Pelvic Fractures

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KEY POINTS

- Approximately 70% of patients with a traumatically disrupted pelvic ring will have a major associated injury.
- If a patient has displacement of 0.5 cm at any fracture site in the pelvis or has an “open book” pelvic fracture, massive transfusion may be needed.
- Blood loss from open book pelvic fractures and vertical shear injuries can be life-threatening.
- Emergency binding of the pelvis can help reduce pelvic volume and tamponade the bleeding. Binding the fractured pelvis too tightly should be avoided.
- Interventional radiology can embolize the vessels.

Epidemiology

Fractures of the bony pelvis account for 3% of all fractures; however, the overall mortality from pelvic ring injuries is 10% to 15%. Motor vehicle collisions (MVCs) involving cars or cars and pedestrians cause approximately 60% of pelvic fractures. Side-impact car collisions more commonly cause pelvic fractures than do head-on car collisions. Falls and motorcycle accidents are also significant causes of pelvic ring injuries.

The blood supply and innervation of the pelvic organs and lower extremities are intimately linked to the pelvic architecture. Major disruptions lead to life-threatening blood loss, damage to urogenital organs, and neurologic deficits. The emergency physician (EP) must identify patients at risk for pelvic ring disruption and aggressively work to control bleeding.

Pathophysiology

The pelvis provides support for upright mobility by connecting the spine to the lower extremities. When viewed as a whole, the pelvis contains a major ring and two inferior rings. The triangular sacrum and two innominate bones form the major pelvic ring (Fig. 81.1). The sacrum is a fusion of the five sacral vertebrae and distributes the weight of the upper part of the body to the innominate bones. The sacrum also conducts the sacral nerve roots to the pelvic organs. Each innominate bone is a fusion of the ilium, ischium, and pubic bones. The intersection of the fusion forms the acetabulum, which articulates with the femur. Posteriorly, the innominate bones are anchored to the sacrum by the anterior and posterior iliac ligaments, two of the body’s strongest ligaments. The sacrotuberous and sacrospinous ligaments attach the sacrum to the ischial tuberosity and the ischial spines bilaterally, thus further reinforcing the posterior arch of the pelvic ring.

Anteriorly, the innominate bones are anchored to each other at the cartilaginous pubic symphysis. Because the innomates and sacrum are dense bone anchored together with equally dense connective tissue, disruption of the architecture of the major pelvic ring requires tremendous force and usually results in bony fractures or ligamentous disruptions at two or more sites in the ring. The inferior rings are formed by the pubic and ischial rami. They serve as attachments for muscles of the thighs and do not bear weight from the upper part of the body. Low-force mechanisms such as straddle injuries and falls onto the buttocks can fracture the rings, usually an isolated pubic ramus.

The left and right internal iliac arteries course in the region of the sacroiliac joints; they branch and form a network of vessels in the posterior pelvic arch. Posteriorly, the superior gluteal artery is commonly injured. Throughout the pelvis, arteries and veins are easily injured during the impact that causes the pelvic fracture, and blood collects in the retroperitoneal space.

Lateral compression, caused by injuries involving the side, crushes the pelvis inward; therefore, massive pelvic bleeding is uncommon with these types of injury. Sacral crush fractures and horizontal pubic ramus fractures can be diagnosed radiographically. Sacroiliac diastasis may also occur.

Anteroposterior compression forces cause the iliac wings to rotate outward, as when a pedestrian is struck directly anteriorly or posteriorly by a car. The fractures are unstable and pelvic volume increases, which allows massive retroperitoneal venous or arterial pelvic bleeding to occur. Diastasis of the anterior pelvic ring may be evident and is often termed an open book pelvic fracture. The posterior ligaments (as a guiding principle) can withstand about 2.5 cm of symphyseal diastasis before the sacral ligaments are disrupted. Associated acetabular fractures are commonly present in about half of cases.
Pelvic Fractures

Box 81.1 Most Common and Most Threatening Pelvic Fractures*

Most Common
- Inferior pubic ramus fractures (type A)
- Avulsion fractures (type A)
- Lateral compression fractures (type B)

Most Threatening
- Open book pelvic fractures (type B)
- Type C fractures

*See “Tile Classification of Pelvic Fractures” in text for discussion of types of fractures.

Vertical shear injuries are less common and result from axial force through the legs or spine to the pelvis. The anterior and posterior rings are both disrupted. As the hemipelvis is forcibly sheared, pelvic volume increases, which results in massive bleeding.

Several classification schemes involving the direction of force applied to the pelvis, the bones injured, the degree of instability of the ring, and any associated injuries are used for pelvic ring disruptions. Fracture stability and increases in pelvic volume determine the magnitude of blood loss and potential mortality. See Box 81.1.

Tile Classification of Pelvic Fractures

The Tile classification adopted by the Orthopedic Trauma Association describes pelvic fractures by the degree of stability. The type and degree of stability predict outcome and associated injuries (see Box 81.1). Type A fractures are stable and include avulsion fractures and isolated fractures of an inferior pubic ramus, iliac wing, or distal sacrum. These fractures cause local pain but do involve the major pelvic ring.

Type B and C fractures are unstable fractures resulting from high-energy force. In both types the pelvic ring is disrupted in two or more places. These disruptions can consist of any combination of fractures and ligament tears. Disruptions may be unilateral, with involvement of only one hemipelvis, or bilateral, with one or more disruptions in both hemipelvises.

Type B fractures are vertically stable but rotationally unstable. These ring disruptions usually involve anterior structures, the superior pubic rami and pubic symphysis and the anterior iliac ligaments. The sacrum and the posterior iliac ligaments are spared. Lateral trauma from a side-impact MVC or anteroposterior trauma from a frontal-impact MVC can cause fractures in this class. The axis of a bony fracture is determined by the orientation of the force applied to the pelvis.

Type C fractures are both vertically and rotationally unstable because the posterior elements of the major pelvic ring are disrupted by a fracture through the sacroiliac joint, which is a complete tear. In addition to lateral and anteroposterior forces, vertical shear mechanisms, including falls, can cause type C fractures.

Avulsion fractures of the pelvis at muscle insertion sites are caused by forced contraction of the thigh muscles when moving the hip.† The apophyses at the anterior superior iliac spine, the anterior inferior iliac spine, and the ischial tuberosity fuse between the ages of 16 and 25. Adolescent athletes involved in strenuous sports are vulnerable to these injuries. EPs should suspect these injuries based on the mechanism of injury (Table 81.1).

Presenting Signs and Symptoms

The classic findings in patients with a major pelvic ring disruption include a chief complaint of pelvic pain or pain with movement at the hips.‡ However, nearly 70% of patients with disruption of the major pelvic ring have associated injuries, such as closed head trauma, blunt chest and abdominal trauma, and long-bone fractures,§ that may mask the symptoms of pelvic pain.

The EP should first suspect a pelvic fracture based on the mechanism of injury and then search for additional signs of
fracture during the physical examination. Uneven leg length or asymmetry of the iliac wings may indicate a pelvic fracture. The perineum is carefully exposed to visualize any flank ecchymoses, scrotal or labial hematomas, and blood at the urethral meatus. When examining the pelvis, the EP should assume that it is fractured and avoid actions that may distract or displace a fracture. The iliac wings are gently palpated and compressed medially. The pubic symphysis is palpated anteriorly, and the sacrum and sacroiliac joints are palpated posteriorly. The rectum is examined for tone; in females, a manual vaginal examination is performed to check for bone protruding into the vagina.

If no obvious fractures of the lower extremities are found, the femurs are rotated at the hips to assess for pain in the acetabula. Pain elicited by physical examination is 98% sensitive and 94% specific for predicting fracture of the posterior aspect of the pelvic ring.6

### Table 81.1 Avulsion Pelvic Fractures

<table>
<thead>
<tr>
<th>Fracture Site</th>
<th>Muscle Involved</th>
<th>Type of Sport</th>
<th>Hip Movement</th>
<th>Initial Treatment</th>
<th>Healing Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASIS</td>
<td>Sartorius</td>
<td>Soccer</td>
<td>Flexion, abduction</td>
<td>Limit weight bearing with crutches</td>
<td>10 wk</td>
</tr>
<tr>
<td>AIIS</td>
<td>Rectus femoris</td>
<td>Sprint runner Kicking</td>
<td>Forced flexion in the starting block Hyperextension of the hip with knee flexion</td>
<td>Bed rest with the rectus femoris relaxed (hip and knee flexed)</td>
<td>6 wk</td>
</tr>
<tr>
<td>Ischial tuberosity</td>
<td>Hamstring</td>
<td>Hurdler, long jumper, gymnast</td>
<td>Forced extension at the hip</td>
<td>Bed rest</td>
<td>12 wk</td>
</tr>
</tbody>
</table>

AIIS, Anterior inferior iliac spine; ASIS, anterior superior iliac spine.

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**Differential Diagnosis and Medical Decision Making**

Figure 81.2 outlines a diagnostic and treatment approach to patients with suspected pelvic ring disruption.
CHAPTER 81  PELVIC FRACTURES

PRIORITY ACTIONS

RESCE Pelvis Mnemonic for the Treatment of Patients with Pelvic Fractures

Resuscitate the Patient
ATLS protocols, IV fluids, pain control

Examine and Obtain Radiographs of the Pelvis and Perineum
Signs of pelvic fracture or instability, urethral injury, neurologic injury

Stabilize the Pelvic Ring
Circumferential sheet, commercial pelvic binder

Consult Trauma, Orthopedics, and Urology
Consult early

Evaluate for Nonpelvic Sources of Bleeding
FAST, DPL, CT of the abdomen

Pelvis Angiography
Persistent hypotension despite stabilization efforts

ATLS, Advanced trauma life support; CT, computed tomography; DPL, diagnostic peritoneal lavage; FAST, focused assessment with sonography for trauma.

TREATMENT

Pelvic fractures need to be reduced rapidly and fixated to prevent ongoing blood loss and promote healing. Reduction of a major pelvic ring disruption should increase interstitial pressure in the pelvis and at the bony surfaces of a fracture to tamponade any venous bleeding. Pelvic volume is also directly related to diastasis at the sites of ligamentous disruption, namely, the pubic symphysis and sacroiliac joints. A 1-cm widening of the pubic symphysis allows pelvic volume to expand 4.6%. A combined 8-cm widening of the pubic symphysis and sacroiliac joints would allow potentially 500 mL of blood to accumulate in the pelvis before the soft tissues even begin to tamponade the bleeding. 7

Prehospital providers should obtain large-bore intravenous access and immobilize the patient on a long spine board.

Initially, the EP can reduce the fracture by applying a sheet circumferentially around the pelvis and tying it so that pelvic volume is reduced (Figs. 81.3 to 81.5). Commercial binders can be applied in the same manner. Such reduction works best for fractures with external rotation of one or both hemipelves, such as an open book pelvic fracture. 8 The EP should be careful to not overcorrect the external rotation by binding the pelvis too tightly. Overcorrection could force sharp bony fragments into the pelvic vasculature and organs.

Orthopedic surgery should be consulted early for reduction of pelvic ring disruptions. Circumferential binding is a temporary reduction and will not stabilize a vertically unstable fracture. Patients with ongoing blood loss may need external fixators to stabilize the ring.

Bleeding can be life-threatening, and the posterior pelvic venous plexus accounts for more than 80% of hemorrhages. 9

Early transfusion is indicated, particularly for patients with vertical shear or anteroposterior compression fractures. If a patient has 0.5-cm displacement at any fracture site in the pelvis or an open book pelvic fracture, massive transfusion will probably be needed. Patients who are persistently

Fig. 81.3  Open book pelvic fracture.

Fig. 81.4  Sheet binder application.
Mortality in patients with hemorrhagic shock from a pelvic fracture is about 50%. Patients who undergo repair of major pelvic ring injuries may have chronic pelvic pain and typical operative complications, including infection and bleeding. Concomitant head, chest, and abdominal injuries will contribute to the overall complication rate of pelvic fractures.

For avulsion fractures, initial treatment is supportive, and physical activity is resumed slowly over a period of weeks to prevent repeated avulsion. After pain control has been achieved, these patients can be discharged home with follow-up by their primary care physician.

Fig. 81.5 Binder reduction of an open book pelvic fracture.

Pelvic Binder Application

To reduce the volume of an open book pelvic fracture, a bedsheet can be used in place of a commercial binder (see Fig. 81.4).

Fold the sheet lengthwise into thirds. Logroll the patient to place the sheet or binder posterior to the pelvis. The superior edge of the sheet should be just inferior to both iliac crests. The umbilicus or natural waist should not be covered by the sheet. The inferior edge should not extend below the lesser trochanter.

The sheet should be knotted anterior to the patient with enough torque to reduce the symphysis diastasis to nearly normal: 1 to 3 cm for many patients.

Patients with unstable pelvic fractures will need to be admitted to a surgical intensive care unit for close hemodynamic and neurologic monitoring. Because many of these patients will have additional head, chest, abdomen, and limb injuries, they are best managed primarily by a trauma surgeon in consultation with orthopedists, vascular surgeons, urologists, and interventional radiologists. If multidisciplinary trauma services are not available at the initial facility, the EP must stabilize the patient and arrange emergency critical care transport for these patients to a designated trauma center.

Patients with single ring disruptions who are able to bear weight and ambulate with minimal assistance may be discharged home with pain control and referral to physical therapy. If they are unable to bear weight, they may need admission to a primary care service for physical and occupational therapy consultation.

Follow-up should also be scheduled with a sports medicine specialist or orthopedic surgeon who will monitor healing and guide the patient’s return to athletic activity.
SUGGESTED READINGS


REFERENCES

References can be found on Expert Consult @ www.expertconsult.com.
REFERENCES