Understanding High-Energy Pelvic Fractures

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Table 1

Types of pelvic fractures

Instability-based

- Pennal/Tile:
  - A) Stable pelvic ring
    - A1: Avulsion fractures
    - A2: Iliac wing fractures
    - A3: Transverse sacral fissures
  - B) Partial instability
    - B1: Open book (external rotation)
    - B2: Lateral compression
    - B3: Bilateral injuries
  - C) Complete instability
    - C1: Unilateral
    - C2: Bilateral (unilateral complete, unilateral partial)
    - C3: Bilateral both complete
- Orthopedic Trauma Association:
  - 61A) Stable pelvic ring
    - A1: Avulsion fractures
    - A2: Iliac wing fractures
    - A3: Transverse sacral fractures
  - 61B) Partial instability
    - B1: Open book (external rotation)
    - B2: Lateral compression
    - B3: Bilateral injuries
  - 61C) Complete instability
    - C1: Unilateral
    - C2: Bilateral (unilateral complete, unilateral partial)
    - C3: Bilateral both complete

Mechanism-based

- Burgess and Young:
  - A) Anterior—posterior compression (APC 1-3)
    - APC 1: Stable
    - APC 2: Partial instability
    - APC 3: Complete instability
  - B) Lateral compression (LC 1-3)
    - LC 1: Stable impacted
    - LC 2: Posterior ring fracture without pelvic floor disruption
    - LC 3: Direct rollover
  - Vertical shear
  - Combined mechanism injury
    - Not classifiable

High-energy pelvic ring injuries represent a severe injury involving major disruption of the bony pelvis and the surrounding soft tissues. The mechanism of injury involves high-energy transfer, thus, these injuries rarely occur in isolation.

The management is often complex, involving fractures, soft tissues, neural element, major blood vessels and often urologic or bowel injuries.

There is no universally accepted classification system for pelvic injuries (Table 1).[1-3]

Table 2

Established protocols for shock management

- ATLS: Identify pelvis as key source
- Temporary pelvic volume reduction
- Acute pelvic external fixation
- Laparotomy (pelvic “packing”)
- Pelvic angiography and embolization

ATLS: Advanced trauma life support

Cover Photograph: Pelvis (Firstlight Images®)

Radiographs

Figure 1. Radiographic signs of mechanical instability.

The single anterior posterior radiograph of the pelvis is one of the three trauma films obtained during resuscitation (Figure 1), the others being the lateral C-spine and chest. This radiograph in conjunction with the physical exam of the pelvis is usually sufficient to identify the pelvis as a source of hemodynamic instability.

Radiographic signs of pelvic instability include:

- > 5 mm of displacement of the posterior sacroiliac joint in any plane;
- the presence of a posterior sacral fracture gap and
- the presence of an avulsion fracture of the transverse process of the fifth lumbar vertebrae, the sacral and/or the spinous processes.

Figure 2. Inlet view.

Figure 3. Outlet view.

The inlet (caudad) and outlet (cephalad) views supplement information obtained from the anterior/posterior (AP) view (Figures 2 and 3). The AP view provides information on vertical translation and asymmetry of the pelvis.

The inlet view performed with the beam directed approximately 30 degrees caudad provides information on the sacral ala, AP translation and internal/external rotation deformities.

The outlet view performed with the beam directed 30 degrees cephalad provides information on the sacral foramina and sacrum and cephalad (vertical) displacement.

The lateral sacral view can provide information on sacral body fractures (useful in the diagnosis of the so-called “H” pattern bilateral sacral fractures which cause kyphosis or anterior translation of the proximal portion of the sacrum).

Figure 4. Computerized tomography scan.

Finally, a computerized tomography scan in 3 mm to 5 mm axial cuts provides further information on the sacrum and sacroiliac joints (Figure 4).

Additional radiographic investigations may be indicated in the hemodynamically stable patient. A retrograde urethrogram is performed when suspicion of a urethral injury is present (*i.e.*, metal blood, no free passage of the foley, high-riding prostate).

A cystogram is indicated when there is gross hematuria (not microscopic) present to rule out a intra- or extra-peritoneal bladder rupture.

Emergent medicine

A high-energy pelvic fracture reflects on the magnitude of the injury and the potential sites of hemmorhage and associated injuries.

The concerns related to pelvic trauma include:

- immediate survival,
- early morbidity and mortality and
- long-term disability.

The initial management follows the principles of advanced trauma life support focusing on fluid and blood administration (Table 2).

Treatment priorities in high-energy pelvic trauma relate to the associated pelvic, abdominal, thoracic and head injury, degree of osseous and ligamentous injury and displacement of the pelvis.

Incidence

The incidence of associated injuries due to pelvic fracture include:

- gemodynamic instability (20%),
- genitourinary (20%),
- lumbosacral plexus (8%) and
- extremity fractures (60% to 85%).

The risk of proximal deep venous thrombosis following high-energy pelvic fractures has been reported to be > 60%.[4] The overall mortality remains at approximately 10%, while that for open fractures is 25%.

The mortality rate after high-energy pelvic fractures is reported to be:

- ≤ 42% when there is hypotension at presentation,
- 50% with a head injury requiring treatment,
- 52% with an intra-abdominal injury and
- > 90% when all of the above are present.

The pelvis serves as a marker for associated injuries and resuscitative requirements:

- deaths following lateral compression injuries relate to associated injuries and
- deaths in anterior posterior compression injuries relate to the severity of the pelvic injury.

Management

The management of the trauma patient includes identifying the cause(s) of hypotension (*i.e.*, hypovolemia, mediastinal injury, myocardial infarction, quadriplegia, terminal brain injury and

Table 3

External fixators

Type

- Standard anterior frame: Inserted into the iliac wing or the anterior inferior iliac spines
- Posterior frame ("pelvic clamp")

Application

- The application of the external fixator should not delay an emergent laparotomy for a patient in extremis with intra-abdominal pathology.
- There is evidence that performing a laparotomy before the application of the external fixator can lead to a loss of the tamponade, leading to further hemodynamic instability.
- The use of external fixation for definitive management of the fracture is recommended only for lateral compression and possibly some anterior-posterior compression injury patterns (Tile type B injuries).
- External fixation alone is not recommended for definitve management of vertical and rotational unstable patterns (Tile type C). In these injuries, additional posterior fixation is required.

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Table 4

Treatment of open pelvic fractures

- Agressive wound management/ packing
- Divert colostomy (distal loop washout)
- Triple antibiotics
- Delayed definitive fixation

hypothermia). Of these, hypovlemia is the most common cause of hypotension in the blunt trauma victim accounting for > 80% of the total.

The most common causes of hypovolemia are bleeding from the intrathoracic, intraperitoneal or retroperitoneal spaces and blood loss from open wounds or at closed extremity fracture sites (most commonly the femur).

The physical examination signs representing significant pelvic trauma include:

- scrotal or labial swelling and ecchymosis,
- abnormal position of the lower extremity,
- abnormal motion of the pelvis and
- painful response to stability testing of the pelvis (compression and distraction).

It should be stressed that, whenever possible, a single exam of the pelvis be done to reduce the risk of dislodging clots. Most of the bleeding following a high-energy pelvic fracture is venous (90%), from the cancellous bony surfaces or the retroperitoneal lumbo venous plexus.[5] The remaining 10% arises from the superior gluteal, obturator, internal pudendal and lateral sacral arteries.

If there is any suspicion of an unstable pelvic injury, measures should be taken to reduce the pelvic volume. These can include the use of military anti-shock trousers, a "bean bag" used in hip arthroplasty or a sheet or commercial fabricated binder.

In the emergency department a "bean bag" or binder/sheet can be applied. Depending on the institution an external fixator can be applied in the resuscitation area for the situation of hypotension associated with an unstable pelvic injury (Table 3).

Reimer *et al.* has shown the incorporation of acute pelvic external fixation during resuscitation reduced mortality from 26% to 6%.[6]

What about open fractures?

Early diagnosis and treatment of an open pelvic injury is required for successful outcome (Table 4).

Immediate packing is required to prevent exsanguination through the open wound. Early aggressive wound management, triple antibiotics and fecal diversion with loop colostomy (including a distal loop washout) form the basis for treatment.

High suspicion is required in the presence of perineal blood with detailed vaginal and rectal examination, including a speculum examination and rigid sigmoidoscopy.

Open fractures of the iliac wing are at low risk of fecal contamination and can usually be managed successfully with wound management, antibiotics and fracture stabilization. Although the mortality rate remains approximately double that for closed injuries, aggressive management has reduced the mortality rate from 50% to 25%.[7]

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