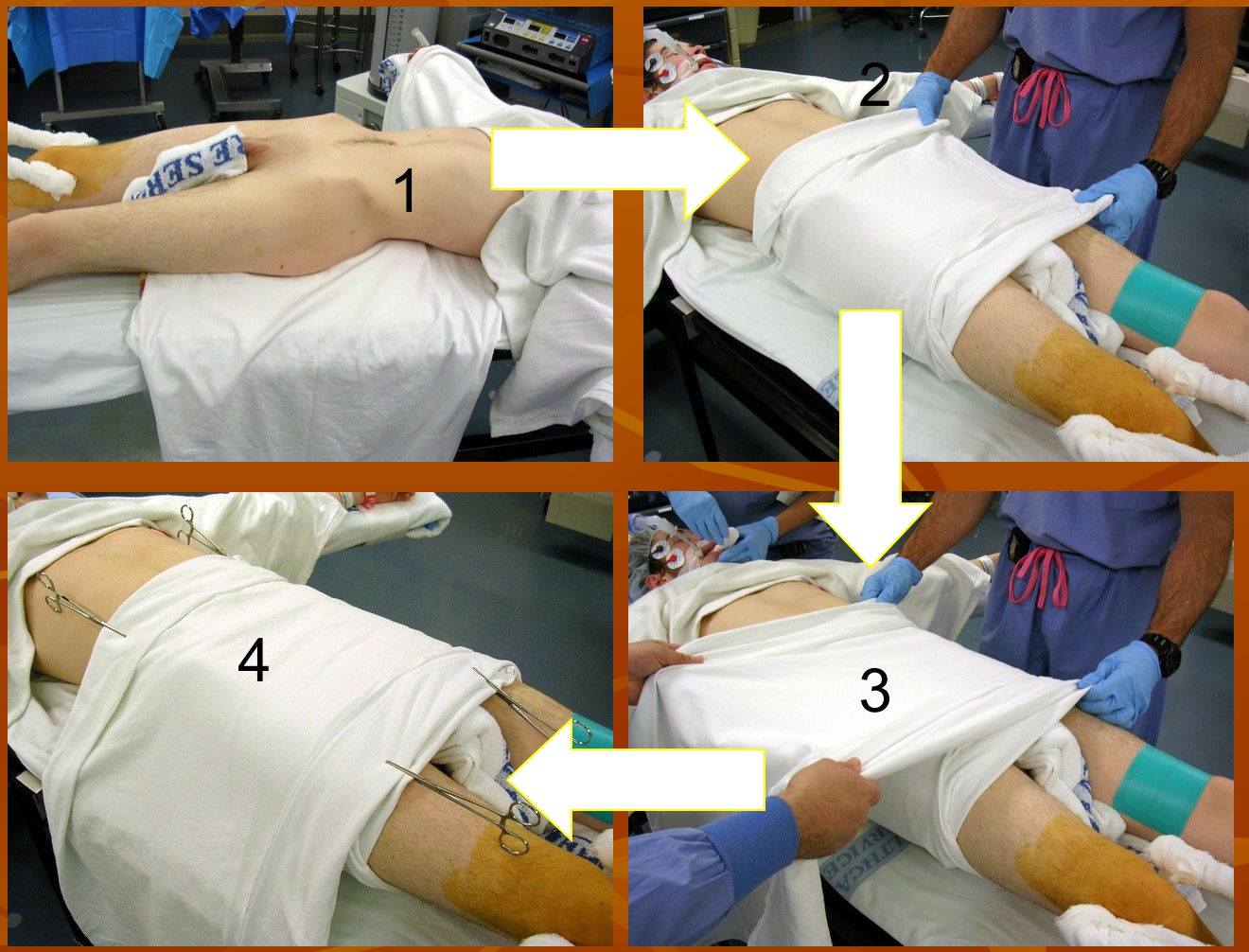


Hemorrhage Control

- Pelvic Containment
  - *Sheet*
  - *Pelvic Binder*
  - *ExternalFixation*
- Angiography
- Laparotomy
- Pelvic Packing

Circumferential Sheeting

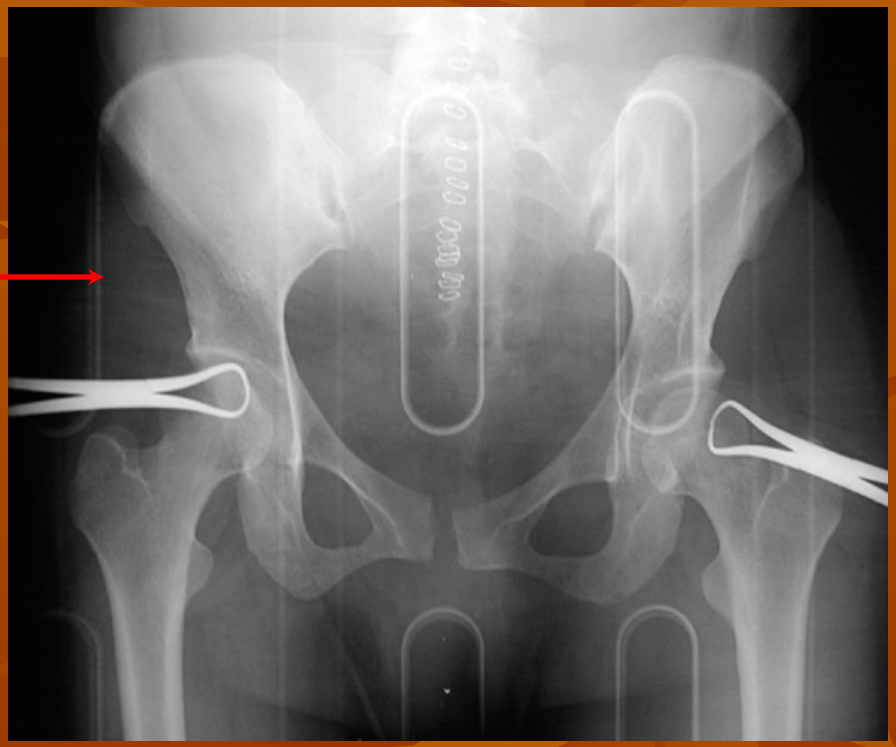
- Supine
- 2 “Wrappers”
- Placement
- Apply “Clamper”
- 30 Seconds

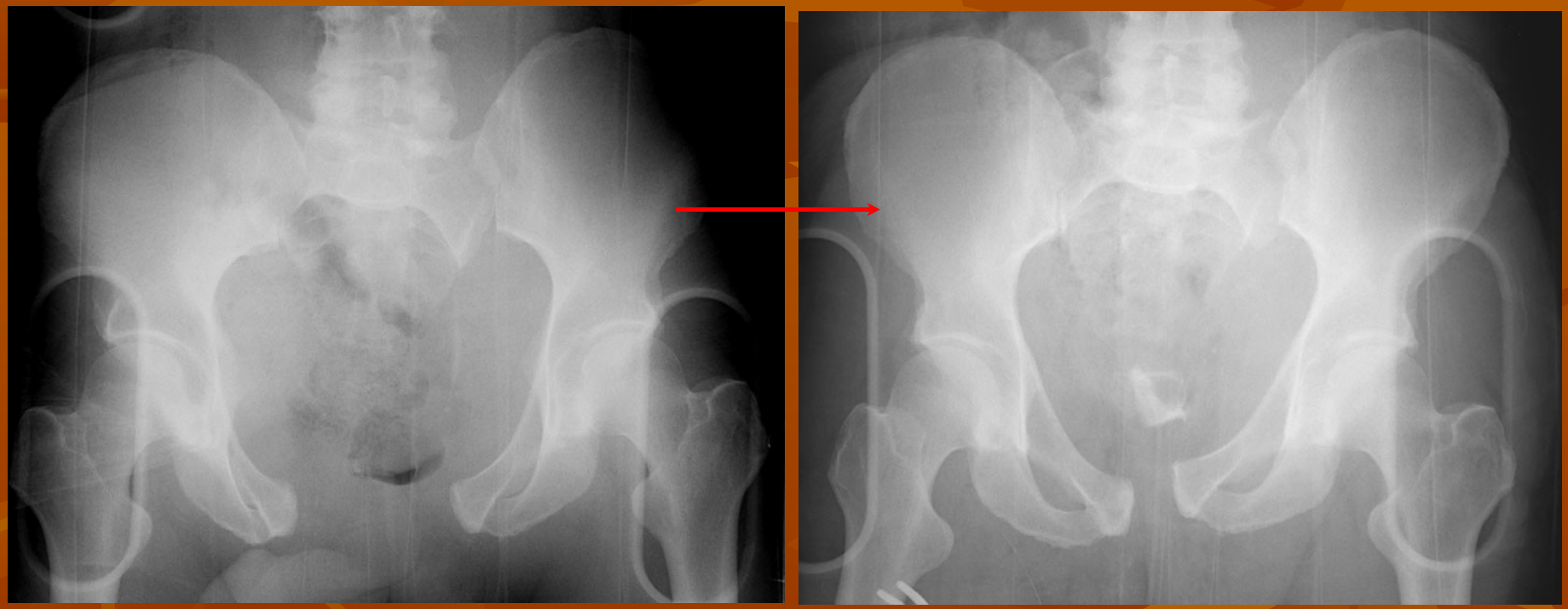


Routt et al, JOT, 2002

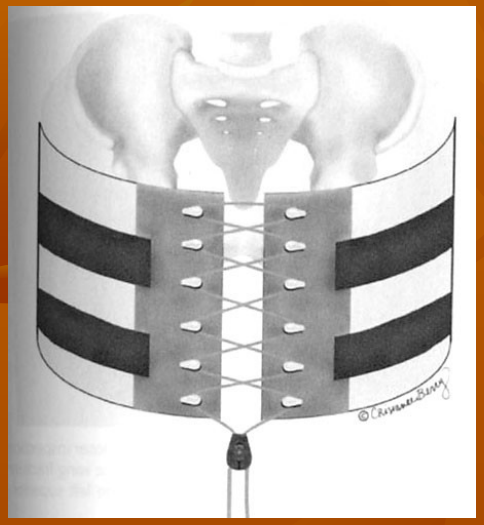
HARBORVIEW MEDICAL CENTER

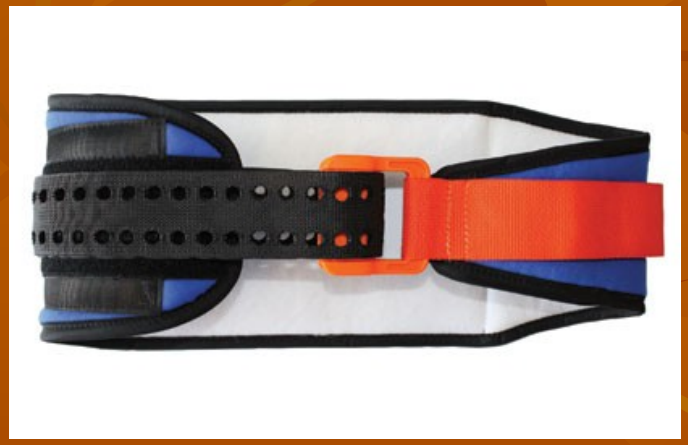
Sheet Application

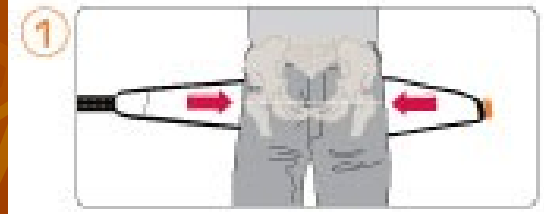


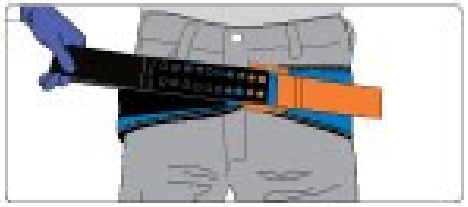


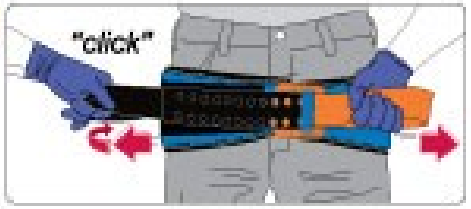
Pelvic Binders





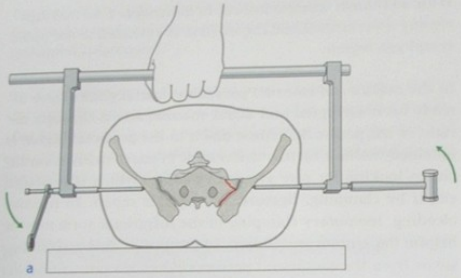


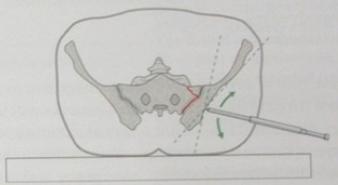


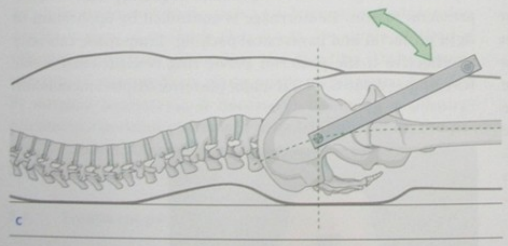


External Fixation

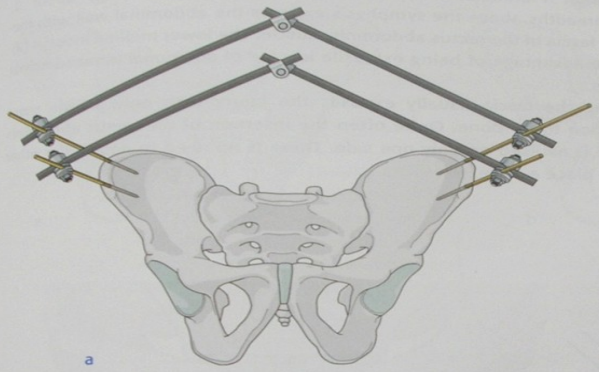
- *Location*
  - AIIS
  - ASIS
  - C-clamp
- *Clinical Application*
  - Resuscitative
  - Augmentative
  - Definitive







sions (type C injuries), the anterior ring must be st
well. The standard device—especially in emerge
simple two-pin external fixator (Fig 6.4-6b).



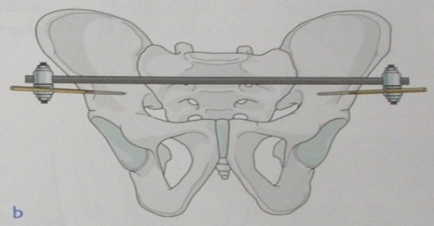
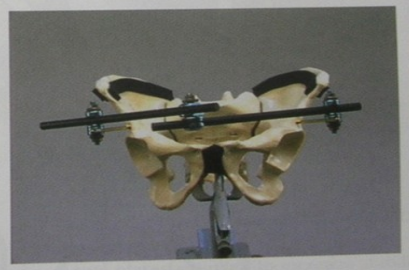
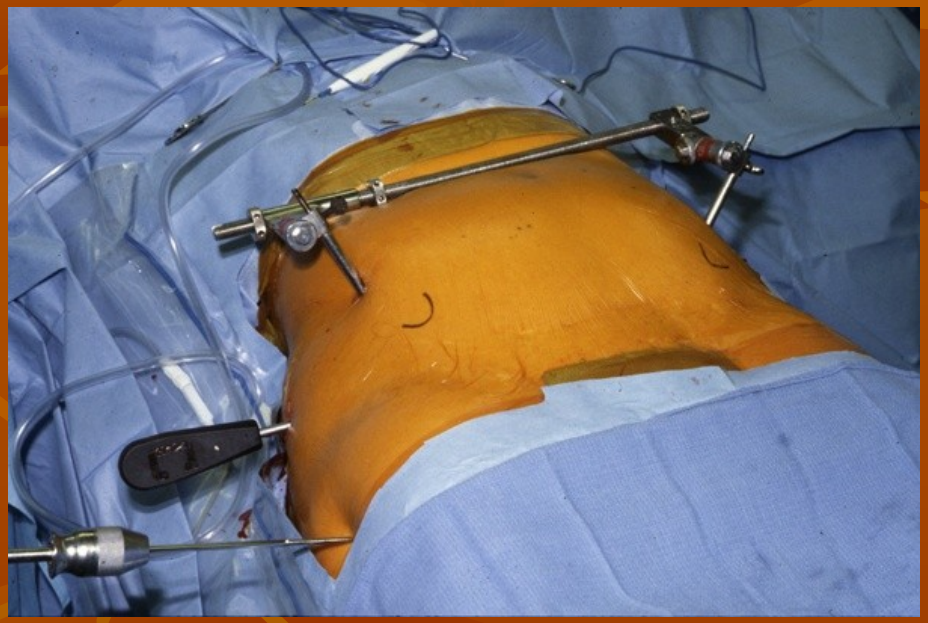


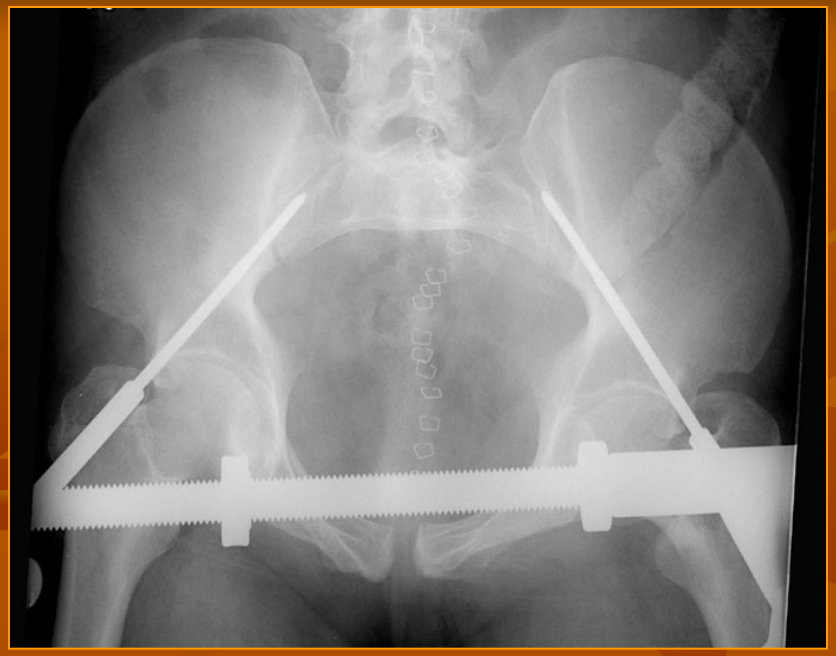
Fig 6.4-6a–b External fixation of the pelvis.

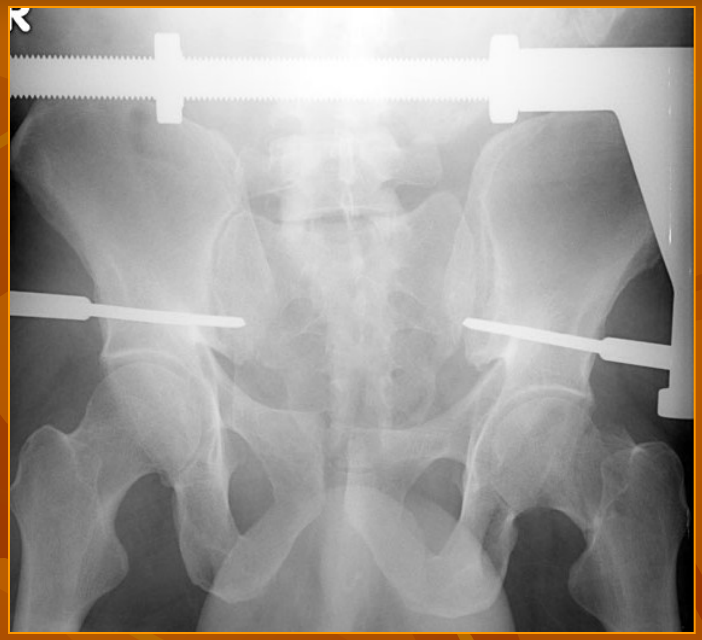
a A pelvic frame with iliac crest fixation ("high route"). Despite the advantage of simple identification of the iliac crest, misplacement of the Schanz screws is frequent.

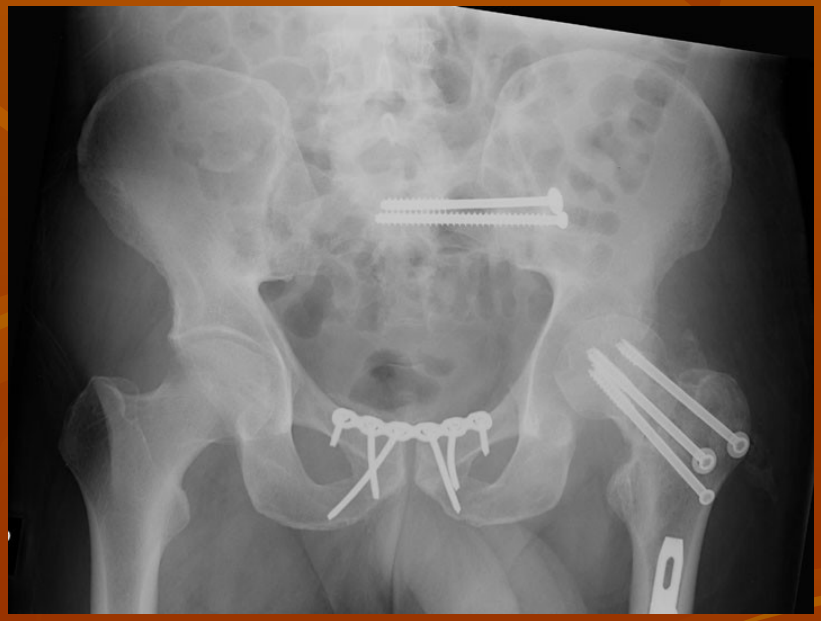
b A simple external fixator with one Schanz screw in the supraacetabular region ("low route") providing optimal holding power in the anterior inferior iliac spine—beware of hip joint penetration!

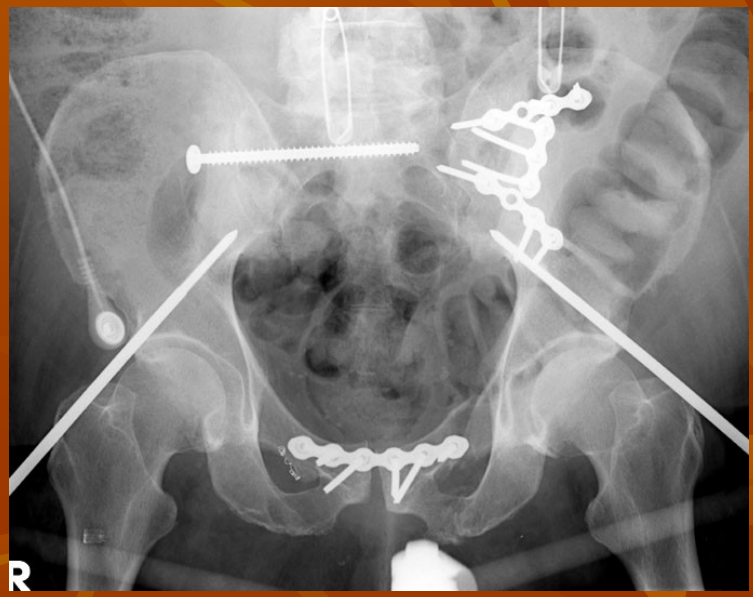




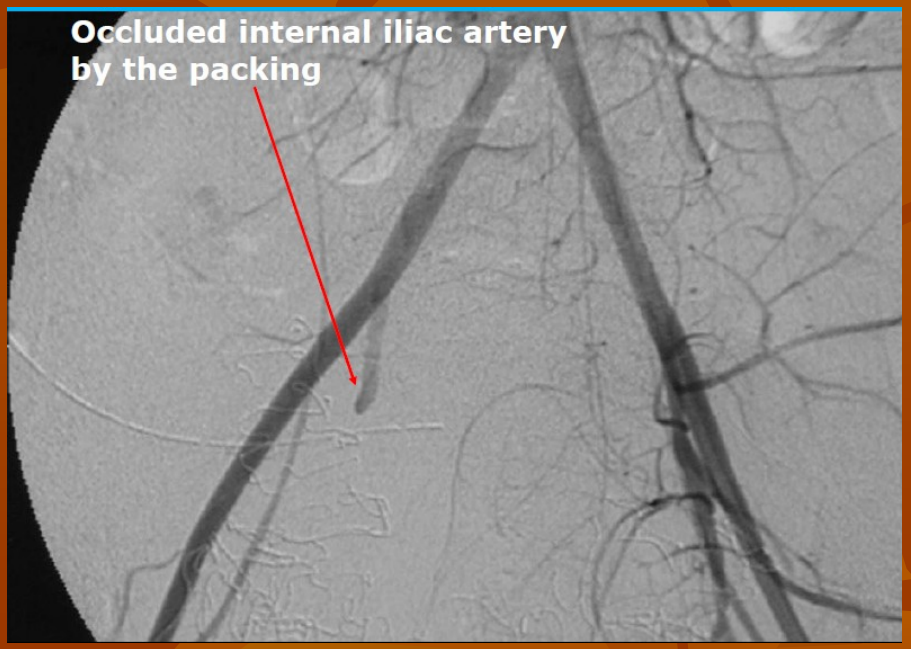




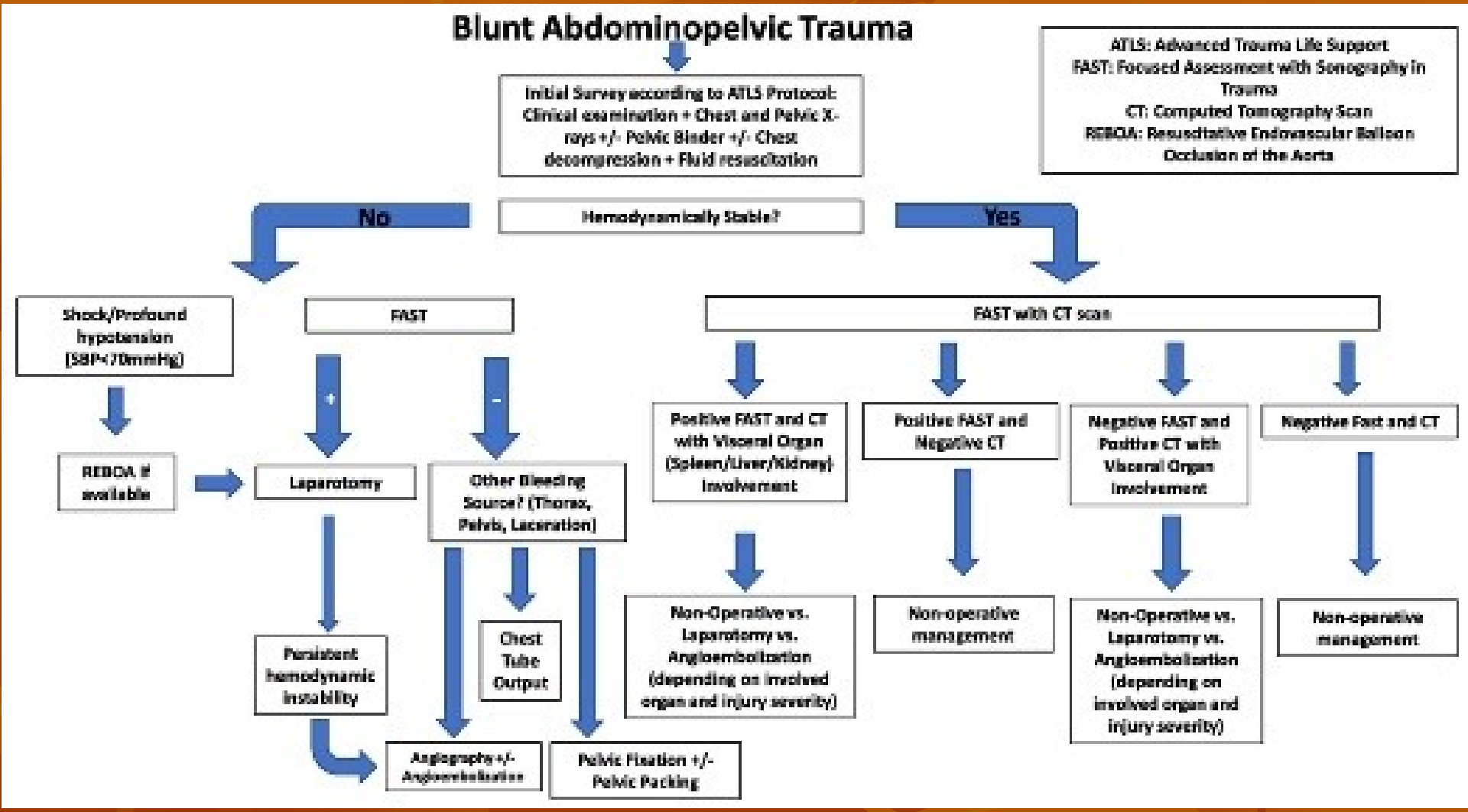




Pelvis Packing



angioembolization


Blunt Abdominopelvic Trauma
Initial Survey according to ATLS Protocol: Clinical examination + Chest and Pelvic X-rays +/- Pelvic Binder +/- Chest decompression + Fluid resuscitation
ATLS: Advanced Trauma Life Support
FAST: Focused Assessment with Sonography in Trauma
CT: Computed Tomography Scan
REBOA: Resuscitative Endovascular Balloon Occlusion of the Aorta
Hemodynamically Stable?
No
Yes
Shock/Profound hypotension (SBP<70mmHg)
REBOA if available
FAST
+
-
Laparotomy
Other Bleeding Source? (Thorax, Pelvis, Laceration)
Persistent hemodynamic instability
Chest Tube Output
Angiography +/- Angioembolization
Pelvic Fixation +/- Pelvic Packing
FAST with CT scan
Positive FAST and CT with Visceral Organ (Spleen/Liver/Kidney) Involvement
Positive FAST and Negative CT
Negative FAST and Positive CT with Visceral Organ Involvement
Negative Fast and CT
Non-Operative vs. Laparotomy vs. Angioembolization (depending on involved organ and injury severity)
Non-operative management
Non-Operative vs. Laparotomy vs. Angioembolization (depending on involved organ and injury severity)
Non-operative management

TRAUMA

- Minor force injuries
- Major force injuries

Minor Injuries

- Ground level falls
- Avulsions

Minor Injuries: Ground Level Falls

- Rami fractures
- Sacrum and coccyx fractures

Rami Fractures

- Osteoporosis is the most common predisposing condition.
- Stable, if isolated.
- Treatment is symptomatic

Sacrum Fractures

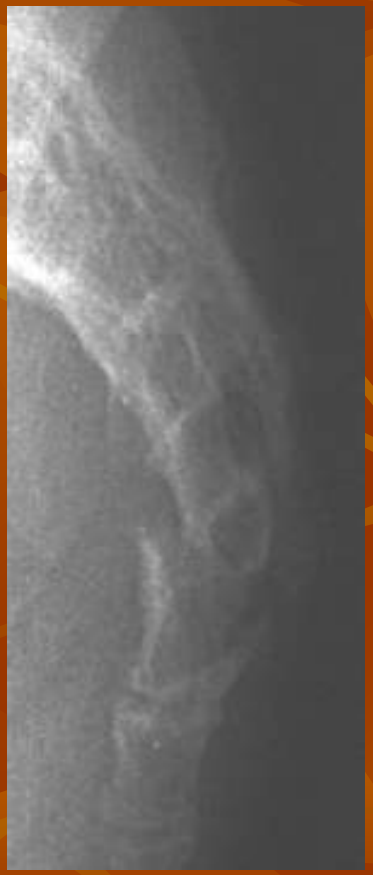
- Fall directly on the buttocks or repetitive microtrauma
- Common in osteoporosis
- Acute and stress types

Sacrum Fractures: Acute

- Can be subtle on plain films.
- Stable.
- Treatment is symptomatic.
- May occasionally damage sacral plexus nerve roots.

Coccyx Fractures

- Fall on buttocks.
- Radiologic diagnosis is difficult due to marked normal variation.
- Clinical diagnosis is more accurate: local tenderness.
- Stable.
- Symptomatic treatment.



Avulsion fractures

Apophyseal avulsions from abnormal tension by tendons: physis injuries.

- Anterior-superior and anterior-inferior iliac spines, and ischial tuberosity are most common sites.
- Athletic older adolescents and young adults.
- Nonoperative injuries.

Anterior-inferior Iliac Spine

- Rectus femoris muscle attaches to and avulses the spine when marked tension is applied to the tendon.

Major Force Injuries

Mechanically challenging
Hemodynamically threatening

Major Pelvis Injuries: Classification

Classification of Burgess-Young

- Based on THREE distinct mechanisms of injury, and TWO combined mechanisms.

- Each of the three has its own anterior ring signature key, which is the clue to the mechanism and to the important posterior ring injury.

Mechanisms

- Lateral Compression (LC)
- Anterior-Posterior Compression (APC)
- Vertical Shear (VS)
- Combined Mechanical: LC + APC or LC+VS

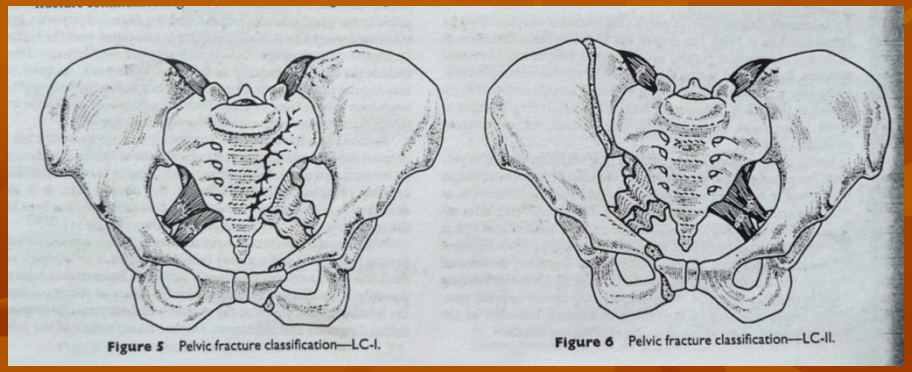


Figure 5 Pelvic fracture classification—LC-I.

Figure 6 Pelvic fracture classification—LC-II.

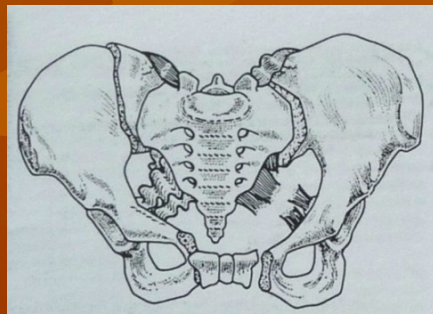


Figure 7 Pelvic fracture classification—LC-III.

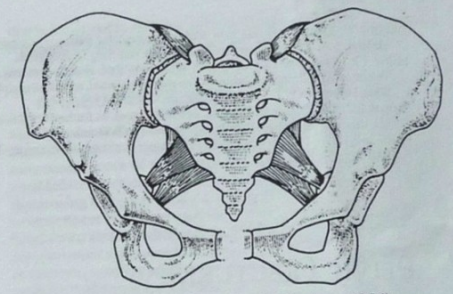


Figure 9 Pelvic fracture classification—APC-II.

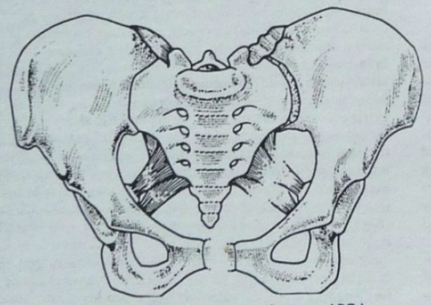


Figure 8 Pelvic fracture classification—APC-I.

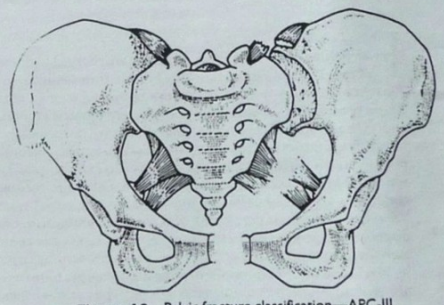
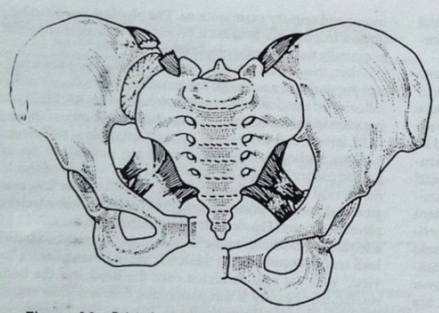


Figure 10 Pelvic fracture classification—APC-III.



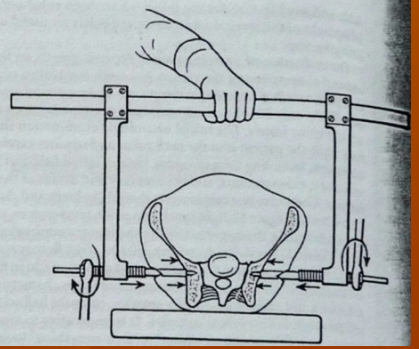
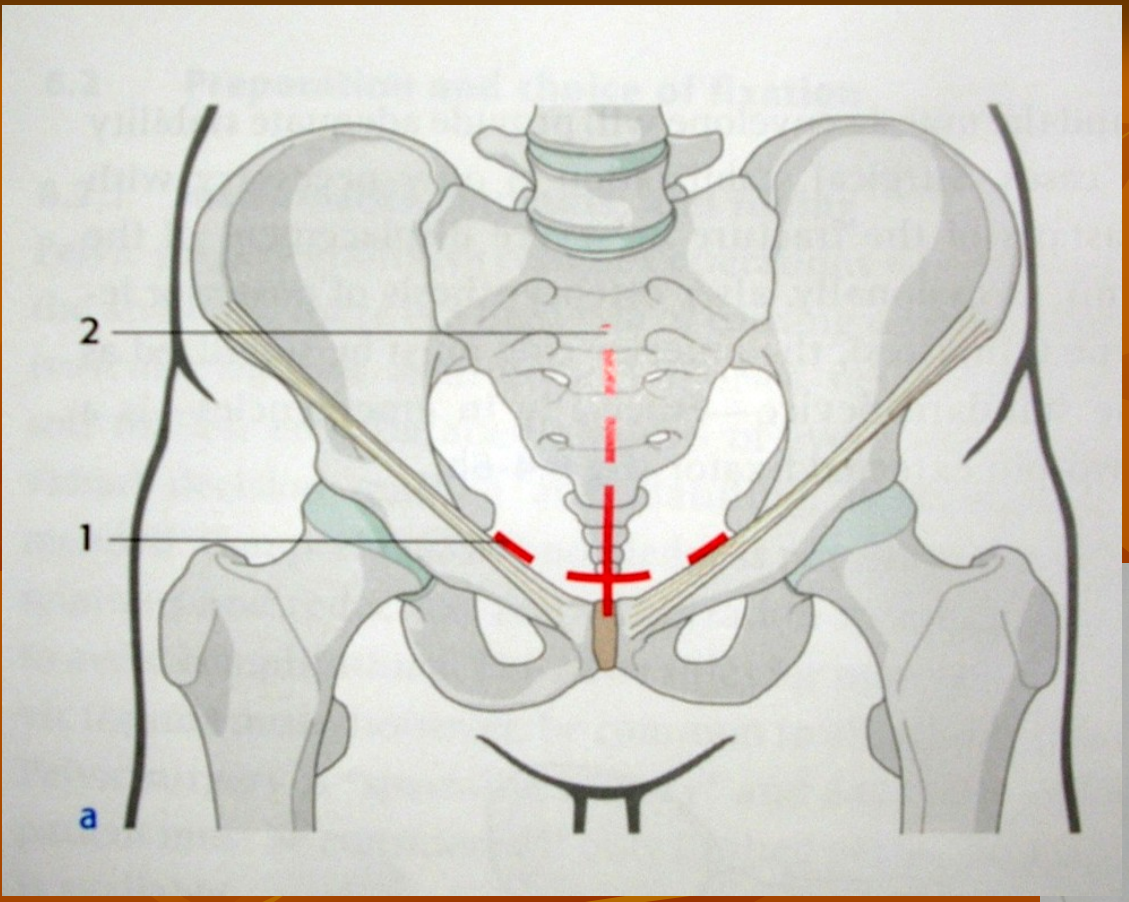


Figure 11 Pelvic fracture classification—VS (vertical shear).

Mechanism and Type	Characteristics	Hemipelvis Displacement	Stability
AP compression, type I	Pubic diastasis <2.5 cm	External rotation	Stable
AP compression, type II	Pubic diastasis >2.5 cm, anterior SI joint disruption	External rotation	Rotationally unstable, vertically stable
AP compression, type III	Type II plus posterior SI joint disruption	External rotation	Rotationally unstable, vertically unstable
Lateral compression, type I	Ipsilateral sacral buckle fractures, ipsilateral horizontal pubic rami fractures (or disruption of symphysis with overlapping pubic bones)	Internal rotation	Stable
Lateral compression, type II	Type I plus ipsilateral iliac wing fracture or posterior SI joint disruption	Internal rotation	Rotationally unstable, vertically stable
Vertical shear	Vertical pubic rami fractures, SI joint disruption +/- adjacent fractures	Vertical (cranial)	Rotationally unstable, vertically unstable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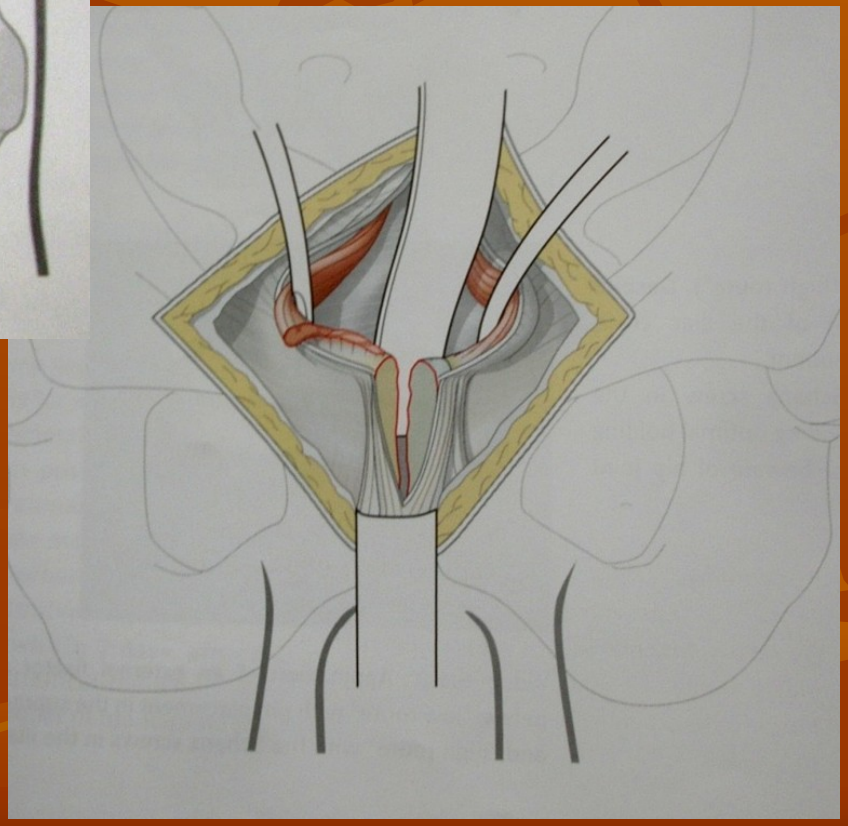
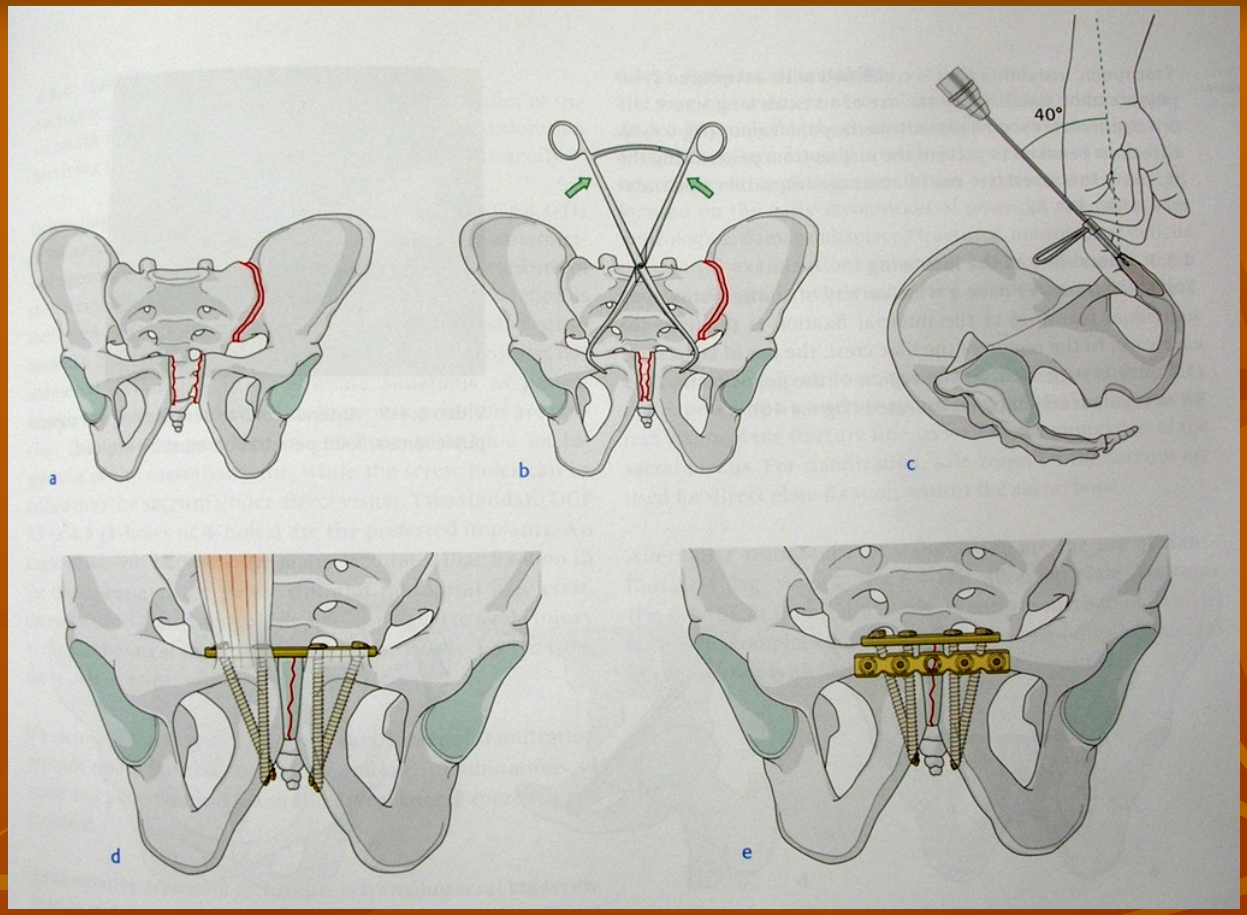
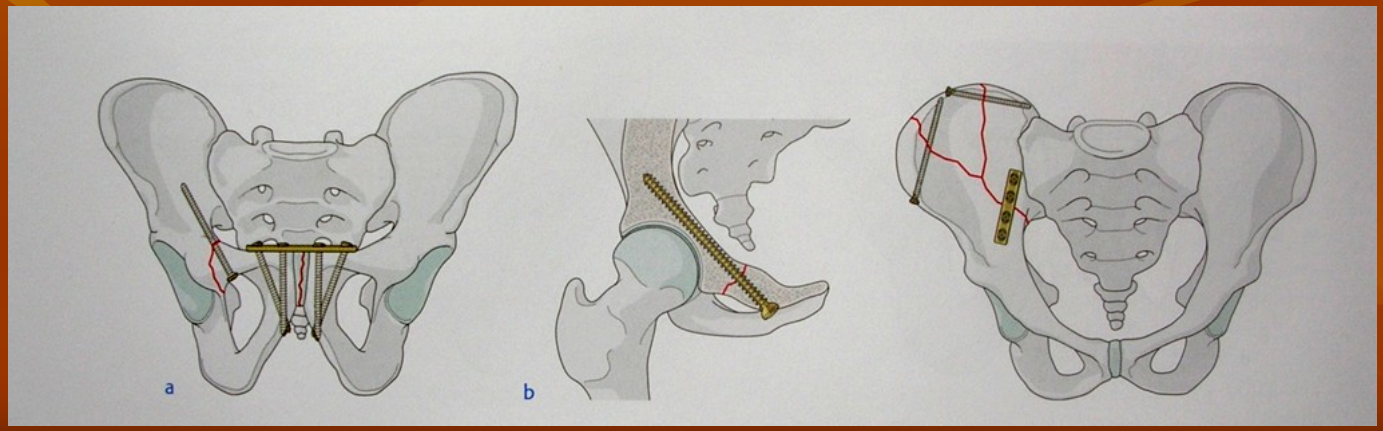



40°
a
b
c
d
e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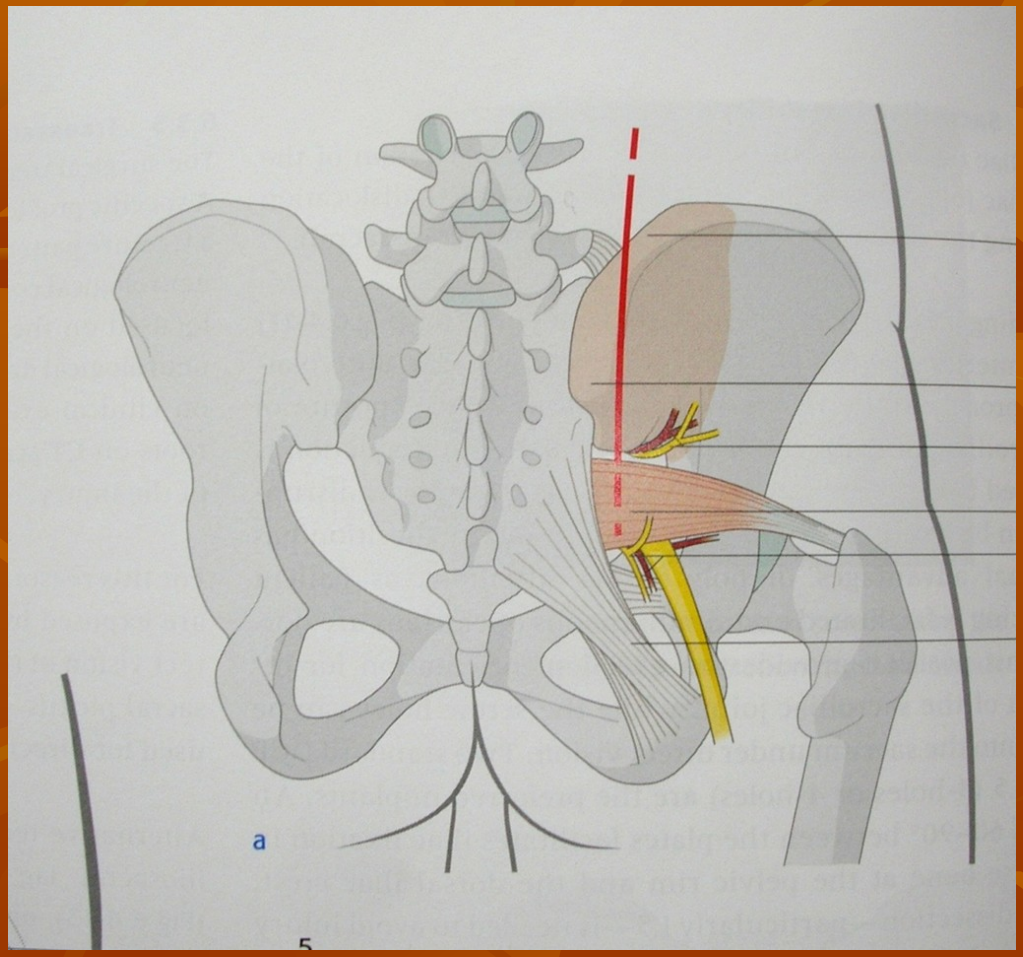
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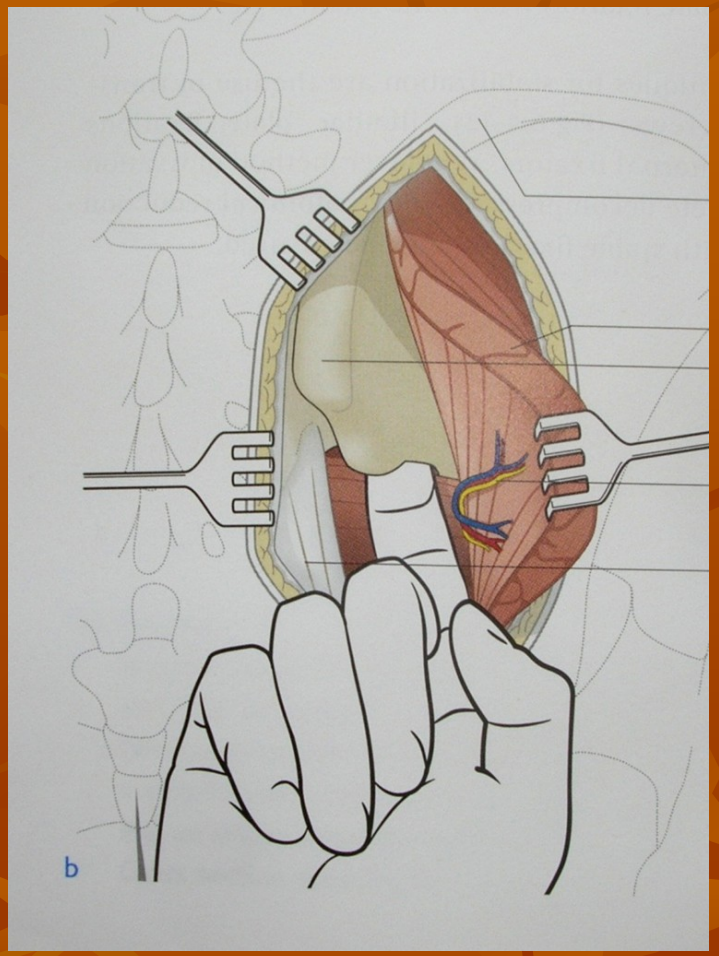
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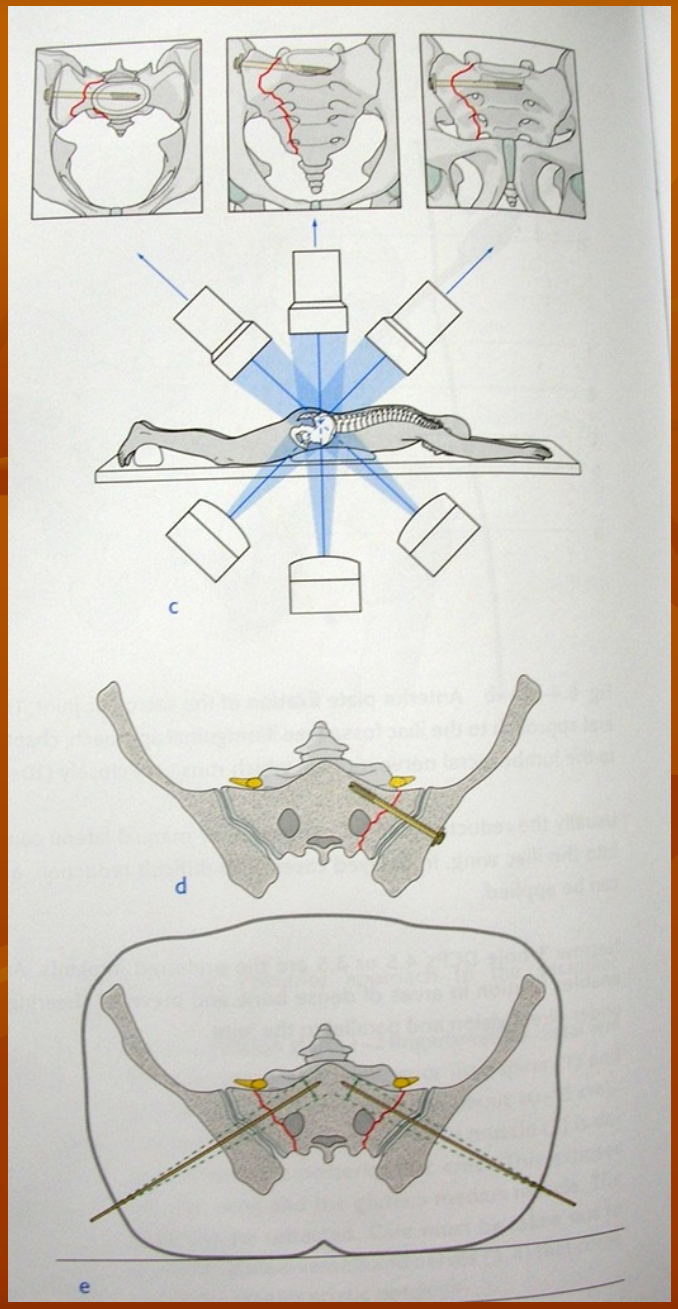
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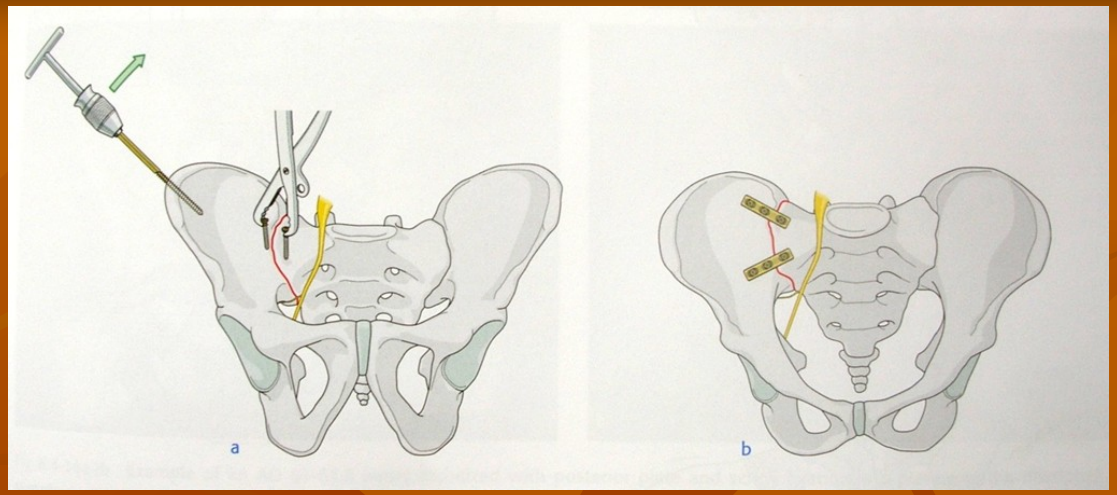
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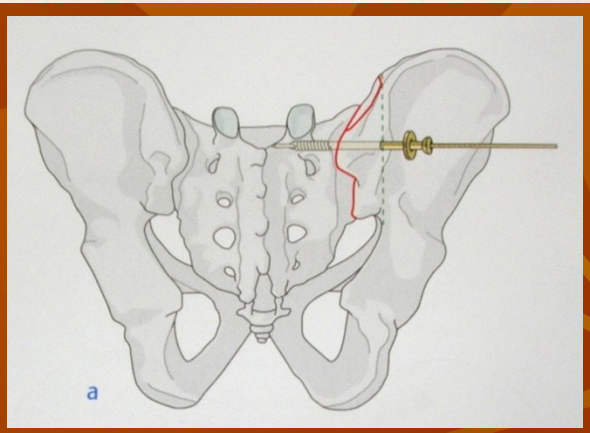
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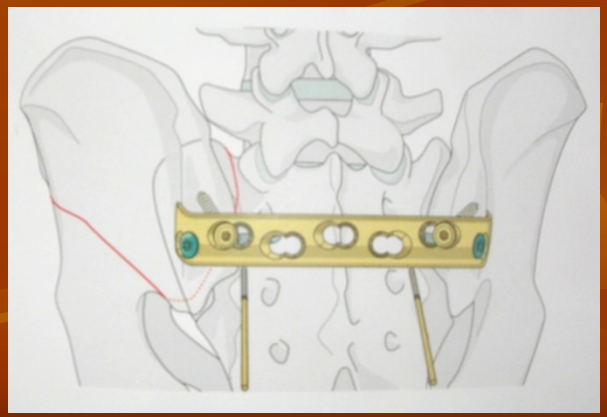


Lateral Compression

- Types I, II, III
- Force applied to side of pelvis: fall from a height, pedestrian vs auto
- All types have horizontal or oblique fracture of a ramus: the anterior key

Lateral Compression: posterior injuries

- Type I: Sacrum arcade fracture(s), ipsilateral
- Type II: Crescent fracture of ilium, ipislateral
- Type III: Anterior disruption of contralateral sacroiliac joint (“open book”)

LATERAL COMPRESSION

- Anterior ring key, common to all LC's: Horizontal or oblique ramus fracture.

LC Type I

- Most common major force pelvis fracture: 70% of total
- Sacral arcade fracture
- Hemodynamic instability: Low
- Treatment: Nonoperative, bed rest

LC Type I

- Arcade fractures can be subtle: look for any asymmetry, irregularity, overlap, discontinuity, or angulation.

LC Type II

- Crescent fracture of ipsilateral ilium
- Hemodynamic instability: moderate
- Treatment: ORIF

LC Type III

- Contralateral disruption of anterior sacroiliac joint, “open book”.
- Hemodynamic instability: high
- Treatment: ORIF

Anterior-Posterior Compression: APC

- A large force applied to the anterior pelvis: pedestrian vs auto, fall from a height

Anterior-Posterior Compression: APC

- Anterior ring key: vertical rami fractures or diastasis of symphysis pubis

APC Type II

- (There is no Type I)
- Disruption of anterior sacroiliac joint(s) (“open book”) or vertical sacrum fractures
- Hemodynamic instability: high
- Treatment: ORIF

APC Type III

- Disruption of anterior and posterior sacroiliac ligaments: SI joint dissociation.
- Hemodynamic instability: very high
- Treatment: ORIF

Vertical Shear: VS

- Force up one leg, by fall from a height or MVA
- Anterior ring key: fractured rami or diastasis symphysis pubis, but with cephalad displacement of hemipelvis

Vertical Shear: VS

- Posterior injury is vertical sacrum/iliac fracture or diastasis of sacroiliac joint, with cephalad displacement.
- Hemodynamic instability: variable
- Treatment: ORIF

Ilium Fracture

- Isolated iliac wing fractures occur with direct force
- A major force fracture, but not part of previous classification
- High incidence of intra-abdominal injuries, so always get CT Abdomen

Hemodynamic Instability in Blunt Trauma

- Determine source: chest, peritoneal cavity, “on the floor”, retro- or extraperitoneum.
- Chest film, FAST/ DPL, pelvis film.
- If pelvis fractures are the source, the bleeding is into the extraperitoneum, and surgery is usually not effective.

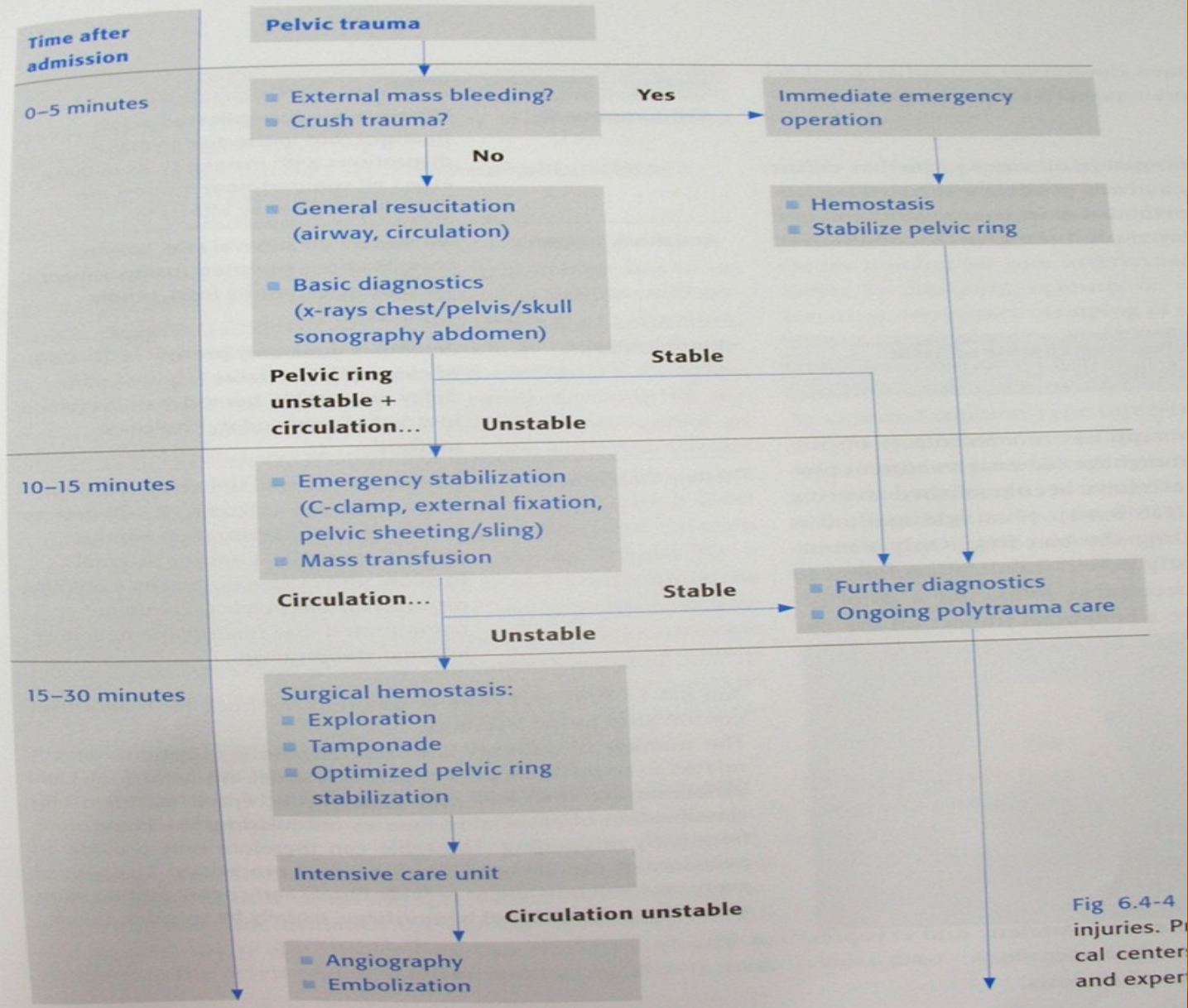


Fig 6.4-4
injuries. P
cal center
and exper

Management of Hemodynamic Instability

- All causes: Fluid/blood replacement
- “Floor”: Rapid suture hemostasis
- Chest: Chest tube, OR
- Peritoneal cavity: OR, observation, (angiography and embolization)
- Extraperitoneum: External fixation, angiography and embolization, (OR)

Angiography and Embolization

- Localize the bleeding vessel, usually a branch of Internal Iliac Artery.
- Occlude it with Gelfoam, coil, etc.
- Complications: ischemia, incontinence, impotence.

Complications

- Immediate complications
- Pelvic hemorrhage.
- Bladder injury
- urethral injury
- Nerve injury

- Early complications
- Blood loss
- Infection
- DVT, tromboembolism

- Late complications.
- Pain
- Malunion.
- Nonunion

Injuries of the Urinary Tract

- Posterior urethra and, rarely, anterior urethra in males. Female urethra injuries rare.
- Bladder.
- Ureters: very rare in blunt trauma.

Evaluation: Retrograde Urethrogram

- Use 30% I.V. type contrast (e.g. Conray 30)
- Flush the Foley to remove air
- Use sterile saline not KY as lubricant
- Insert Foley until balloon disappears
- Inflate balloon
- Drip in 15-20cc contrast from bottle 2 ft above table top

RUG: Normal

- Smooth urethra
- Normal caliber
- No extravasation
- Contrast reaches internal sphincter or bladder

Urethra Injury

- Narrowing or false channel, but no extravasation

- Note the air bubbles: always clear the Foley catheter of air before insertion!

- Extravasation: Base of bladder, scrotum, upper medial thigh

Bladder Injuries

Extraperitoneal

Intraperitoneal

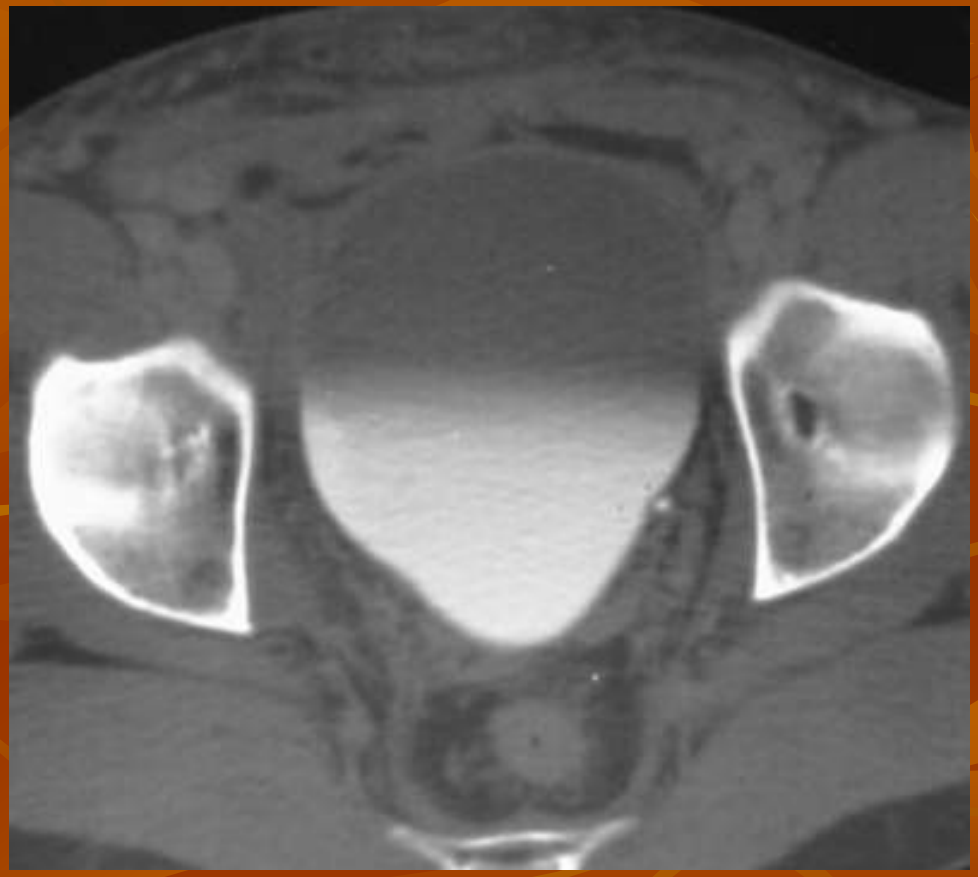
Combined

Conventional Cystogram: Normal

CT Cystogram

- Can do CT cystogram, which is more sensitive. Technique is similar to conventional cystogram.
- Both conventional and CT cystograms must be done retrograde.
- Antegrade filling by I.V. contrast is not sensitive enough for small leaks.

CT Cystogram: Normal

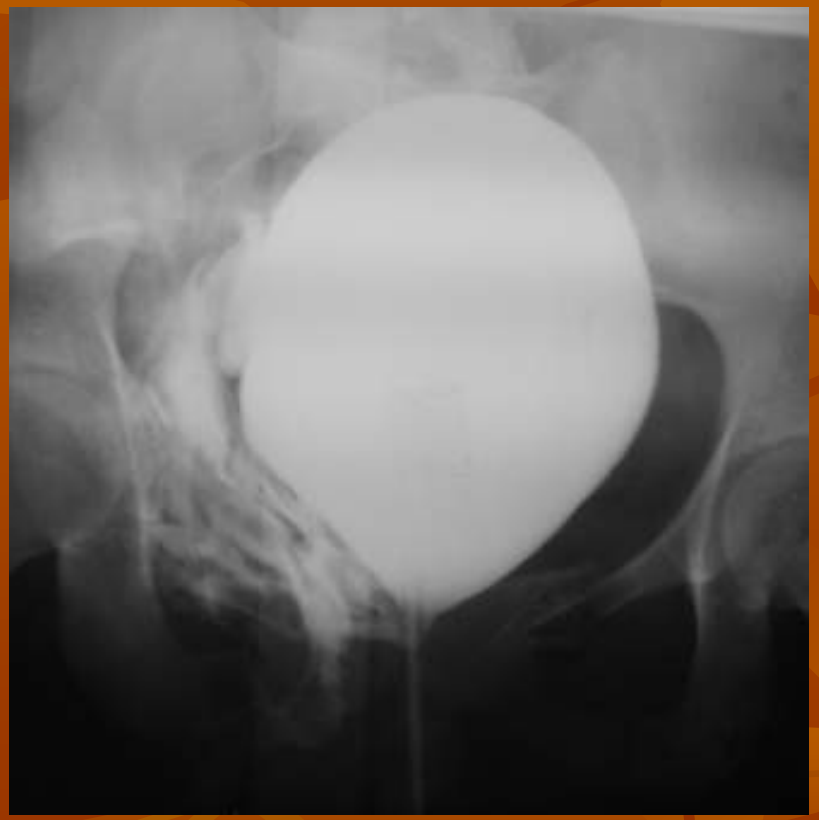


Bladder Injuries: Minor

- Perivesical hematoma
- Mucosa and mural injuries without rupture

Extraperitoneal Rupture

- 2-3 X more common than intraperitoneal injury
- Anterior pelvis fractures
- Injury is at bladder base
- Extravasation around base of bladder
- Management: Divert with suprapubic catheter and debride

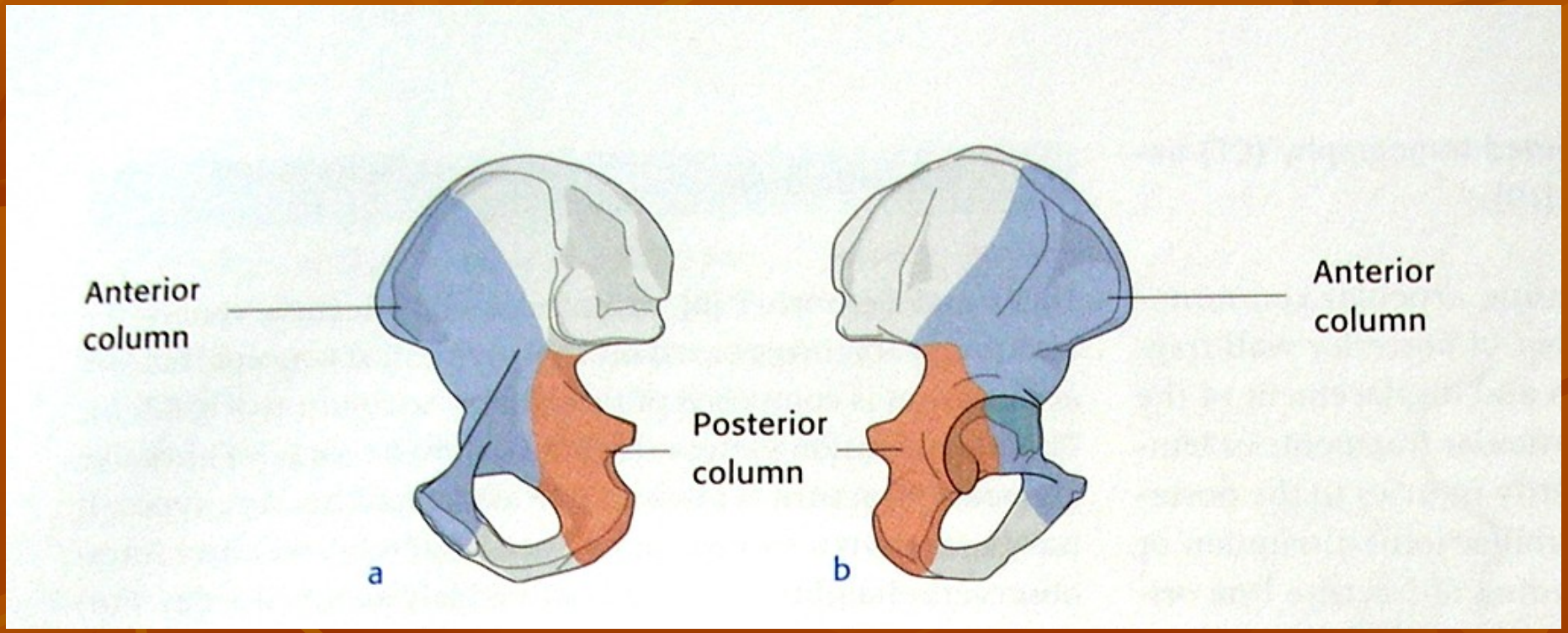


Intraperitoneal Rupture

- Often no pelvis fractures, usually blow to full bladder
- Dome is injury site
- Contrast in paracolic gutters and around bowel
- Management: emergency laparotomy to repair tear and prevent peritonitis

Acetabular fractures

- Commonly associated with high energy trauma, and frequently associated with (especially posterior) hip dislocation
- Although they can also occur with lower energy injuries in the osteoporotic elderly after a fall
- Fractured acetabulum is by definition an intra-articular fracture and as such is a joint threatening fracture that frequently
- needs anatomic reduction and fixation, especially in the young


Anterior column
Posterior column
Anterior column
a
b

- Letournel Classification
- Elementary types
- Posterior wall
- Posterior column
- Anterior wall
- Anterior column
- Transverse

- Associated types
- T-type
- Transverse and posterior wall
- Posterior column and posterior wall
- Anterior and posterior hemitransverse
- Both columns

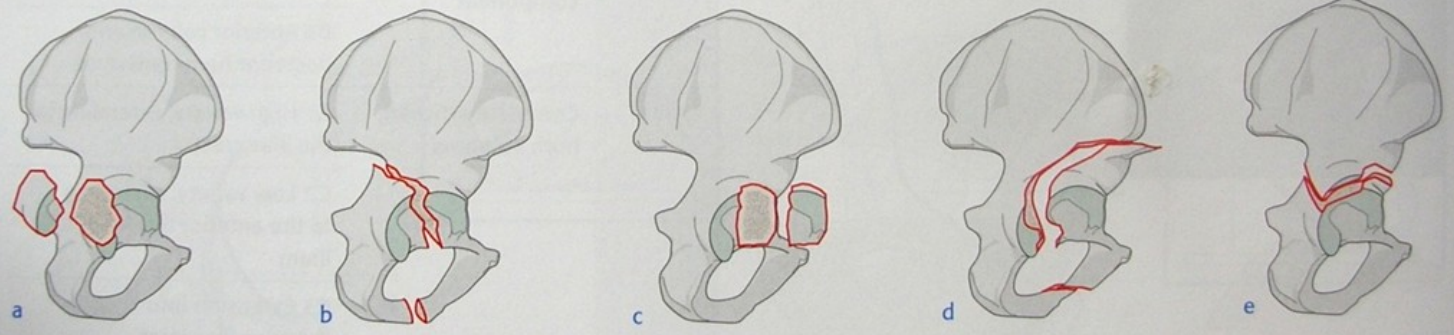


Fig | Animations 6.5-6a–e The Letournel classification: the five elemental fracture types.

a Posterior wall.
b Posterior column.
c Anterior wall.
d Anterior column.
e Transverse.

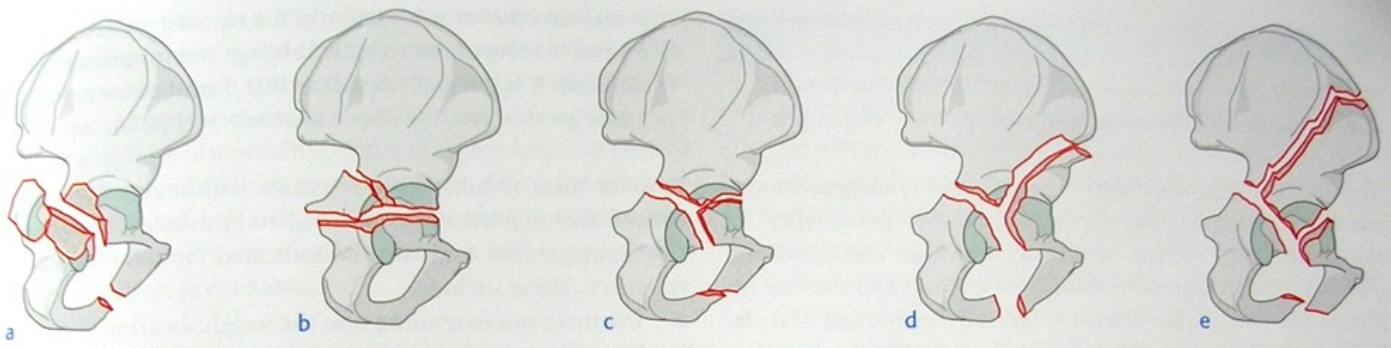


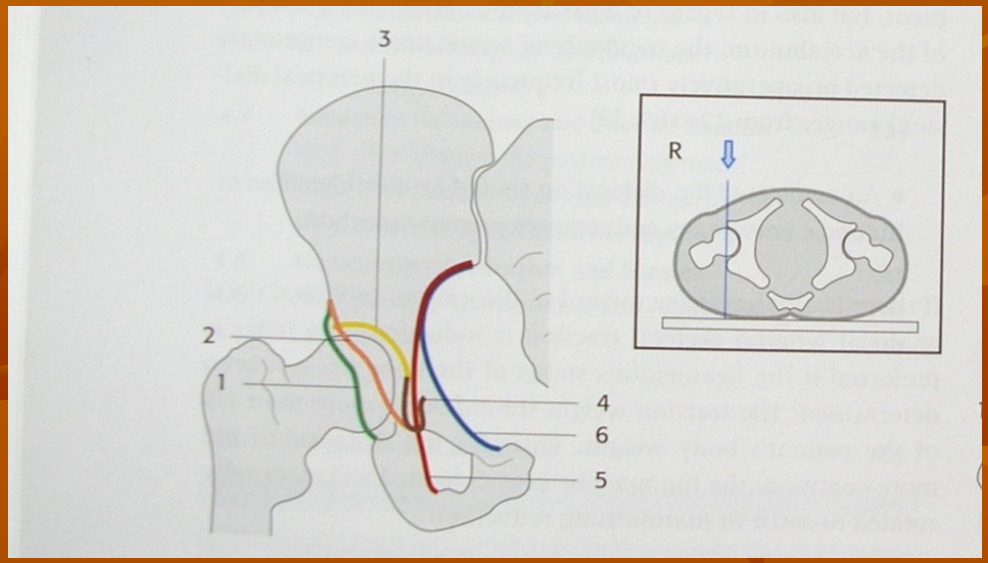
Fig | Animations 6.5-7a–e The Letournel classification: The five associated fracture types.

a Posterior column and wall.
b Transverse and posterior wall.
c T type.
d Anterior column and posterior hemitransverse.
e Both columns.

- Priority is to exclude any associated life threatening or limb-threatening injuries first
- Most fractures of the acetabulum can be seen on AP X-ray of the pelvis during screening in the acute setting
- When patient is stabilised, obtain standard Judet views ± pelvic inlet/outlet view
- Document any associated soft tissue and neural injury
- Arrange for urgent/early reduction of any hip dislocation
- Central hip dislocation, say, in transverse fractures, may need to apply leg traction to diminish chance of impingement of the femoral head cartilage

- Five Standard X-ray Views
- AP view
- Judet views – sometimes hip subluxation only seen in these oblique views
- Pelvic inlet
- Pelvic outlet

- CT Assessment
- Hip congruency
- Intra-articular fragments
- 3D reconstruction in complex fracture patterns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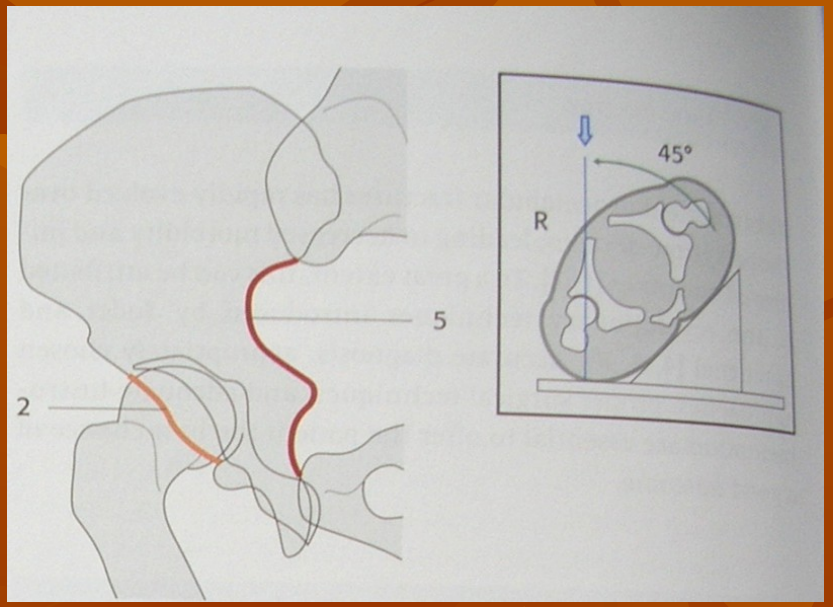
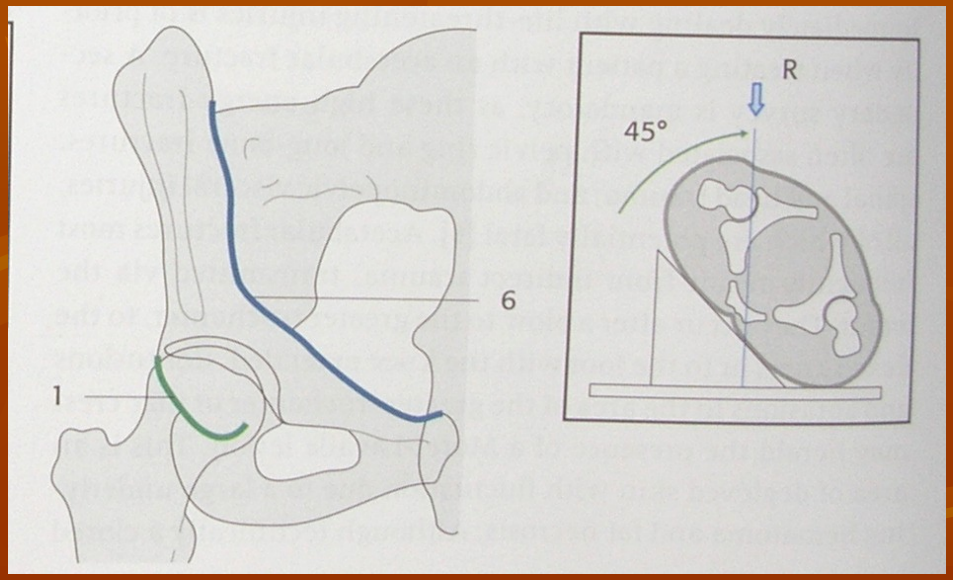

5
2
45°
R

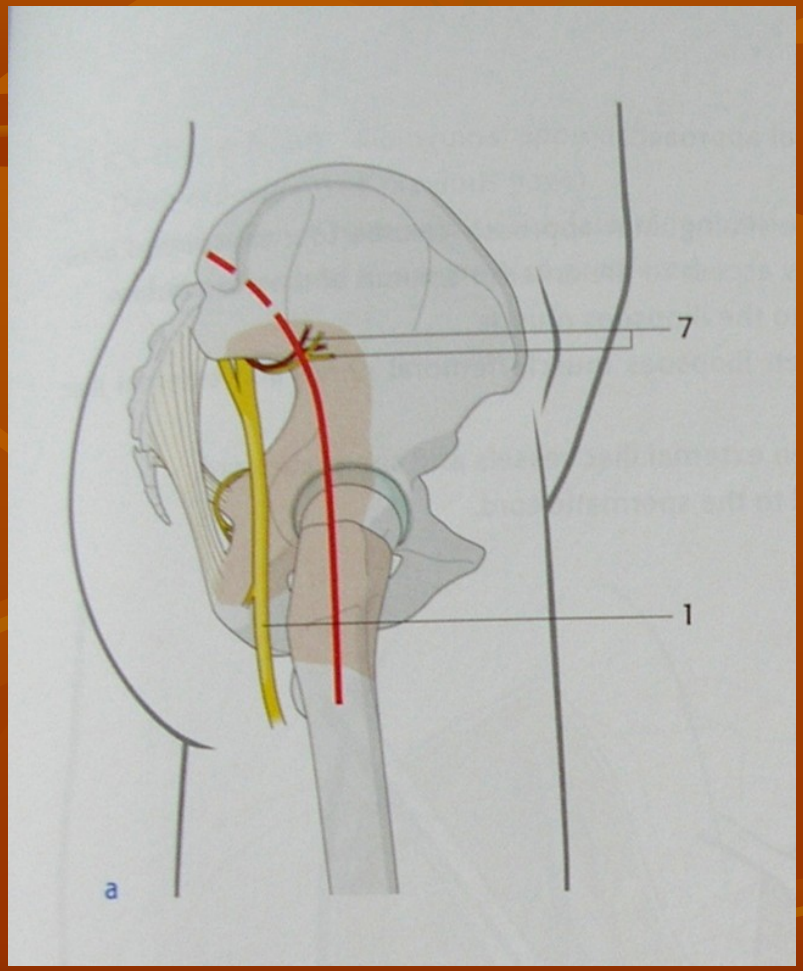

6
1
R
45°

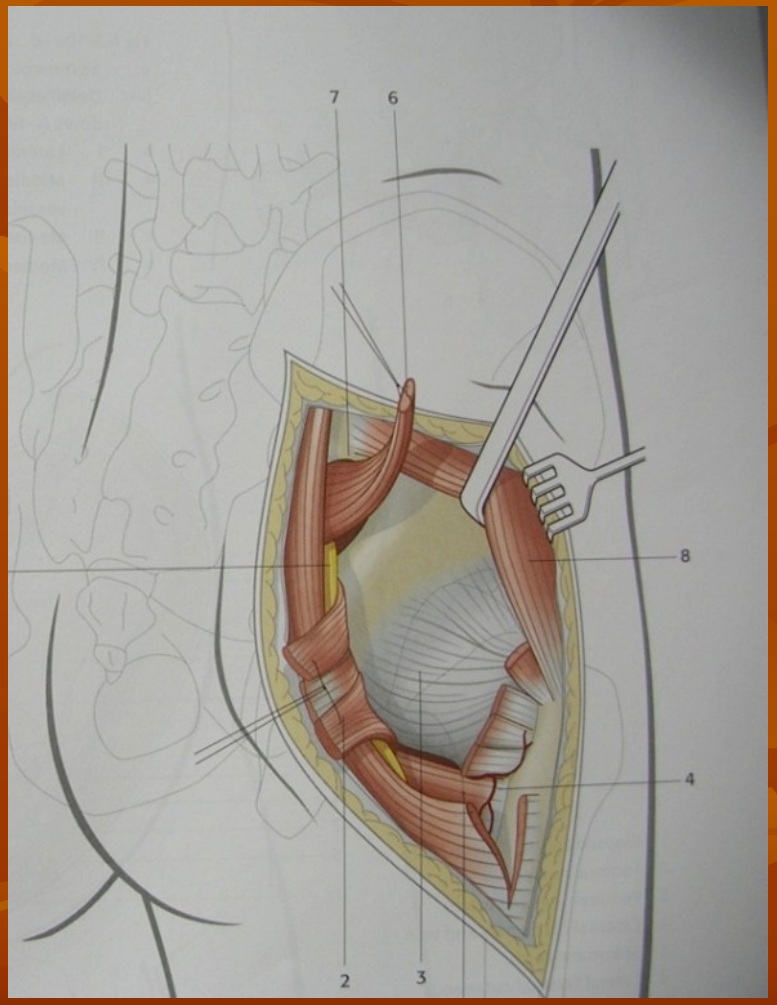
- The Case for Early/Urgent Operation
- Open fracture
- Vascular injury
- Associated irreducible hip (e.g. loose body)
- Hip instability after reduction
- Progressive nerve palsy

- Indications for Operative Intervention
- Most displaced (> 2 mm) acetabular fractures
- Hip joint incongruent
- Especially if involve weight-bearing dome

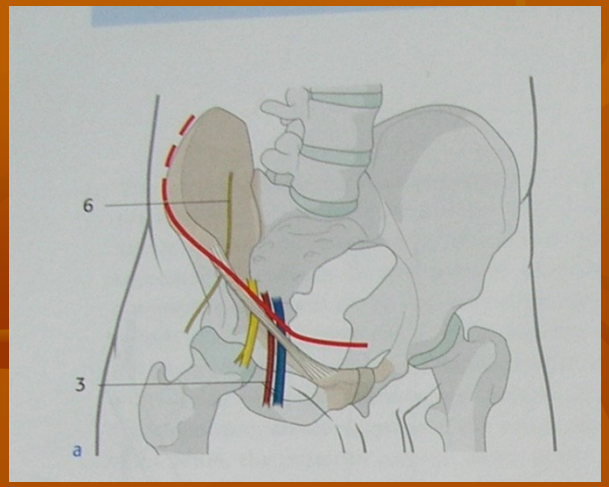
- Goal of Surgery
- Restoration of joint congruity
- Anatomical reduction of weight-bearing dome
- Rn of associated injury

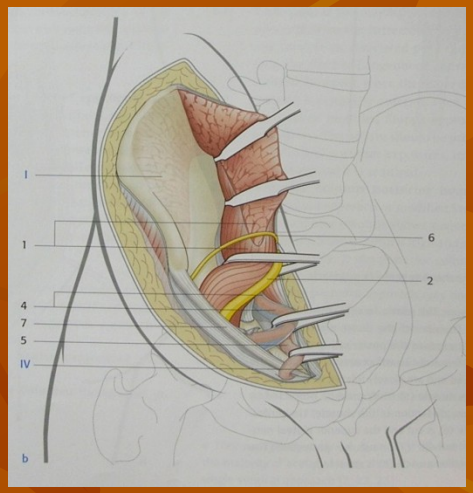
- Approaches
- Kocher-Langenbeck



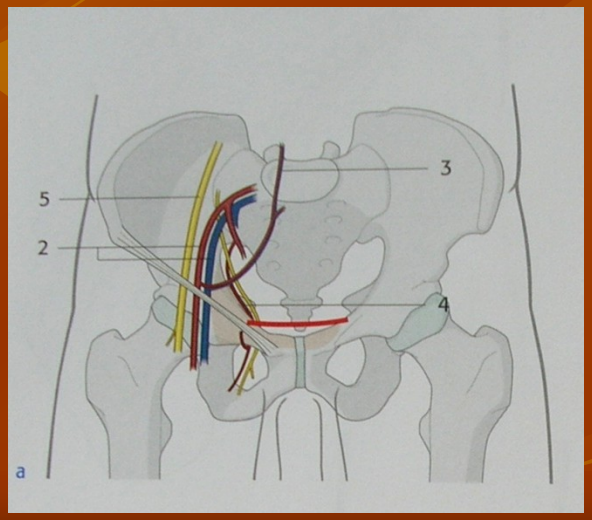


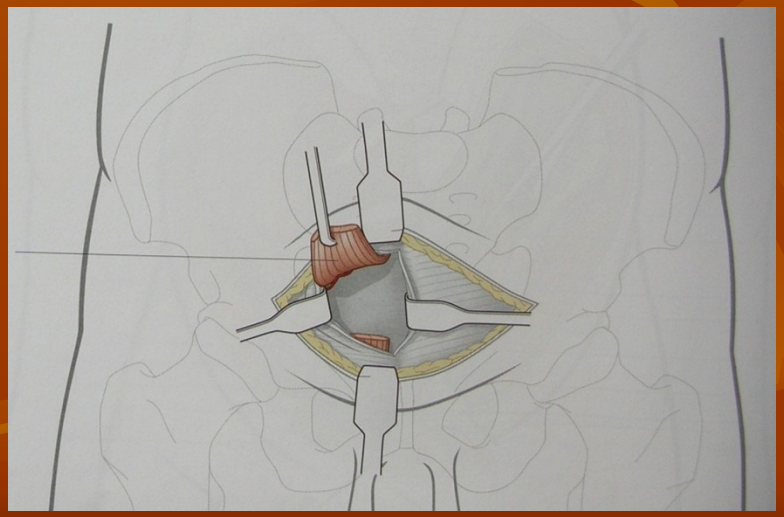
- Ilioinguinal



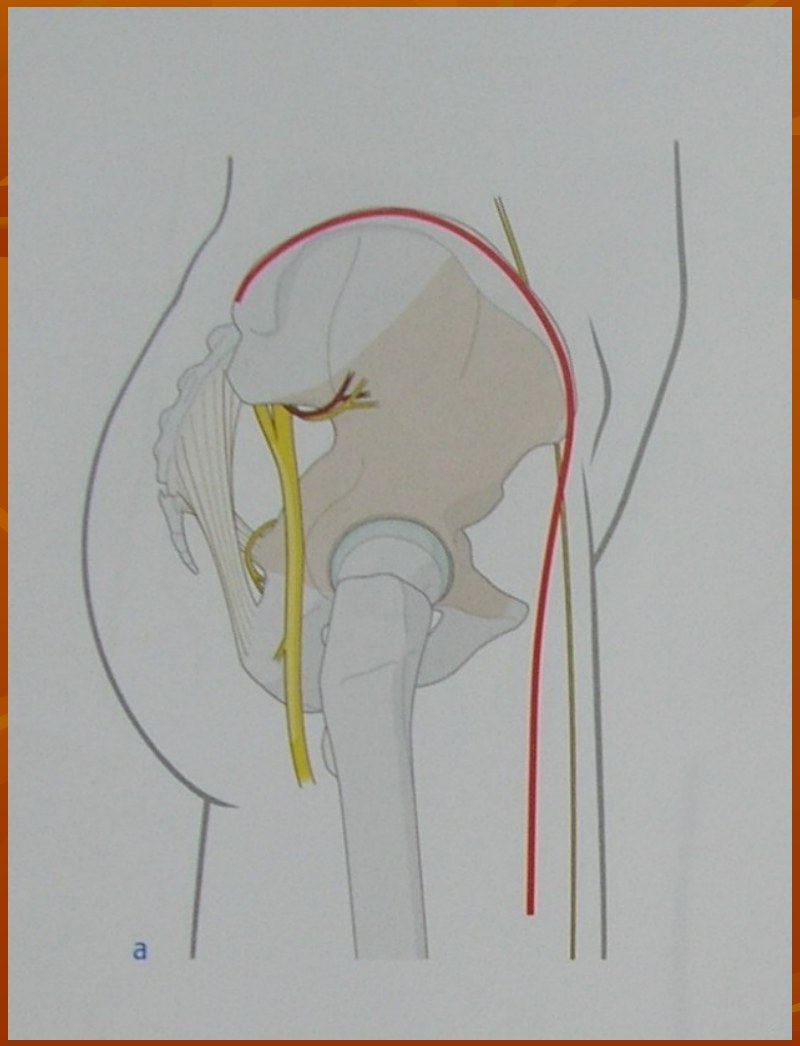


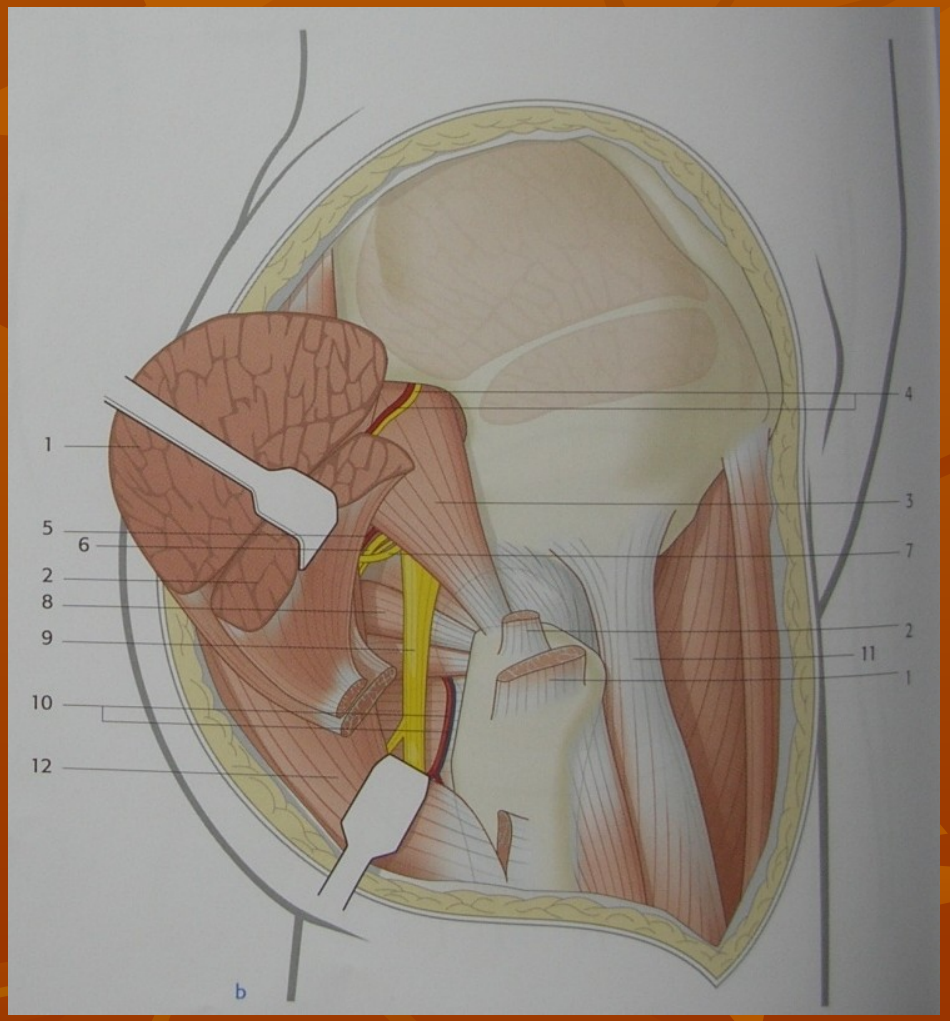
- Stoppa





- Extended iliofemoral





Posterior Wall

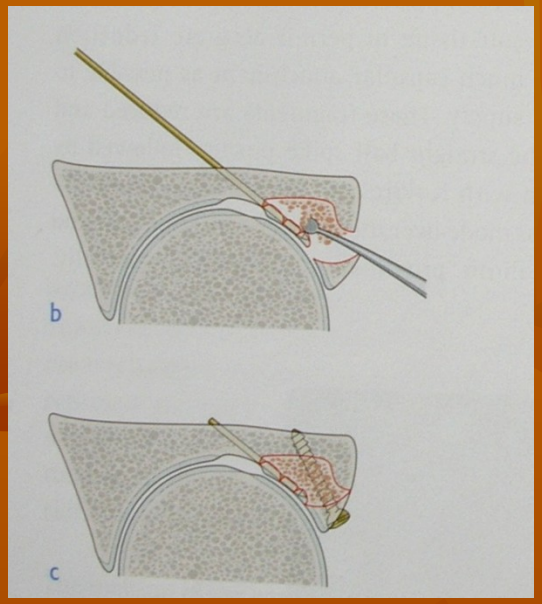
- Common
- Association with posterior hip dislocation
- the joint congruency, any subluxation, or loose fragment
- Fix any sizable fragment with Kocher-Langenbeck approach
- Fixation involves the use of screws or buttress plate

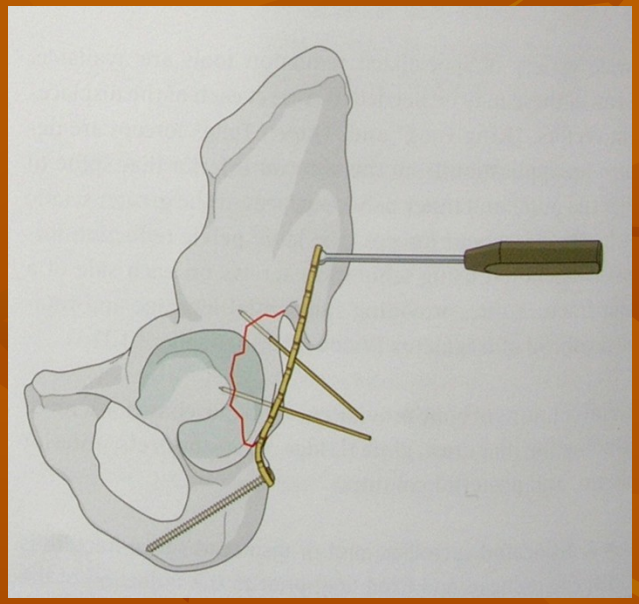
Posterior Column

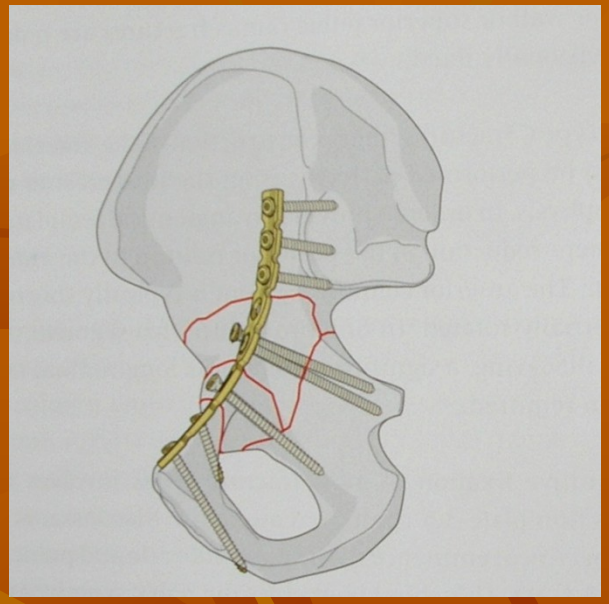
- Ensure ruling out of injury/bleeding from superior gluteal artery in
- those fractures that exit at the greater sciatic notch
- Fixation may consider the use of a buttress plate. Kocher-Langenbeck approach recommended

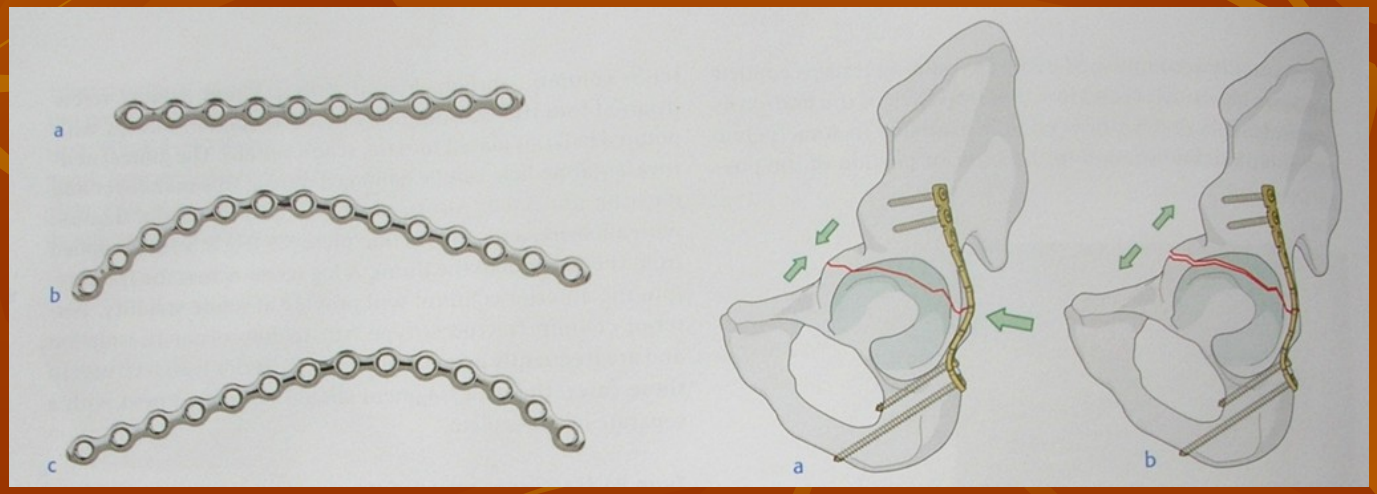
Anterior Wall

- Significantly rarer than posterior wall fractures
- Ilio-inguinal approach
- Fix with reconstruction plate


b
c






a
b
c
a
b

Anterior Column

- Ilio-inguinal approach
- Fix with reconstruction plate

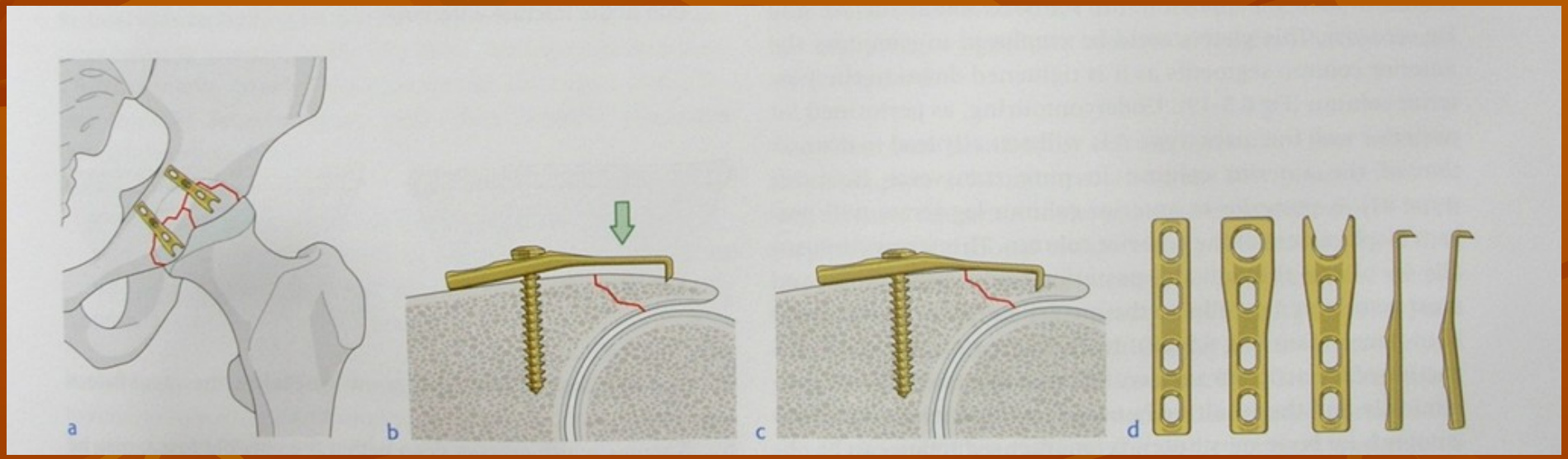
Transverse Fractures

- Posterior approach if displacement mainly
- posterior or anterior fracture that is relatively undisplaced
- Anterior approach if displacement mainly anterior
- or posterior fracture that is relatively undisplaced
- Complex cases or delayed presentation: combined or extensile approach

T-fractures

- Can be thought of as a transverse fracture with a vertical limb
- Difficult to reduce and fix, may sometimes use cerclage as temporary
- fixation or as adjunctive definitive fixation
- Most need extended iliofemoral approach or triradiate approach

- Hook plate



Posterior Column and Posterior Wall

- Kocher-Langenbeck approach
- In cases of combined posterior column and posterior wall fractures,
- fix the posterior column first

Transverse and Posterior Wall

- Kocher-Langenbeck approach
- Fix the transverse component first

Anterior Column and Posterior Hemi-transverse

- Mostly use ilio-inguinal approach
- Anterior column fixation by buttress plate and screw
- Sometimes posterior column lag screw can be inserted via the ilioinguinal Approach

- ***Double Column Fractures***
- In the occasional case the ilio-inguinal approach alone may suffice
- if posterior wall intact and posterior column is a big piece whereby
- application of lag screw ± cerclage (Fig. 11.10) from the anterior approach
- is feasible after fixation of the anterior column has been performed

- ***Complications of Fractured Acetabulum***

General:

DVT/PE, unstable haemodynamics from associated injuries like fractured pelvis

Local complications:

Neurologic Deficits

Example: sciatic nerve palsy

Most common present as foot drop

Cartilage Defects ± *Later OA*

Heterotopic Ossification

Higher association with surgical approaches that involve extensive surgical dissection

AVN Hip

Can occur after hip dislocation/subluxation

Although immediate reduction of the hip decreases AVN risk, the patient is at risk for up to 5 years after the injury

Effect of AVN – depends on site and size