



TREATMENT OF VICTIMS WITH UNSTABLE INJURIES, PELVIC RING INJURIES

THE LECTURER – ANTWI ALBERT (1751)

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PLAN OF THE LECTURE

Introduction (Anatomy)

Epidemiology

Classification

Risk Factors

Treatment (Non-Operative and Operative)

Complications

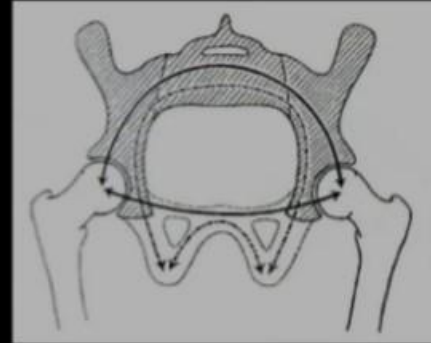
References



Anatomy

Ring structure of the pelvis

- The pelvis is a true ring structure.
- It is self-evident that if the ring is broken in one area and displaced, then there must be a fracture or dislocation in another portion of the ring.



Pelvic Stability

- Definition of pelvic stability:
 - The ability of the pelvis to withstand physiological forces without significant displacement.
- An **unstable injury** may be characterized by the type of displacement as:
 - **Rotationally unstable** (open and externally rotated, or compressed and internally rotated).
 - **Vertically unstable**

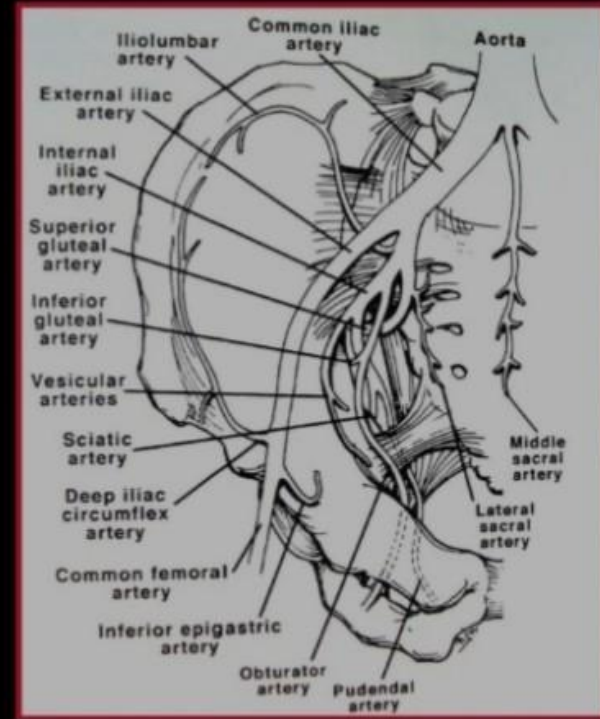
Pelvic Stability

- The pelvic bones themselves have **no inherent stability** and therefore the integrity of the ligamentous structures is crucial to the preservation or the loss of stability.
- If the ligamentous structures are removed, the pelvis falls into its 3 component parts.



Neurovascular structures

- The iliac arterial and venous trunks pass near the ventral aspect of the SI joints bilaterally.
- Disruption of the SI joints and associated ligaments increases the risk of vascular injury and resultant hemorrhage, which usually arises from the anterior and posterior divisions of the internal iliac vessels.



Pelvic Viscera

- The bladder and urethra are located immediately posterior to the pubic symphysis and the rectum lies immediately ventral to the sacrum.
- The intimate association of these viscera with the pelvic skeleton increases the risk of injury when pelvic fracture occurs.

Epidemiology

- The overall incidence of pelvic ring injuries is estimated at about 3% of all fractures (*AO*).
 - Among the polytrauma patients, the incidence has risen to 25%.

Epidemiology

- **Severity of fracture depends on mechanism of injury**
 - **Minor pelvic fractures** (fractures of individual bones or single breaks in the pelvic ring; lower energy) – elderly patients after simple falls
 - **Complex pelvic fractures** (higher energy) – younger patients, M:F = 3:1
- Severe pelvic injury usually due to high-velocity MVA, industrial accidents, falls off a significant distance

Classification of Pelvic Fractures

- Classification of pelvic fractures and dislocations requires adequate plain radiography (AP, inlet, and outlet x-rays) and thin-cut (3-mm) CT scanning.

Tile's classification ¹⁸	Young and Burgess classification ²⁹
<p>Type A, Stable A1, Without involvement of pelvic ring A2, With involvement of pelvic ring</p> <p>Type B, Rotationally unstable B1, Open book B2, Ipsilateral lateral compression B3, Contralateral lateral compression</p> <p>Type C, Rotationally and vertically unstable C1, Rotationally and vertically unstable C2, Bilateral C3, With associated acetabular fracture</p>	<p>Lateral compression (LC) I, Sacral compression on side of impact II, Iliac wing fracture on side of impact III, LCI or LCII injury on side of impact with contralateral open-book injury</p> <p>Anterior posterior compression (APC) I, Slight widening of pubic symphysis or anterior part of sacroiliac joint with intact anterior and posterior sacroiliac ligaments II, Widened anterior part of sacroiliac joint with disrupted anterior and intact posterior sacroiliac ligaments III, Complete disruption of sacroiliac joint</p> <p>Vertical shear (VS) Vertical displacement anteriorly and posteriorly</p> <p>Combined mechanism (CM) Combination of other injury patterns</p>

Classification

Young and Burgess

- This system is based on the mechanism of injury:
 - Lateral Compression (LC)
 - AP Compression (APC)
 - Vertical Shear (VS)
 - Combined Mechanism (CM)

Classification

Young and Burgess

Lateral Compression (LC)

- Transverse fracture of pubic rami, ipsilateral or contralateral to posterior injury
 - LC-I: **Sacral compression on side of impact** (Stable because ligaments remain intact)
 - LC-II: **Crescent (iliac wing) fracture on side of impact**. Lateral force delivered more anteriorly than the LC-I pattern
 - LC-III: LC-I or LC-II injury on side of impact; **contralateral open-book (APC) injury**



Classification

Young and Burgess

AP Compression (APC)

- Symphyseal diastasis or longitudinal rami fractures
 - APC-I: Slight widening of symphysis (<2.5 cm), but the posterior pelvic ligaments are intact
 - APC-II: Widening of the symphysis > 2.5 cm with anterior opening of the sacroiliac joint. The posterior sacroiliac ligaments are intact, but the anterior sacroiliac, sacrotuberous, and sacrospinous ligaments are torn
 - APC-III: Complete disruption of the ipsilateral ligaments, including the posterior sacroiliac ligaments, which results in rotational and vertical instability of the hemipelvis.



Classification

Young and Burgess

Vertical Shear (VS)

- Vertically applied forces caused by falls onto an extended lower extremity, impacts from above, or MVA with an extended lower extremity against the floorboard or dashboard.
- Typically associated with complete disruption of the symphysis, sacrotuberous, sacrospinous, and sacroiliac ligaments and result in extreme instability.
- Highly associated with neurovascular injury and hemorrhage.



Classification
Young and Burgess
Combined Mechanisms (CM)

- Combination of other injury patterns, LC/VS being the most common.



Classification

Tile

- This classification combines a patient's mechanism of injury and pelvic stability.
- It classifies pelvic fractures into 3 groups:
 - Type A: Stable fractures
 - Type B: Rotationally unstable, vertically stable
 - Type C: Rotationally and vertically unstable (i.e. complete disruption of the anterior and posterior pelvic rings).

Tile classification of pelvic fractures

Type A: Pelvic ring stable

- a) A1: fractures not involving the ring (i.e. avulsions, iliac wing or crest fractures)
- b) A2: stable minimally displaced fractures of the pelvic ring

Type B: Pelvic ring rotationally unstable, vertically stable

- a) B1: open book
- b) B2: lateral compression, ipsilateral
- c) B3: lateral compression, contralateral or bucket handle–type injury

Type C: Pelvic ring rotationally and vertically unstable

- a) C1: unilateral
- b) C2: bilateral
- c) C3: associated with acetabular fracture

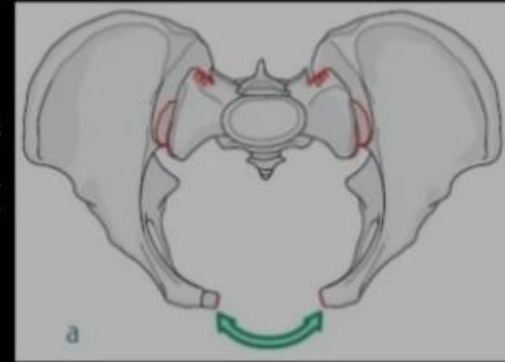
Classification

Tile

Type B

Rotationally unstable, vertically stable

- **B1:** External rotation instability; open-book injury
- **B2:** LC injury affecting only one side of the pelvis, ipsilateral anterior and posterior ring involvement with instability in internal rotation
- **B3:** LC injury affecting both sides of the pelvis; bilateral rotational instability ('bucket handle' fracture)



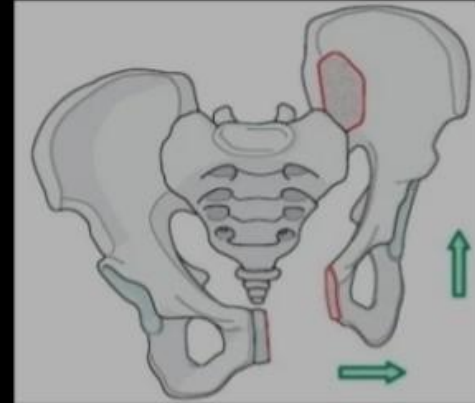
Classification

Tile

Type C

Rotationally and vertically unstable

- **C1: Ipsilateral** anterior and posterior injury resulting in rotational and vertical instability of the hemipelvis
- **C2: Bilateral** injury resulting in rotational instability on one side and vertical instability on the other side
- **C3:** Bilateral pelvic injury in which both sides are rotationally and vertically unstable with an associated acetabular fracture



Factors increasing mortality

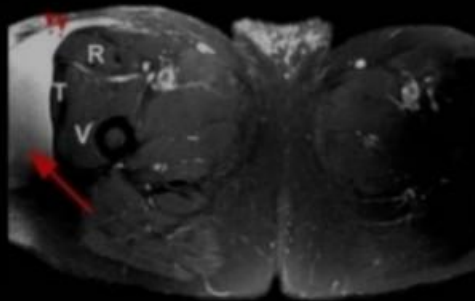
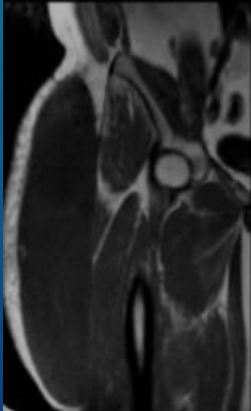
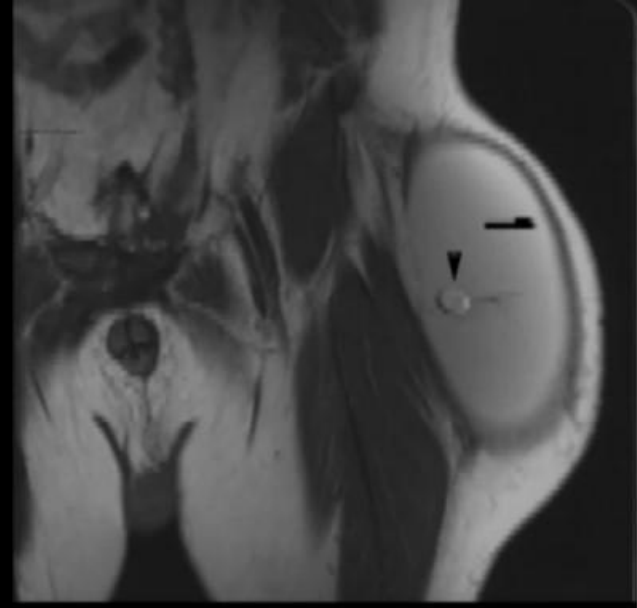
- Type of pelvic ring injury: Posterior disruption is associated with higher mortality (APC III, VS, LC III)
- High Injury Severity Score
- Associated injuries: Head and abdominal, 50% mortality
- Hemorrhagic shock on admission
- Requirement for large quantities of blood
- Perineal lacerations, open fractures
- Increased age

Morel-Lavallé lesion (Skin Degloving Injury)

- A Morel-Lavallée lesion is a closed degloving injury associated with severe trauma to the pelvis.
- It presents as a hemolymphatic mass located over the external aspect of the thigh.
- Since Morel-Lavallée first described the lesion in the 19th century, the term has been used to describe similar lesions in other anatomic sites such as the lumbar area and over the scapula.

Morel-Lavallé lesion (Skin Degloving Injury)

- Infected in one-third of cases
- Requires thorough debridement before definitive surgery



Open pelvic fractures

- Open pelvic fractures occur when there is communication between a fracture fragment and the skin or a pelvic visceral cavity.
- These injuries are observed in 4-5% of patients with pelvic fracture.
- The incidences of pelvic infection including soft tissue infection and osteomyelitis, as well as high mortality and long-term disability, are raised in patients with open pelvic fracture.

TREATMENT

Decision making

- Decision making can be divided into 2 phases:
 - Detection and treatment of life-threatening situations (Emergency algorithm)
 - Diagnosis and detailed classification of the osteoligamentous injury and operative planning and surgery, if required.

Decision making

- Possible posterior ring injuries are iliac wing fractures, SI dislocations, and sacral fractures.
- Possible anterior ring injuries are rami fractures and symphyseal disruptions.
 - Pelvic injuries can include any combination of anterior and posterior injuries, unilateral or bilateral.

Non-operative Treatment

- Fractures amenable to nonoperative treatment include:
 - Lateral impaction injuries with minimal (<1.5 cm) displacement.
 - Pubic rami fractures with no posterior displacement.
 - Gapping of pubic symphysis <2.5 cm.

Non-operative Treatment

- Rehabilitation:
 - Protect weight bearing typically with a walker or crutches initially.
 - Serial radiographs are required after mobilization has begun to monitor for subsequent displacement.
 - If displacement of the posterior ring >1 cm is noted, weight bearing should be stopped. Operative treatment should be considered for gross displacement.

Principles of Definitive Fixation of Pelvic Fractures

1. With complete instability of the posterior ring (i.e., the posterior SI ligaments are disrupted), anterior fixation alone is inadequate.
2. With complete instability of the posterior ring and vertical instability, any posterior fixation should be supplemented with some form of anterior stabilization.
3. With partial instability of the pelvic ring (i.e., the posterior SI ligaments are intact), anterior fixation alone is adequate and full weight-bearing may be permitted.

Definitive Fixation of Pelvic Fractures

Disruptions of the Pubic Symphysis

- Options for stabilizing symphyseal disruptions:
 - Anterior external fixators
 - Internal fixation with plate and screws

Definitive Fixation of Pelvic Fractures

Disruptions of the Pubic Symphysis

- Advantages of external fixations:
 - They can be easily applied to pubic rami fractures as well as symphysis disruption
 - They can be applied in the emergency room, ICU, or operating room.
 - External fixators can be applied when contamination from abdominal and genitourinary injuries makes internal fixation approaches hazardous.
 - External fixation devices can be removed in the clinic or office setting.
- Disadvantages of external fixation:
 - Interference with positioning, sitting, and clothing.
 - Pin site care and infection can be problematic, particularly with obese patients.
 - It is more difficult to obtain and maintain an anatomic reduction of the anterior pelvic ring with external fixation devices.

Definitive Fixation of Pelvic Fractures

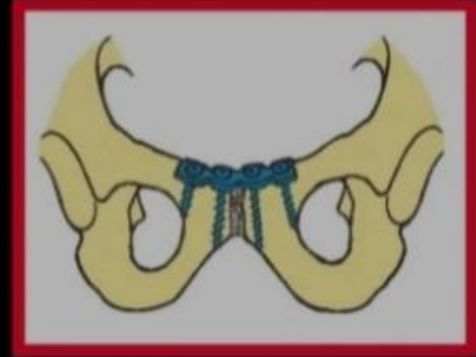
Disruptions of the Pubic Symphysis

- **Advantages of Internal Fixation:**
 - Absence of interference with positioning, sitting, or with clothing
 - No attendant problems of pin site care.
- **Disadvantages of Internal Fixation:**
 - It cannot be employed when there is contamination of the operative field
 - Formal reoperation is necessary if the fixation hardware must be removed
 - Internal fixation potentially limits pelvic relaxation in women during childbirth.

Definitive Fixation of Pelvic Fractures

Disruptions of the Pubic Symphysis

- Fixation options are essentially the same for pubic ramus fractures as for pubic symphysis diastasis.
 - However, internal fixation with plating does not carry the same long-term obstetrical or hardware failure sequelae.



Definitive Fixation of Pelvic Fractures

Fixation of Posterior Pelvic Fractures

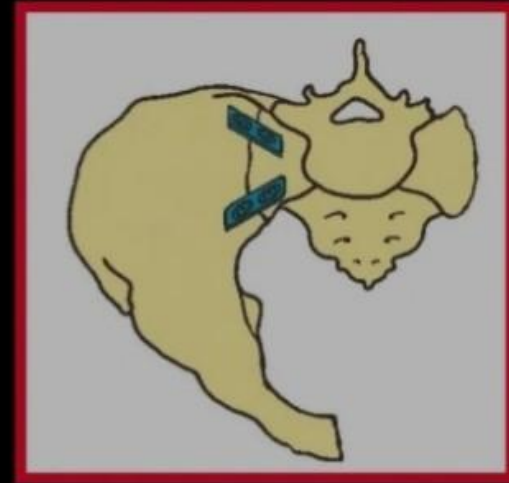
- Usually, a single pelvic reconstruction plate or lag screw along the crest supplemented with a second reconstruction plate or lag screw at the level of the pelvic brim or sciatic buttress will suffice in neutralizing deforming forces until healing has occurred.



Definitive Fixation of Pelvic Fractures

Fixation of Posterior Pelvic Fractures

- SI joint fixation options include:
 - iliosacral screws
 - anterior SI plating
 - posterior trans-iliac plating or compression rods



Treatment according to Tile Classification

Type A Stable

- **A1:** Fractures of the pelvis not involving the ring; avulsion injuries
- **A2:** Non-displaced or minimally displaced pelvic ring fracture (eg, superior & inferior pubic ramus fracture)
- **A3:** Transverse fractures of the inferior sacrum or coccyx with no disruption of the pelvic ring

Stable, minimally displaced fractures with minimal disruption of the bony and ligamentous stability of the pelvic ring may successfully be treated with **protected weight bearing** and **symptomatic treatment**.

Treatment according to Tile Classification

Type A Stable

- Virtually all type A fracture can be managed symptomatically with the following exceptions.
 - Avulsion fractures (A1) of the iliac crest, esp. in young athletes, can be fixed with lag screws if widely displaced.
 - Fractures of the iliac wing with wide displacement (A2) *may* be fixed with standard techniques, especially in young women, as this injury can leave a malalignment of the iliac crest.
 - Transverse sacral fractures (A3) should be considered spinal injuries; therefore, with wide displacement and a sacral plexus neurological deficit, reduction with or without decompression is usually required.

Treatment according to Tile Classification

Type B

Rotationally unstable, vertically stable

- **B1:** External rotation instability; open-book injury
- **B2:** LC injury affecting only one side of the pelvis, ipsilateral anterior and posterior ring involvement with instability in internal rotation
- **B3:** LC injury affecting both sides of the pelvis; bilateral rotational instability ('bucket handle' fracture)
- **B1:**
 - Symphyseal diastasis <2.5 cm: Protected weightbearing & symptomatic treatment.
 - Symphyseal diastasis >2.5 cm: Ext fixation or symphyseal plate is performed (ORIF preferred if laparotomy for associated injuries and no open injury), with possible fixation for the posterior injury.
- **B2:** Elastic recoil may improve pelvic anatomy. No stabilization is necessary
- **B3 (bucket handle):** The posterior sacral complex is commonly compressed.
 - Leg-length discrepancy <1.5 cm: No stabilization is necessary.
 - Leg-length discrepancy >1.5 cm: External fixation? ORIF?

Treatment according to Tile Classification

Type C

Rotationally and vertically unstable

- **C1: Ipsilateral** anterior and posterior injury resulting in rotational and vertical instability of the hemipelvis
- **C2: Bilateral** injury resulting in rotational instability on one side and vertical instability on the other side
- **C3:** Bilateral pelvic injury in which both sides are rotationally and vertically unstable with an associated acetabular fracture
- **C1, C2, C3:** External fixation \pm skeletal traction *and* ORIF are options.

Treatment according to Young & Burgess Classification

LC

- **LC-I: Sacral compression on side of impact** (Stable)
- **LC-II: Crescent (iliac wing) fracture on side of impact.** Lateral force delivered more anteriorly than the LC-I pattern
- **LC-III: LC-I or LC-II injury on side of impact; contralateral open-book (APC) injury**
- **LC-I: Protected weight bearing on the side of the posterior ring injury.** Repeat x-rays 2-5 days after injury
- **LC-II: Anterior and posterior fixation**
- **LC-III: Anterior and posterior fixation**

Treatment according to Young & Burgess Classification

APC

- Symphyseal diastasis or longitudinal rami fractures
 - APC-I: Slight widening of symphysis (<2.5 cm), posterior ligaments intact
 - APC-II: Widening of symphysis > 2.5 cm with anterior opening of sacroiliac joint. The posterior sacroiliac ligaments are intact, but the anterior sacroiliac, sacrotuberous, and sacrospinous ligaments are torn
 - APC-III: Complete disruption of the ipsilateral ligaments, including the posterior sacroiliac ligaments, which results in rotational and vertical instability of the hemipelvis.
- APC-I: Symptomatic management only
- APC-II: ORIF
- APC-III: Control haemorrhage by fracture reduction and stabilization with external fixation. posterior percutaneous iliosacral screws, either acutely or on a delayed basis depending on the patient's physiologic status

Treatment according to Young & Burgess Classification

VS

- Symphyseal diastasis or vertical displacement anteriorly and posteriorly, usually through the SI joint, occasionally through the iliac wing or sacrum.

Depends on the posterior fracture location. Reduction with traction, percutaneous iliosacral screw fixation, and anterior stabilization (ORIF or external fixation).

Operative Techniques

External Fixation

- This can be applied as:
 - a construct mounted on 2-3 5-mm pins spaced 1 cm apart along the anterior iliac crest, or
 - single pins placed in the supraacetabular area in an AP direction (Hanover frame).
- External fixation is a *resuscitative* fixation and can only be used for definitive fixation of anterior pelvis injuries.
 - It cannot be used as definitive fixation of posteriorly unstable injuries.

Internal Fixation

- This significantly increases the forces resisted by the pelvic ring compared with external fixation.

Internal Fixation

- **Iliac wing fractures:** Open reduction and stable internal fixation using lag screws and neutralization plates.

Internal Fixation

- **Diastasis of the pubic symphysis:** Plate fixation (if no open injury or cystostomy tube is present).
 - If the patient has a visceral injury necessitating a paramedian midline or Pfannenstiel incision, or if preferred by the surgeon to external fixation, internal fixation using a 4.5-mm plate will restore stability.
 - A single four-hole plate placed across the superior surface of the symphysis pubis is used.
 - This should be done *immediately after* the abdominal procedure prior to closure of the skin.

Internal Fixation

- **N.B.** Plates should not be used in the presence of fecal contamination or the proposed use of a suprapubic tube.
 - In that situation, external fixation is usually the safer and preferred option.

Internal Fixation

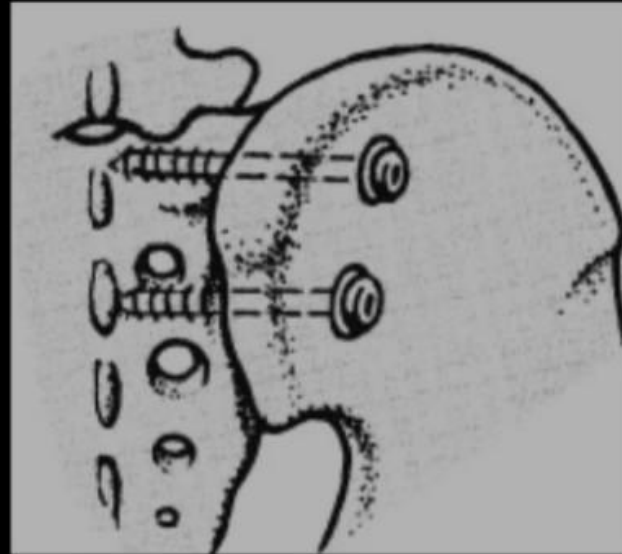
- **Sacral fractures:** Trans-iliac bar fixation may be inadequate or may cause compressive neurologic injury; in these cases, plate fixation or sacroiliac screw fixation may be indicated.



**Transiliac bar
posterior fixation**

Internal Fixation

- Unilateral sacroiliac dislocation: Direct fixation with cancellous screws or anterior sacroiliac plate fixation is used.



Internal Fixation

- **Bilateral posterior unstable disruptions:** Fixation of the displaced portion of the pelvis to the sacral body may be accomplished by posterior screw fixation.

Implants

Plates:

- Because of the difficulty in contouring the standard plates in the several directions required, the 3.5-mm and 4.5-mm reconstruction plates are recommended for pelvic fixation.
 - In general, the 3.5-mm plates are used on most women and smaller men, and the 4.5-mm plates on larger men.



Implants

Screws:

- The 3.5-mm fully threaded cancellous screws and the 6.5-mm fully threaded cancellous screws are essential components of the fixation system, as well as all the standard lag screws in the two sizes (4.0 mm and 6.5 mm).
- Screws of exceptional length, up to 120 mm, are required in the pelvis.

Implants

Instruments

- Since reduction of the pelvic fragments is the most difficult part of the operation, special pelvic clamps are essential.
- These include the pointed fracture reduction clamps and the large pelvic reduction clamps held in place with 2 screws.
- Other specialized pelvic reduction clamps are also available.

Post-operative Management

- Aggressive pulmonary toilet:
 - Incentive spirometry
 - Early mobilization
 - Encouraged deep inspirations and coughing
 - Suctioning or chest physical therapy if necessary.

Post-operative Management

- Prophylaxis against thromboembolic phenomena:
 - Combination of:
 - elastic stockings
 - sequential compression devices
 - chemoprophylaxis (if hemodynamic status allows)
 - Duplex ultrasound examinations may be necessary.
 - Thrombus formation may necessitate anticoagulation and/or IVC filter placement.

Post-operative Management

- Weight-bearing status may be advanced as follows:
 - Full weight bearing on the *uninvolved* lower extremity within several days.
 - Partial weight bearing on the *involved* lower extremity is recommended for at least 6 weeks.
 - Full weight bearing on the affected extremity without crutches is indicated by 12 weeks.
 - Patients with bilateral unstable pelvic fractures should be mobilized from bed to chair with aggressive pulmonary toilet until radiographic evidence of fracture healing is noted. Partial weight bearing on the less injured side is generally tolerated by 12 weeks.

Complications

- Infection:
 - Incidence is variable (0%-25%)
 - Presence of contusion or shear injuries to soft tissues is a risk factor for infection if a posterior approach is used.
 - This risk is minimized by a percutaneous posterior ring fixation.

Complications

- **Thromboembolism:** Disruption of the pelvic venous vasculature and immobilization constitute major risk factors for the development of DVT.

Complications

- **Malunion:** Significant disability may result, with complications including chronic pain, limb length inequalities, gait disturbances, sitting difficulties, low back pain, and pelvic outlet obstruction.

Complications

- Nonunion:
 - Rare, although it tends to occur more in younger patients (average age 35 years) with possible sequelae of pain, gait abnormalities, and nerve root compression or irritation.
 - Stable fixation and bone grafting are usually necessary for union.

REFERENCES

Britanica Encyclopedia

Wikipedia

WebMD

AIIMS Archives

THANK

YOU

