

Pelvic Fractures

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Agenda

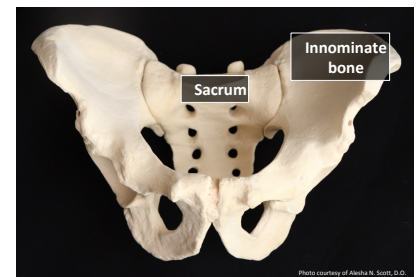
- Pelvic Anatomy
- Mechanisms of Pelvic Fractures
- Epidemiology
- Early Management/Associated Injuries
- Surgical Management
- Bringing it all together: Cases
- Questions

Pelvic Ring Anatomy

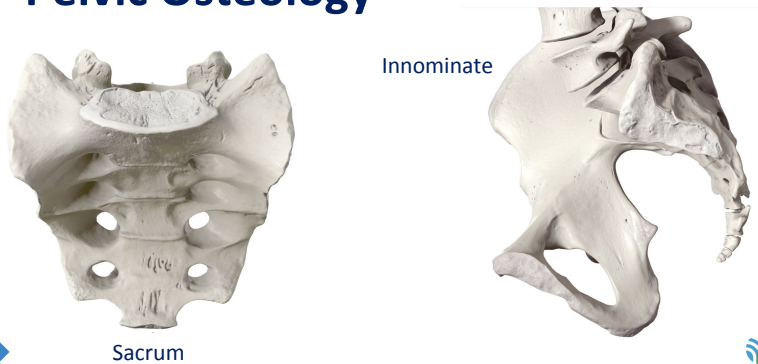
- Osteology
- Ligamentous
- Muscular
- Neurovascular

Pelvic Osteology

- 3 bones
 - Innominate bones x2
 - Sacrum



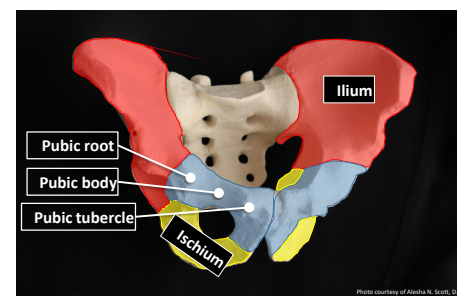
Pelvic Osteology



Pelvic Osteology

Innominate Bone

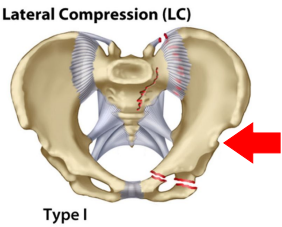
- Ilium
 - Pubic root
 - Pubic body
 - Pubic tubercle
- Ischium



Mechanism of Pelvic Ring Injury

- 3 main biomechanical mechanisms
 - Lateral Compression (internal rotation of hemipelvis)
 - Anterior Posterior Compression (external rotation of hemipelvis)
 - Vertical Shear (hemipelvis moves cranial)

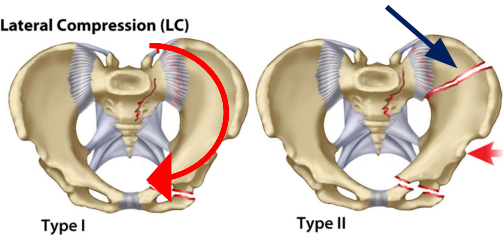
Mechanism of Pelvic Ring Injury



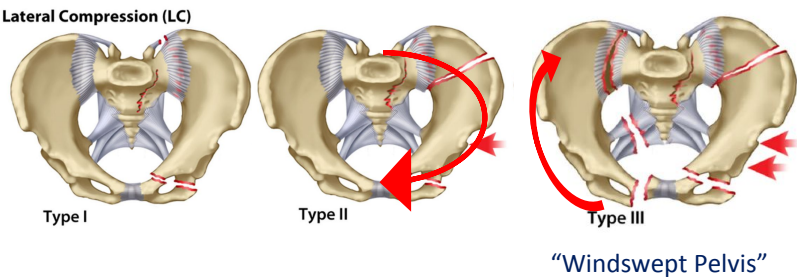
*Burgess AR, Eastridge BJ, Young JW, Ellison TS, Ellison PS Jr, Poka A, Bathon GH, Brumback RJ (1990). "Pelvic ring disruptions: effective classification system and treatment protocols". *J Trauma* 30 (7): 848-56.



Mechanism of Pelvic Ring Injury



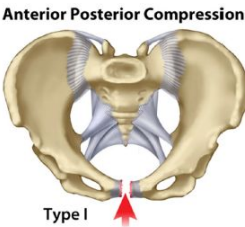
Mechanism of Pelvic Ring Injury



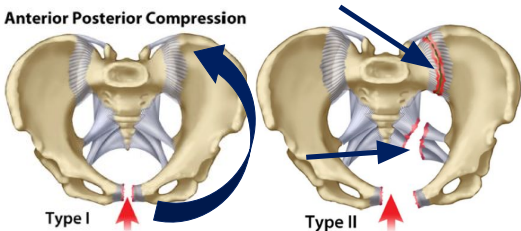
*Burgess AR, Eastridge BJ, Young JW, Ellison TS, Ellison PS Jr, Poka A, Bathon GH, Brumback RJ (1990). "Pelvic ring disruptions: effective classification system and treatment protocols". *J Trauma* 30 (7): 848-56.



Mechanism of Pelvic Ring Injury



Mechanism of Pelvic Ring Injury

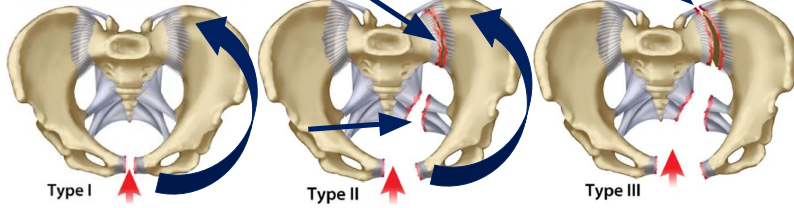


*Burgess AR, Eastridge BJ, Young JW, Ellison TS, Ellison PS Jr, Poka A, Bathon GH, Brumback RJ (1990). "Pelvic ring disruptions: effective classification system and treatment protocols". *J Trauma* 30 (7): 848-56.



Mechanism of Pelvic Ring Injury

Anterior Posterior Compression

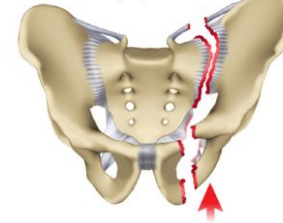


“Open Book”

*Burgess AR, Eastridge BJ, Young JW, Ellison TS, Ellison PS Jr, Poka A, Bathon GH, Brumback RJ [1990]. “Pelvic ring disruptions: effective classification system and treatment protocols”. *J Trauma* 30 (7): 848-56.

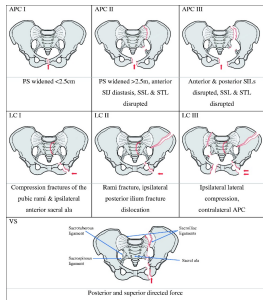
Mechanism of Pelvic Ring Injury

Vertical Shear (VS)



*Burgess AR, Eastridge BJ, Young JW, Ellison TS, Ellison PS Jr, Poka A, Bathon GH, Brumback RJ [1990]. “Pelvic ring disruptions: effective classification system and treatment protocols”. *J Trauma* 30 (7): 848-56.

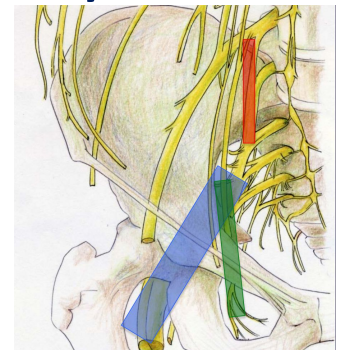
Young and Burgess Classification



Type of Injury	Figure	Morphologic Characteristics	Stability
Lateral compression	...	Transverse overlapping obturator ring fractures	Head injury, direct vascular, pelvic, and bladder injuries
1	8a	Sacral impaction (buckle), intact ligaments	Stable
2	8b	Disc crescent fracture	Rotationally unstable, vertically stable
3	8c	Lateral compression type 1 or 2 on one side and AP compression injury on the opposite side	Globally unstable
AP compression	...	Distraction of pubic symphysis without anterior fracture	Substantial hemorrhage
1	8d	Less than 2.5 cm pubic diastasis	Stable
2	8e	More than 2.5 cm pubic diastasis, widening of anterior SI joint	Rotationally unstable, vertically stable
3	8f	Often more than 5 cm pubic diastasis, widening of both anterior and posterior SI joints	Globally unstable
Vertical shear	8g	Vertical displacement of hemipelvis, fracture of pubis and SI joint	Visceral injuries, unstable
Combined	...	Complex fracture with combined elements of AP compression, lateral compression, or vertical shear	Variable

Neural Pelvic Anatomy

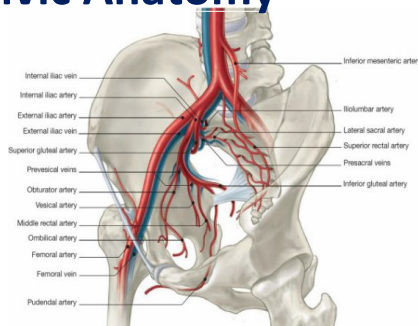
- **L4/L5 nerve roots**
 - Courses over anterior sacrum
- **Sciatic Nerve**
 - Exits through greater sciatic notch
- **Obturator nerve**
 - Exits out lateral aspect of obturator foramen
- **Femoral Nerve**



Vascular Pelvic Anatomy

Bleeding

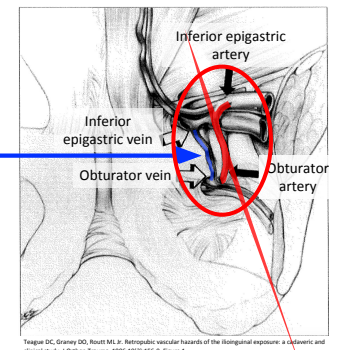
- Venous
- Arterial
 - Internal Iliac System
 - External Iliac System



Vascular Pelvic Anatomy

Retropubic anatomy

- **Small caliber anastomosis** between obturator and external iliac/inferior epigastric systems are common (~70%)
 - Average of 6.2cm lateral to the symphysis
- In small percentage, obturator artery can be of large caliber and originate from inferior epigastric or external iliac
 - “Corona mortis”

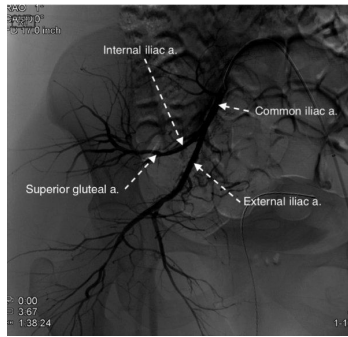


Tenquer DC, Grimes DS, Routh ML Jr. Retropubic vascular hazards of the ilioinguinal exposure: a cadaveric and clinical study. *J Orthop Trauma*. 1996;10(1):135-9. Figure 1.

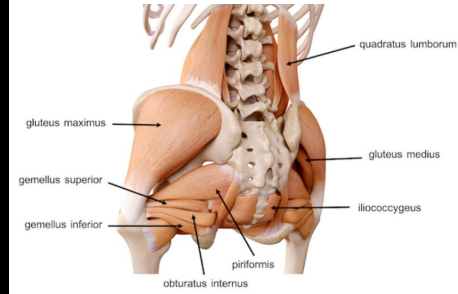
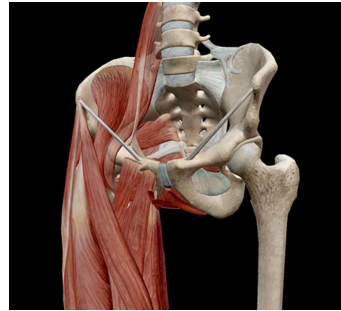
Vascular Pelvic Anatomy

Common iliac system

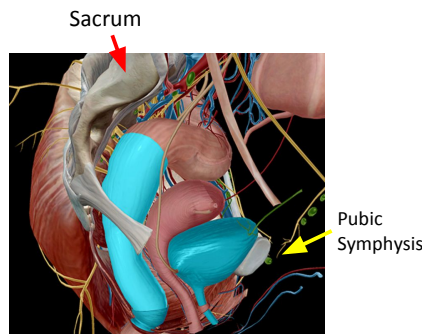
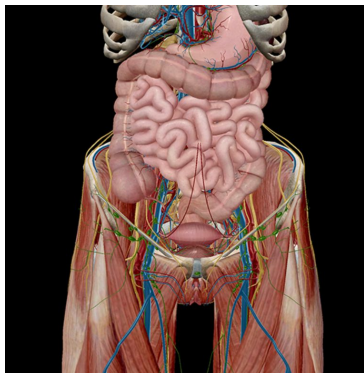
- External iliac artery
- Internal iliac artery
- Sacral venous plexus
 - Majority of the hemorrhage following pelvic ring injuries



Muscular Pelvic Anatomy



Animesh Agarwal. Pelvic Ring Injuries. In: Tometta P, Ricci WM, eds. Rockwood and Green's Fractures in Adults, 9e. Philadelphia, PA: Wolters Kluwer Health; Inc; 2019. Figure 49-28.



Epidemiology



Epidemiology

- Historically younger patients
- High energy
- Often polytrauma
 - Bones, anorectal, urogenital, soft tissue, head injuries
- MC High energy
 - MVA, MCC, Falls from large height

- Elderly (low energy populations)
 - Increasing, osteoporosis
 - 1990-2008
 - The proportion pts 56-75 undergoing surgery increased: 5.8% to 15%
 - Age >75: 13.6% to 39%
 - Avg Length of stay:
 - 1990: 11.2 days
 - 2008: 6.5 days

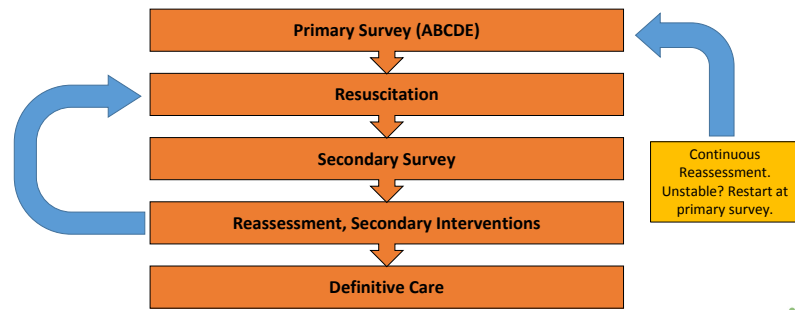
Epidemiology

- 10-20% Mortality (higher energy)
- In hospital mortality (US): 8.3% (declining)
 - MC Cause = hemorrhage (APC)
 - Closed Head Injury = LC
 - Increased Mortality:
 - Systolic <90
 - Age >60
 - Inc ISS/RTS
 - Need >4 units
 - Assoc Conditions:
 - Chest Injuries (63%)
 - Long Bone Fx (50%)
 - Sexual Dysfunction (50%)
 - Head/Abd Injuries (40%)
 - Spine Fx (25%)



Early Management/Associated Injuries

Principles of ATLS



Primary Survey – ABC, DE

- **A**irway with cervical spine protection
- **B**reathing – oxygenation and ventilation
- **C**irculation – including hemorrhage control
- **D**isability – neurologic status
- **E**xposure/Environment – expose patient, avoid hypothermia

Physical Exam



- Assess pelvic stability manually (once)
- Contusions, ecchymoses, degloving injuries
- Open wounds around pelvis, groin, perineum
- Leg length inequality
- Blood at urethral meatus, rectum or vagina
- Scrotal edema
- Lower extremity neurologic deficits



Hemorrhage and Pelvic Fractures

- Control of pelvic bleeding is integral in the management of a trauma patient with pelvic fractures
- Arterial and venous structures at risk within the pelvis
 - Venous plexus most frequent source of hemorrhage
 - Mortality associated with arterial injury
- Some degree of hemorrhage expected from fractured bone

Shock (SBP<90) on presentation
Early transfusion requirements



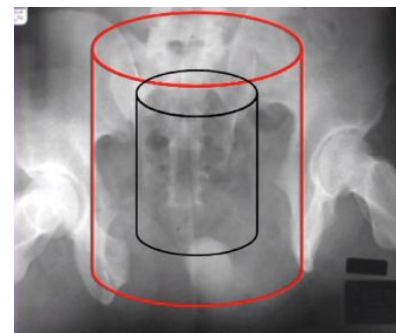
Increased Mortality

Hemorrhage and Pelvic Fractures

- An unstable pelvic injury may allow hemorrhage to collect in the true pelvis as there is no longer a constraint which allows tamponade.
- Cylinder: $\pi r^2 h$

Sources of blood loss

- Pre-sacral venous plexus
- Exposed cancellous bone
- Arterial extravasation



Hemorrhage and Pelvic Fractures

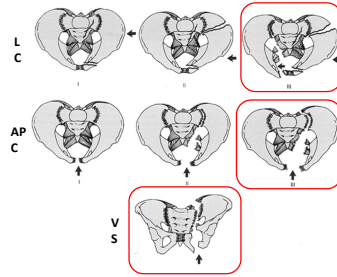
- Fracture pattern is associated with risk of hemorrhage + transfusion requirements

- Original Young and Burgess description:

- LC – 3.6 units
- APC – 14.8 units
- VS – 9.2 units
- Combine – 8.5 units

- Highest risk with LC III, APC II, APC III and VS

- Severe hemorrhage can occur in any pattern



Hemorrhage Control

- Pelvic Containment

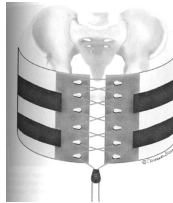
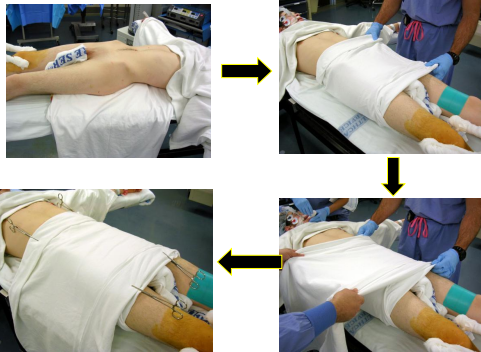
- Binder, Sheet, External Fixation, C-clamp, Internal Fixation

- Angiography with embolization

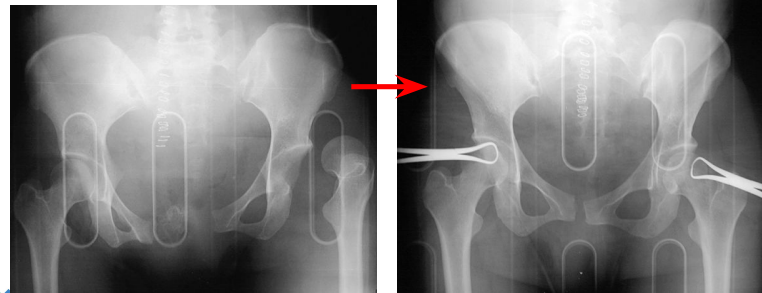
- Laparotomy with pelvic packing

Pelvic Sheet/Binder

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



Pelvic Sheet/Binder



Pelvic Sheet/Binder

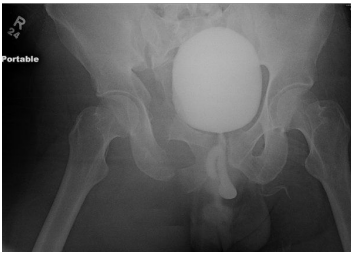


Taping lower extremities

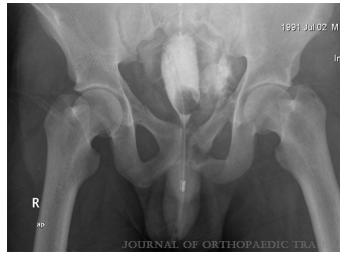
Another method for stabilizing the pelvis and decreasing pelvic volume



Urologic Injury



A. Proximal urethral disruption seen by contrast extravasation over the perineum



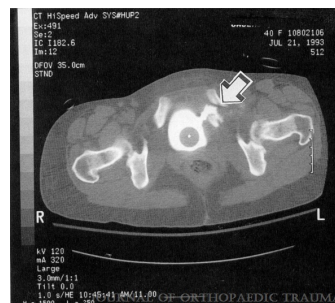
B. Cystogram showing bladder rupture with contrast extravasation

Urologic Injury

- Bladder rupture
 - Intraperitoneal = Ex-Lap and repair
 - Extraperitoneal = suprapubic catheter or direct repair. Must coordinate with urology for optimal catheter placement and/or repair in conjunction with definitive fixation
- Urethral injuries
 - Initial treatment with foley followed by delayed repair

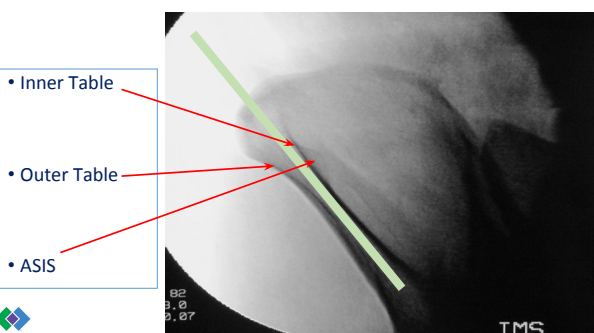
Urologic Injury

- CT cystogram with arrow indicating bladder entrapment within ramus fracture and contrast extravasation.



Surgical Management

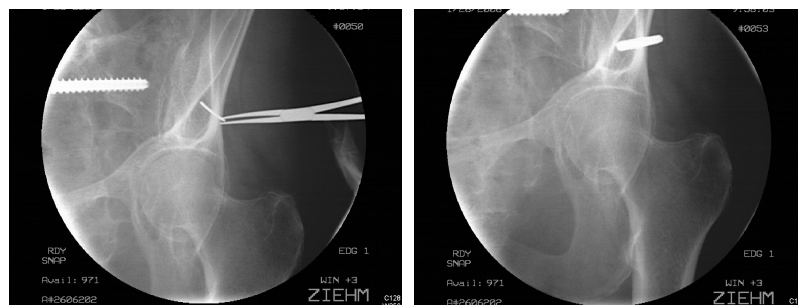
External Fixator Placement: ASIS Technique



Outlet Oblique View

Courtesy of Sean Nark, MD

External Fixator Placement: AIIS Technique



Outlet Obturator Oblique

Images courtesy of Sean Nark, MD

ORIF Anterior Pelvic Ring Injuries

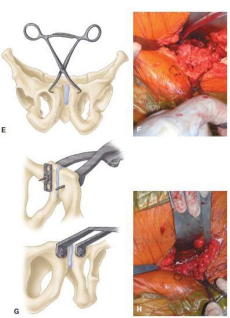
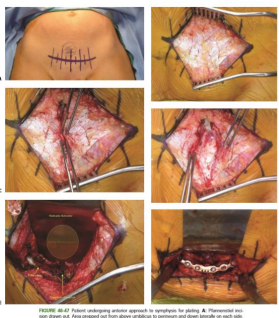
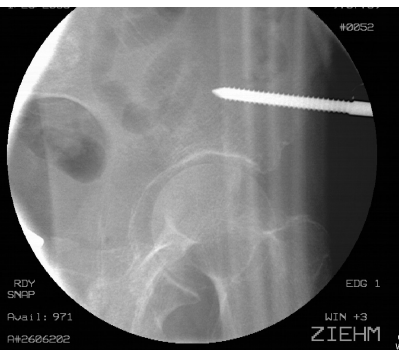


FIGURE 46-54 Patient undergoing anterior approach to symphysis for plating. A: Preoperative anteroposterior view of the pelvis showing the approach. B: Intraoperative view of the approach. C: Intraoperative view of the approach. D: Intraoperative view of the approach. E: Intraoperative view of the approach. F: Intraoperative view of the approach.



Iliac Oblique



Obturator Inlet Oblique

Images courtesy of Sean Nark, MD

ORIF Anterior Pelvic Ring Injuries

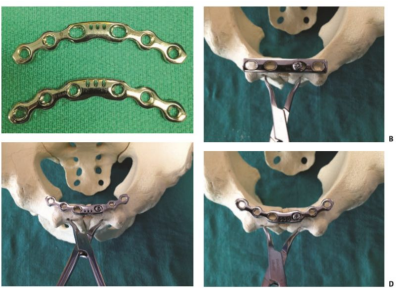


FIGURE 46-54 Photographs of symphyseal specific designed plates. A: Top with oblong holes centrally and locking holes peripherally, bottom plate with all locking holes. B & C: Representation of plate applications superiorly with CMF clamp holding reduction (B), old style four-hole plate. C, oblique symphyseal plate. D, locking symphyseal plate.

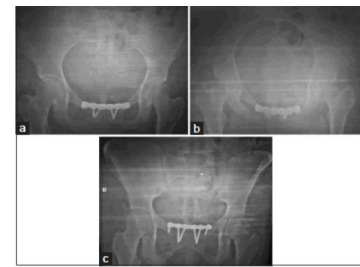
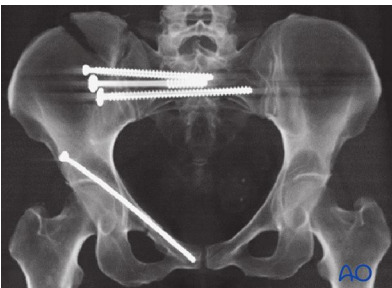
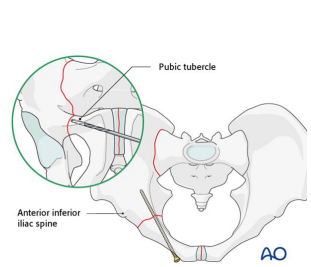


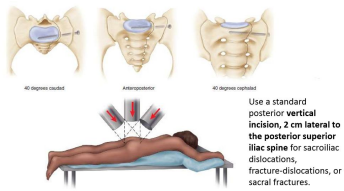
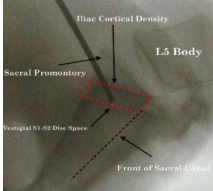
Figure 3: Anteroposterior (a), inlet (b), and outlet (c) views of the pelvis how pubic symphysis reduction with internal fixation using small fragment reconstruction plate and screws. The plate was placed over

Percutaneous Fixation of Anterior Pelvis



Percutaneous Sacral Fixation

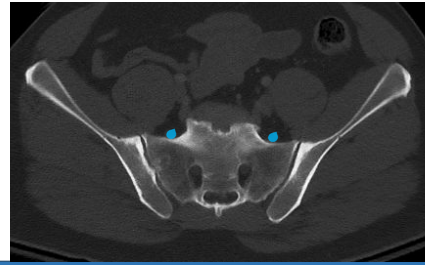
- Patient supine
- Closed reduction achieved via pelvic compression
- Entry point determined
 - Should aim anterior in S1 & inferior to the iliac cortical density

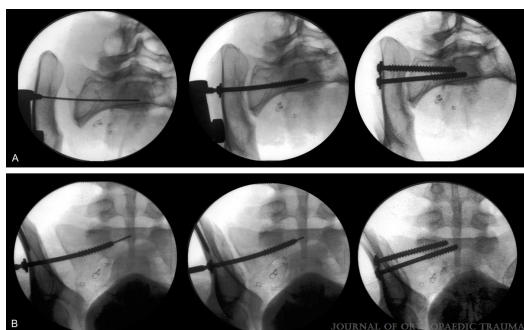


Use a standard posterior vertical incision, 2 cm lateral to the posterior superior iliac spine for sacroiliac dislocations, fracture-dislocations, or sacral fractures.

Neural Pelvic Anatomy

- L5 nerve root at risk with percutaneous iliosacral screw placement
 - 2cm medial to the S1 joint



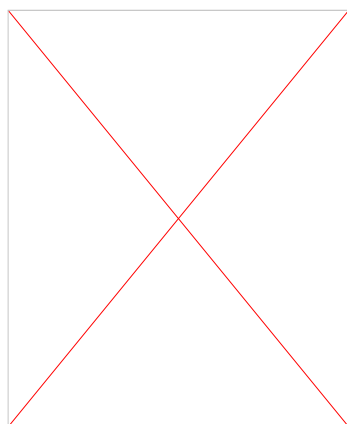


The patient underwent antishock iliosacral screw procedure to reduce wide sacroiliac diastasis, as seen on pelvic inlet view (row A) and pelvic outlet view (row B). Starting points and orientations of two screws were planned to allow balanced reduction of sacroiliac joint and safe screw placement.

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Bringing it together: Cases

Questions?



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