

An Evidence-Based Approach To Managing Injuries Of The Pelvis And Hip In The Emergency Department

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CME Objectives

Upon completion of this article, you should be able to:

1. Recognize the importance of pelvis and hip injuries and their associated injuries.
2. Describe the treatment protocols for patients with pelvic ring disruptions.
3. Recognize the importance of a timely hip reduction and the methods to achieve the reduction.

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You have started your shift and things are relatively quiet until the paramedics radio that they are bringing in a 20-year-old male who was struck by a car while crossing the street. The patient is complaining of severe lower abdominal and groin pain, and he cries out upon any attempts to manipulate his pelvis. He is tachycardic, and his blood pressure is 90 mm Hg systolic. The paramedics have started 1 large-bore IV.

While a room is being prepared for this young man, a 14-year-old girl with sharp right-sided pelvic pain is brought back from triage. You stop in her room for a quick assessment and see that she is still wearing her soccer uniform and is in a moderate amount of discomfort. When asked about the location of the pain, she points directly to her lateral beltline. You have just begun to examine her when another paramedic crew arrives with an elderly male.

The crew has just transported an 80-year-old man who fell from a standing position and landed on his left hip/flank area. His vitals are stable, and he describes pain around his left pelvic area. You finish taking his history and complete the physical, concluding that this gentleman has significantly injured himself. You are then called away upon the arrival of a 20-year-old who suffered a motor vehicle accident.

Awesome! It looks like an orthopedic type of shift tonight....

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Injuries to the pelvis and hip are wide-ranging, from benign to life-threatening. The life-threatening injuries predominantly involve disruption of the pelvic ring. Although hip injuries that are localized to the acetabulum and proximal femur and avulsion injuries can be severe and cause significant morbidity, they are generally not life-threatening. This issue of *Emergency Medicine Practice* will discuss several common hip and pelvis injuries, dividing them into high-energy and low-energy injuries. High-energy injuries, generally the result of motor vehicle collisions and high-level falls, include pelvic ring disruptions, hip dislocations, and acetabulum fractures. Low-energy injuries can be seemingly atraumatic in nature, and include avulsion injuries, hip arthroplasty dislocations, and insufficiency fractures.

Critical Appraisal Of The Literature

A literature search was undertaken utilizing PubMed, Ovid MEDLINE®, and multiple evidence-based medicine reviews, including ACP, DARE, and EMBZ, as well as the Cochrane Database of Systematic Reviews and the National Guideline Clearinghouse. The following organizations were also consulted for

any applicable policies: American College of Emergency Physicians, American College of Radiology (ACR), American Association of Orthopedic Surgery, Orthopedic Trauma Association, Eastern Association for the Surgery of Trauma, and the Infectious Diseases Society of America. The search terms included *pelvic fracture, pelvic injury, hip dislocation, acetabulum fracture, avulsion injury, and hip fracture*.

The published literature and relevant guidelines on these topics are extremely limited. The majority of the studies have been case series, and there are only a few randomized controlled trials. Possible reasons for the limited amount of data include the heterogeneity of the patient populations, variations among “preferred” treatment methods, and the relatively limited number of these injuries that occur. Considering these factors, randomized controlled studies have not been feasible and would require multicenter enrollment.

The ACR and the National Guideline Clearinghouse do provide recommendations for assessing and treating hip fractures. For example, the ACR recommends magnetic resonance imaging (MRI) for patients with normal results on radiographs but are suspected of having insufficiency fractures.¹

Anatomy Of The Pelvis And Hip

The anatomy of the pelvis and hip is complex. The 3 innominate bones — the ilium, ischium, and pubis — combine with the sacrum and coccyx to form the bony pelvis. (See **Figure 1.**) The 3 innominate bones fuse to form the acetabulum, the “socket” within which the femoral head articulates to form the ball-and-socket hip joint. The strength and stability of the pelvis relies on the strong ligaments that connect the sacrum to the other pelvic bones. These ligaments include the anterior and posterior divisions of the sacroiliac, sacrospinous, sacrotuberous, and iliolumbar ligaments. Pelvic instability occurs when these ligaments become disrupted. (See **Figure 2.**)

Within the pelvis lies an extensive vascular

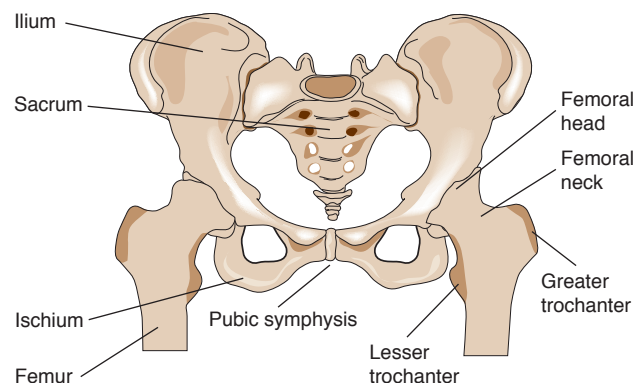
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Figure 1. Pelvis And Hip Anatomy



system, numerous nerves, and pelvic organs. The primary visceral organs include the rectum, anal canal, bladder and urethra, as well as the uterus and vagina in females and the prostate in males.

Although the vascular system in the pelvis has some anatomic variability, it generally begins with the division of the common iliac artery at the level of the pelvic brim. The external iliac artery follows the pelvic brim to exit the pelvis under the inguinal ligament as the common femoral artery. The internal iliac artery has much more variation but does lie more posteriorly in the pelvis, especially the posterior division, which overlies the sacroiliac joint and branches into the superior gluteal, iliolumbar, and lateral sacral arteries. The anterior division gives off many more branches, the most important of which are the obturator and internal pudendal arteries. These 2 branches can be injured as a result of pubic rami fractures. The venous system parallels the arterial system with an additional venous plexus that overlies the sacrum. The plexus contains many thin-walled veins and is a common source of bleeding in patients with pelvic injuries.

The primary nerves within the pelvis are branches of the sacral plexus, arising from the L4 to S3 nerve roots. The nerves of this plexus and their corresponding motor functions are listed in **Table 1**. The femoral and obturator nerves, although not part of this plexus, are included because of their

proximity to the pelvis. The other sacral nerves exit the pelvis via the sacral neural foramina and can be injured with sacral fractures. Such fractures can lead to bowel, bladder, or sexual dysfunction.

The hip itself includes the acetabulum and the proximal femur. The proximal femur is subsequently divided into intracapsular (within the hip labrum) and extracapsular segments. Intracapsular injuries include hip dislocations and femoral head and neck fractures. Extracapsular injuries include intertrochanteric and subtrochanteric fractures. The femoral neck serves as the strut that connects the pelvis to the femur and permits a tremendous range of motion; however, this construct also allows for potentially destructive shearing forces on the femoral neck. The femoral head receives arterial blood from 3 sources: the ascending cervical arteries which run along the femoral neck, the intraosseous cervical vessels, and the tenuous foveal artery that lies within the ligamentum teres. Fractures of the femoral head and neck have the potential to compromise this vascular network.

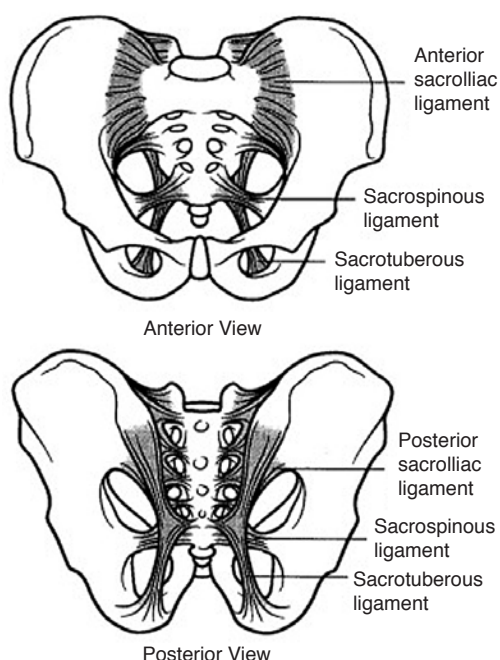
Epidemiology

The exact incidence of pelvic fractures in the United States is unknown, but these injuries represent approximately 3% of all skeletal injuries.² An Australian study determined an incidence in that country of 23 per 100,000 persons per year.³ The prevalence of pelvic fractures in admitted trauma patients is approximately 9%.^{4,5} The overall mortality from pelvic fractures ranges from 10% to 16%; however, open fractures, which represent 2% to 4% of pelvic fractures, have a higher mortality rate of 45%.^{2,6}

A British study determined the incidence of acetabulum fractures to be 3 per 100,000 persons per year, with an associated mortality of 3%.^{7,8}

Approximately 340,000 hip fractures occur every year in the United States. Two studies reviewing

Figure 2. Posterior Pelvic Ligaments



Gibbs MA, Bosse MJ. Pelvic ring fractures. In: Ferrara PC, Colucciello SA, Marx JA, Verdile VP, Gibbs MA, eds. *Trauma Management: An Emergency Medicine Approach*. St. Louis, Mo: Mosby Inc; 2001:331. Used with permission from Elsevier Inc.

Table 1. Primary Nerves Within The Pelvis

Nerve	Roots	Motor Function
Femoral	L2–L4	Knee extension
Obturator	L2–L4	Hip adduction
Superior gluteal	L4, L5, S1	Hip abduction
Inferior gluteal	L5, S1, S2	Hip external rotation
Common peroneal	L4, L5, S1–S3 (posterior portion of sciatic nerve)	Knee flexion (short head of biceps femoris) Foot dorsiflexion Foot eversion Toe extension
Tibial	L4, L5, S1–S3 (anterior portion of sciatic nerve)	Knee flexion (primary) Foot plantar flexion Toe flexion

Medicare data determined the annual mean number of fractures to be 957.3 per 100,000 women and 414.4 per 100,000 men; the femoral neck was fractured in approximately 48% of cases.^{9,10} One-year mortality rates remain high in patients who sustain hip fractures (ie, 21.9% for women and 32.5% for men).¹⁰

Differential Diagnosis

High-energy injuries to the pelvis and hip have a fairly straightforward differential diagnosis, which includes fracture, dislocation, ligamentous injury, or referred pain from an intraabdominal injury. Low-energy or atraumatic injuries have a much broader differential, including the aforementioned diagnoses as well as the following: bursitis, tendonitis, stress fractures of the femoral neck or pelvis, tumors, osteoarthritis, avascular necrosis, diskitis, osteomyelitis, lumbar disk herniation, retroperitoneal hematoma, iliopsoas abscess, inguinal hernia, inguinal lymphadenopathy, genitourinary issues, arterial insufficiency, and deep venous thrombosis.

Prehospital Care

For injuries due to high-energy mechanisms (eg, motor vehicle collisions), prehospital personnel should follow standard trauma guidelines to stabilize the airway, breathing, and circulation while minimizing on-scene time. When a pelvis injury is suspected in a hemodynamically unstable patient, stabilizing or “closing” the pelvis can be performed by several methods such as commercial binders, sheets, tying the legs together, or even taping the feet together. Care should be taken not to over-reduce the pelvis. Proper reduction can be assessed by the symmetrical position of the legs, greater trochanters, and patellas. (See Figures 3 and 4.)

Patients suspected of having isolated hip injuries should be placed in a comfortable position, generally with a blanket or pillow placed under the knee. Pelvis and hip fractures resulting from high-energy trauma are considered “distracting injuries.” As such, clinical clearance of the cervical spine using National Emergency X-Radiography Utilization Study (NEXUS) criteria is inappropriate.¹¹ In this setting, complete spinal immobilization is mandatory until the possibility of cervical injury can be definitively excluded.

As on-scene time allows, prehospital personnel play a key role in obtaining bystander history (eg, mechanism of injury, syncopal event, loss of consciousness). In many cases, these personnel are also the only healthcare providers in a position to evaluate the patient’s home for possible causes of injury, such as overall safety and maintenance of the interior, evidence of possible overdose (eg, empty pill bottles), or even something as simple as loose

floor rugs. Such information can significantly affect decision-making with regard to both the ED evaluation and the ultimate disposition of the patient.

Emergency Department Evaluation

Triage

Patients who present to the ED with pelvis and/or hip pain can range from the moribund to those who are able to walk. Knowing the mechanism of injury and assessing the patient’s appearance and vital signs can help the clinician quickly identify the sickest patients and those who require immediate resuscitation. Based on the prehospital assessment, the trauma response may be activated and the staff mobilized accordingly.

History

For patients who have suffered high-energy trauma, a history may not be obtainable. As noted in the preceding section, prehospital personnel play a key role in providing details concerning the mechanism of injury, the initial assessment of limb positions, and associated details (eg, loss of consciousness or a syncopal event).

When patients are able to communicate, the information gained from the history frequently reveals the diagnosis. It is important to determine the mechanism of injury. For example, if it resulted from a fall, the events leading up to the fall are critical: Did this patient have a syncopal event or chest pain, or was it a medication-induced fall? Was the fall mechanical in nature? Also, it is critical to determine the time of the injury, especially for falls in the elderly since prolonged periods of immobility may result in dehydration, electrolyte abnormalities, rhabdomyolysis, and/or renal impairment.

An increase in activity or intensity can suggest a stress fracture, whereas a sudden “pop” with localized pain can indicate an avulsion fracture.

Other important questions to ask regarding the event include whether the patient is ambulatory or not, the location of the pain, and whether there is bowel/bladder incontinence, hematuria, rectal or vaginal bleeding, numbness, or weakness. Lastly, it is important to document the patient’s oral intake, since these patients may require procedural sedation or a trip to the operating room.

Past medical and surgical history, as well as medications taken, contribute to the patient’s profile. Previous hip surgery, especially total hip arthroplasty (THA) and previous dislocations are key to knowing whether hip dislocation is a possibility. Other systemic illnesses such as sickle cell disease or the use of steroid medications can lead to avascular necrosis (AVN) of the femoral head. Although several studies have shown an increased association between proton pump inhibitors and hip fractures,

other studies have not.¹² Lastly, it is critical to determine whether the patient is taking warfarin.

Physical Examination

Initially, the clinician should inspect the lower extremities to detect any rotational or length discrepancies. An internally rotated shortened lower leg suggests a posterior hip dislocation, whereas an externally rotated leg suggests a femoral neck fracture (much more common than an anterior dislocation). The perineal area should be inspected for evidence of hematoma or bleeding from the vagina and/or rectum.

The iliac crests, pubic symphysis, sacrum, sacroiliac joint, and greater trochanters should be palpated. With posterior hip dislocations, one can occasionally palpate the femoral head in the buttock. The pelvis can be gently compressed to assess stability, but care should be taken not to displace fracture fragments or worsen the injuries. Note that the once widely performed maneuver of “rocking” the pelvis to rule out pelvic instability is no longer recommended for 3 important reasons: (1) this test is neither sensitive nor specific; (2) it invariably causes severe pain; and (3) most importantly, it may worsen bleeding from displaced fracture fragments. With suspected avul-

Figure 3. Fracture Stabilization: Thighs Taped To Maintain Symmetric Position Of Lower Legs



Figure 4. Alternate Method For Pelvic Fracture Stabilization: Taping Feet Together



sion injuries, the site of tenderness should be palpated to determine which bony landmark is involved.

For elderly patients who present after a fall or for trauma patients with no obvious deformity, the authors will ask the patient to perform a supine, straight-leg raise. If the patient is unable to do this, range-of-motion testing should be deferred until imaging studies have been carried out. Otherwise, range of motion is tested.

A thorough neurovascular examination should be completed. Approximately 10% of posterior dislocations will be accompanied by sciatic nerve palsy, specifically of the peroneal nerve branch. The peroneal nerve can be evaluated by testing the extensor hallucis longus (most sensitive sign), dorsiflexion, and sensation over the dorsum of the foot. Vascular injuries are rare with posterior dislocations, being more likely to result from anterior dislocations.

In patients with high-energy trauma, rectal and vaginal examinations should be performed to assess for open pelvic fractures. The examiner should evaluate for the presence of palpable bone fragments, gross blood, and a high-riding prostate in males, and should assess the integrity of the rectal/vaginal walls. In patients with open pelvic fractures, the digital rectal examination has been shown to be of some use beyond the usual clinical examination in cases of trauma.¹³

Laboratory Studies

Laboratory studies are not needed to make the diagnosis of these injuries, but they do play a supporting role in care. They may also be indicated depending on the mechanism of the injury (eg, a syncopal work-up). At a minimum, patients who have sustained high-energy trauma require a complete blood count (CBC), electrolyte measurements, and a blood type and screen. Patients with fractures that require surgery should undergo preoperative studies. In addition, the international normalized ratio (INR) will need to be checked in any patient who is taking warfarin.

Diagnostic Studies

Plain Film Radiography

Plain radiographs have been the mainstay in the evaluation of pelvis and hip injuries. They are most useful in cases of unstable trauma, hip dislocations, and avulsion injuries (especially when a radiograph of the contralateral side is available for comparison). Plain films are also useful for acetabulum fractures and are the initial test of choice for femoral neck evaluation, although this approach does have certain limitations.

The primary limitation of pelvis radiographs is their inability to detect some fractures of the pelvis and hip. In the elderly, such occult fractures present both a diagnostic and a therapeutic challenge, since osteo-

porosis related to aging leads to bone fragility. Two studies of plain radiography have found miss rates of 23% and 14%, respectively, for occult pelvic fractures, predominantly involving the pubic rami.^{14,15} In an ED-based population study, the miss rate was 4.4%.¹⁶

Multiple studies have shown the limited usefulness of plain radiographs in patients with blunt trauma who are hemodynamically stable, regardless of their Glasgow Coma Score (GCS). Two recent studies showed plain radiographs had poor sensitivity to detect fractures (64% and 78% respectively) and resulted in no management changes^{17,18}; however, an important point to consider with these studies is that every patient underwent computed tomography (CT) scanning, which did guide treatment.

For clinicians who practice in hospitals without ready access to CT imaging or who evaluate hemodynamically unstable patients, portable pelvic radiography should be used as the initial part of the evaluation. These radiographs may show displaced fractures, open-book injuries, and sacroiliac injuries but may not reveal the true degree of injury to the pelvis. A recent cadaveric study showed that the pelvis recoiled 40% to 44% in open-book injuries and 80% in lateral compression injuries.¹⁹

Protocols have been developed to identify patients who do not require radiographic evaluation. Duane et al suggested that pelvic radiographs might be unnecessary in patients who have a GCS greater than 13; have no complaints of pain in the abdomen, back, hip, or groin; and experience no tenderness in these areas or over bony landmarks. After following these patients clinically, the authors reported that the protocol had 100% sensitivity and that 273 pelvic radiographs were avoided.²⁰

Specialized pelvic radiographs called *Judet views* can be used to better evaluate the acetabulum and are obtained by rolling the patient 45° to each side to permit iliac oblique and obturator oblique views. The iliac oblique view shows the posterior column and anterior wall of the acetabulum, while the obturator oblique view highlights the anterior column and the posterior wall of the acetabulum. Although CT scanning has largely replaced the Judet views for operative planning, they still have a role in postoperative evaluations.

The anteroposterior (AP) view of the pelvis will diagnose the majority of hip dislocations as well. If this view is inconclusive, lateral views of the hip can be obtained. On the AP view, subtle signs of posterior dislocation include a smaller, superiorly located femoral head and disappearance of the lesser trochanter which result from the internal rotation of the femoral head away from the acetabulum. (See Figure 5.) In anterior dislocations, the femoral head will be larger (farther from the radiograph cassette) and noncongruent with the acetabulum and the lesser trochanter will be more prominent. (See Figure 6.)

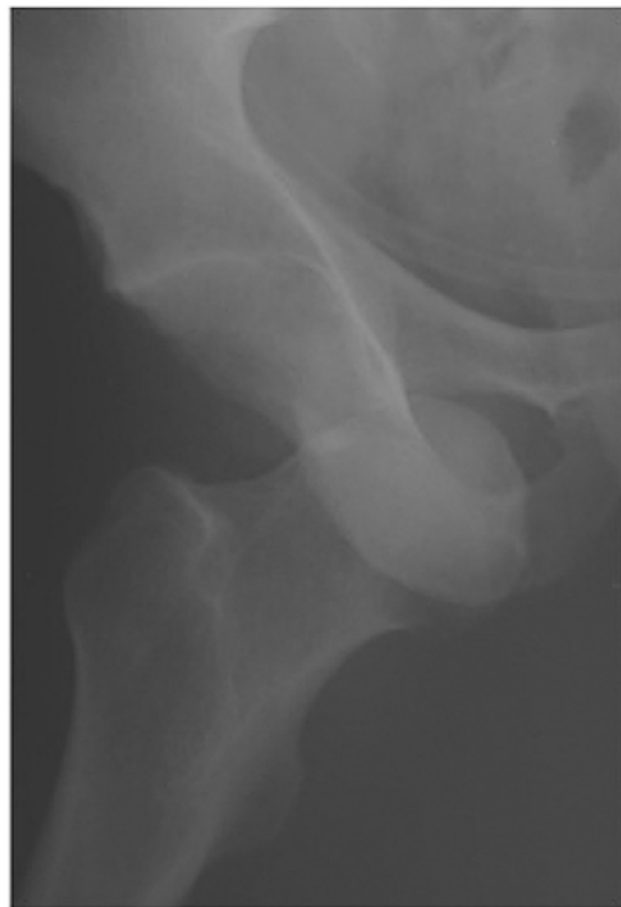
The AP view of the pelvis should be evaluated

for additional fractures of the femoral head, neck, or shaft, and the acetabulum. These fractures (with the exception of femoral neck fractures) are not absolute

Figure 5. Rotational Loss Of Lesser Trochanter From View In Posterior Hip Dislocation



Figure 6. Prominent Lesser Trochanter In Anterior Hip Dislocation



contraindications to reduction but can make reduction more difficult. (See Figures 7 and 8. See page 17 for discussion of femoral head fractures and Pipkin classification of femoral head fractures, as well as page 16 for discussion of acetabulum fractures.)

Computed Tomography

Computed tomography scanning is the current gold standard for the diagnosis and assessment of pelvic ring injuries because of its high sensitivity and ability to precisely define fracture lines. It also allows for the coincident identification and staging of associated visceral and vascular injuries. Imaging by CT is also desirable for characterizing acetabulum fractures in preparation for operative repair and can be useful for evaluating the adequacy of hip reduction, the presence of intraarticular loose bodies, and the presence of occult femoral head fractures.

Figure 7. Posterior Dislocation With Fracture Of Posterior Acetabular Wall



Figure 8. Posterior Dislocation With Femoral Head Fracture (Pipkin Type 1)



Magnetic Resonance Imaging

Magnetic resonance imaging has become the gold standard for the definitive identification and evaluation of occult fractures. When compared with other imaging modalities, MRI has been reported to be 100% accurate and cost-effective.²¹ A small study comparing CT and MRI in the diagnosis of occult hip fracture showed a 66% misdiagnosis rate with CT scanning.²² MRI should be considered when radiographic results are negative, when the patient is unable to walk, and when one suspects occult fracture.

Retrograde Cystourethrography

For patients who present with blood at the urethral meatus, a high-riding prostate, or gross hematuria, the Advanced Trauma Life Support (ATLS) course recommends performing a retrograde cystourethrogram (RUG) prior to placing a Foley catheter.²³ The results of one recent case series including 46 patients called this recommendation into question when the researchers found no worsening of bladder or urethral injuries after a blind, gentle attempt at Foley catheter placement prior to completing RUG.²⁴ This study, although limited by its small size and retrospective design, suggests that such catheter placement may be safely attempted in selected patients.

The timing of the genitourinary tract evaluation is important in relation to the overall context of the diagnostic plan. Because extravasated contrast instilled during RUG may interfere with the interpretation of pelvic angiograms, angiography should be performed prior to evaluation of the urethra or bladder.

Ultrasonography

The Focused Assessment with Sonography for Trauma (FAST) can be used to detect hemoperitoneum in patients with pelvic ring disruptions; however, the sensitivity of FAST in blunt trauma with pelvic fractures in 2 retrospective studies was 26% and 81%, respectively, when compared with the sensitivities of either CT scanning (96%) or laparotomy findings (87%).^{25,26} In one of these studies, the free peritoneal fluid depicted on ultrasound was actually urine, rather than blood, in 19% of the patients.²⁶ Despite its limited sensitivity, FAST has been incorporated into several protocols for the assessment of pelvic fractures in patients with blunt trauma. (See **Treatment For Pelvic Ring Disruption**, page 9.)

Diagnostic Peritoneal Aspiration

Given the relatively poor sensitivity of FAST in pelvic trauma, a “negative” study in a patient at significant risk for abdominal injury must be followed by another definitive test. In hemodynamically stable patients, abdominopelvic CT will identify associated visceral injuries and will characterize

the extent of pelvic injury. In hemodynamically unstable patients, diagnostic peritoneal aspiration (DPA) should be considered. A DPA is performed by inserting a standard diagnostic peritoneal lavage catheter above the umbilicus. The aspiration of 10 mL of gross blood is diagnostic of hemoperitoneum. Despite the one small study mentioned in the Ultrasonography section (see page 7), in which urine was discovered 19% of the time, the literature does not support the routine use of DPA in patients with positive results on FAST.²⁶

High-Energy Injuries: Pelvic Ring Disruptions, Hip Dislocations, Acetabulum Fractures, And Femoral Head Fractures

Pelvic Ring Disruptions

The most significant pelvis injuries are disruptions of the pelvic ring. The pelvis is a “ringed” structure, so that if an injury or fracture is identified in one location, a second injury or fracture should be sought. Isolated pelvic ring injuries can be seen in 2 groups of patients: the elderly (with their osteopenia and insufficiency fractures) and pediatric patients (with their elastic bones and isolated fractures of the pubic rami).

Several classification schemes have been developed to describe pelvic ring disruptions. This review utilizes the Young–Burgess classification, which characterizes 3 types of pelvic ring disruptions based on the direction of the causative injury vector.²⁷ Within each type of injury, increases in the grading scale indicate greater injury to the posterior ligamentous complex. (See Figure 9.) In Figure 9, Scale A illustrates lateral compression fractures; Scale B, anteroposterior compression fractures; and Scale C, a vertical shear fracture. Patients can also present with combinations of these injury patterns.

Lateral Compression Injuries Of The Pelvic Ring

Lateral compression injuries result from an injurious force delivered to the side of the body, as might be seen following a T-bone motor vehicle collision or in a pedestrian who is struck from the side.

- Type I (most common): Sacral compression fracture on the side of impact with either unilateral or bilateral rami fractures. (See Figure 10, page 10.)
- Type II: Crescent (iliac wing) fracture on the side of impact.
- Type III: Force extends to opposite hemipelvis, creating an open-book injury on the side opposite the impact (also known as the “wind-swept pelvis”). (See Figure 11, page 10.)

Anteroposterior Compression Injuries Of The Pelvic Ring

Anteroposterior compression (APC) injuries occur when the force impacts the patient anteriorly, as might be seen in head-on motor vehicle collisions or

in the pedestrian who is struck head-on.

- Type I: Widening of the pubic symphysis, usually less than 2 centimeters, with intact posterior pelvic ring ligaments.
- Type II: Widening of the anterior sacroiliac joint occurs due to disruption of the anterior portion of the sacroiliac, sacrotuberous, and sacrospinous ligaments. The anterior pelvic ring can demonstrate either a widened pubic symphysis or rami fractures. The posterior portion of the sacroiliac ligament remains intact. (See Figure 12, page 10.)
- Type III: Complete disruption of the sacroiliac joint with anterior pelvic ring injuries similar to Type II. (See Figure 13, page 10.)

Vertical Shear Injuries Of The Pelvic Ring

Vertical shear injuries are rare and occur when 1 hemipelvis is forced upward and becomes separated from the other. This might result from a head-on motor vehicle crash during which the occupant’s leg is fully extended and braced on the brake pedal. The femur is driven upward, completely disrupting the anterior pelvis (symphysis or rami) and the posterior pelvis (predominantly the strong sacroiliac ligaments). As a result, the ipsilateral hemipelvis gets displaced superiorly. (See Figure 14, page 10.)

Young and Burgess found a correlation between the more significant injuries (ie, lateral compression Type III and anteroposterior compression Types II and III) and risk for major hemorrhage,²⁷ but other studies have not found this correlation.^{28,29} Salim and his group showed sacroiliac disruption, regardless of the Young-Burgess classification, and predicted the need for embolization.³⁰

The term *open-book pelvic fracture* is commonly used to describe pelvic ring disruptions. This fracture encompasses an anterior injury (either widening of the pubic symphysis, rami fractures, or a combination of the two) and a posterior pelvic fracture or ligamentous injury. Lateral compression, anteroposterior compression, and vertical shear injuries may all be termed open-book depending on the extent of injury and anterior widening. The degree of anterior pelvic ring widening is significant: when the anterior widening is greater than 2.5 cm, the posterior pelvis (especially the anterior portion of the sacroiliac ligamentous complex) is routinely injured, leading to an increase in pelvic volume and the risk of hemorrhage.

Because of the high energy involved with pelvic ring disruptions, significant coexisting injuries can occur. Life-threatening hemorrhage is the most worrisome associated injury. Hemorrhaging can occur from the bone fragments themselves, arterial lacerations, or venous injuries. The most common source of bleeding — and unfortunately the most difficult to control — is venous bleeding. A venous source is identified in 80% to 90% of cases.³¹ Several case series have illustrated the need for blood transfusions

in these patients: 38.5% of hospitalized trauma patients with pelvic fractures required transfusion, as did 34% of trauma patients with isolated pelvis and acetabulum fractures in another case series.^{6,32} Every emergency clinician should recognize that any pelvic fracture pattern can be associated with hemorrhaging and should be alert for that possibility.

Other injuries associated with pelvic trauma are as follows:

- Intraabdominal injury occurs in 16.5% of patients with pelvic trauma and predominantly involves the liver, spleen, and bowel.⁶
- The bladder is injured in approximately 3.39% and the urethra in 0.94% of pelvic trauma cases. Males are much more likely than females to sustain urethral injuries (1.54% vs 0.15%).³³
- Nerve deficits associated with pelvic ring disruptions occur in 10% to 15% of pelvic trauma

cases, with rates up to 50% in sacral fractures medial to the sacral neural foramina.^{34,35}

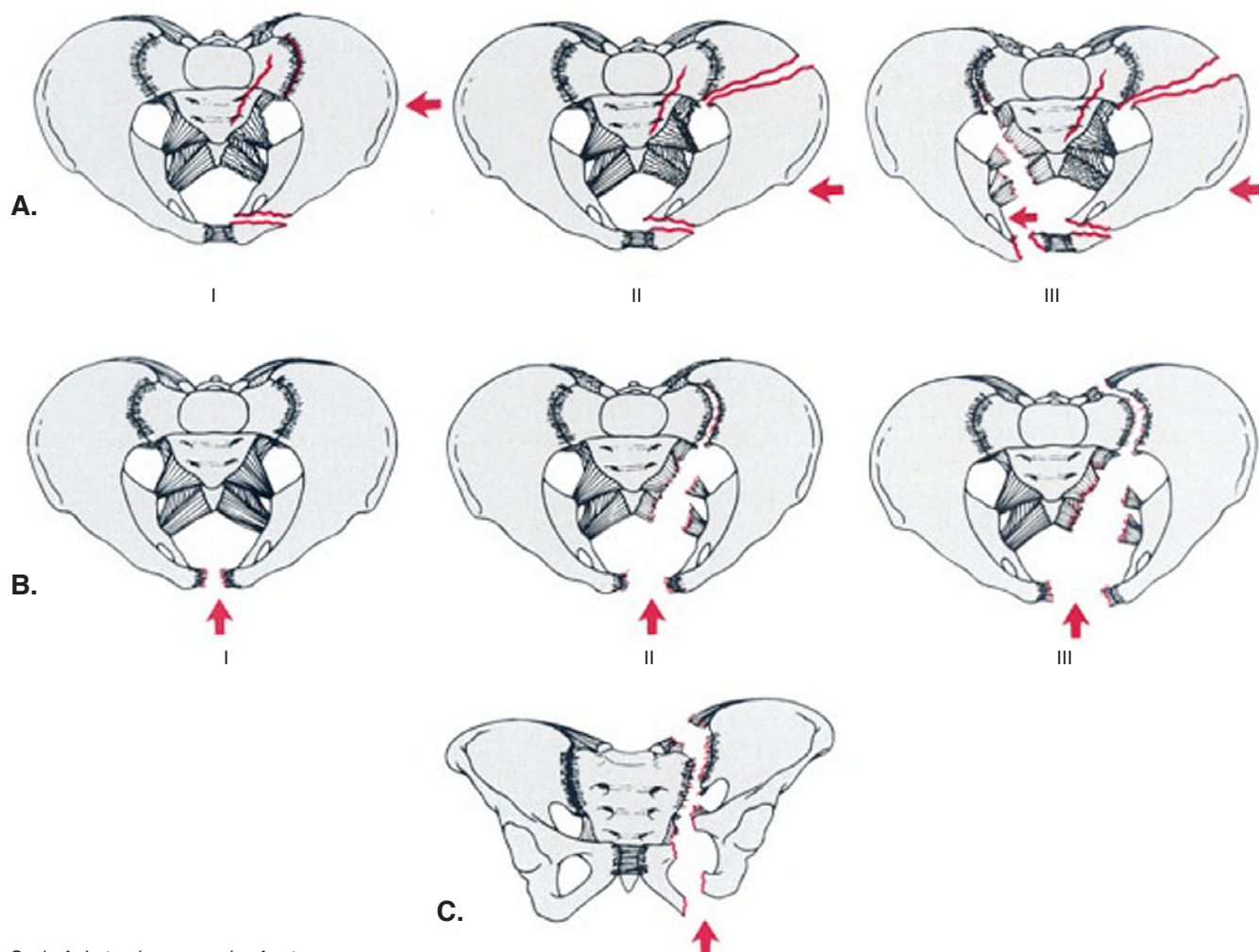
- Blunt thoracic aortic disruption occurs in 1.4% of patients with blunt trauma that includes a pelvic fracture, compared to 0.3% of all blunt trauma patients.⁶

Treatment For Pelvic Ring Disruptions

Initial resuscitation and management should focus on airway, breathing, and circulation. All patients with pelvic ring disruptions should be evaluated for associated internal injuries. If an emergency clinician is practicing in an area that lacks facilities for trauma or orthopedic surgery support, the focus must be on stabilizing and transferring the patient to a trauma center for timely, definitive care.

If a pelvic ring disruption is discovered or a patient with a pelvic fracture remains hemodynamically

Figure 9. Young-Burgess Classification Of Pelvic Fractures



Scale A: Lateral compression fractures

Scale B: Anteroposterior compression fractures

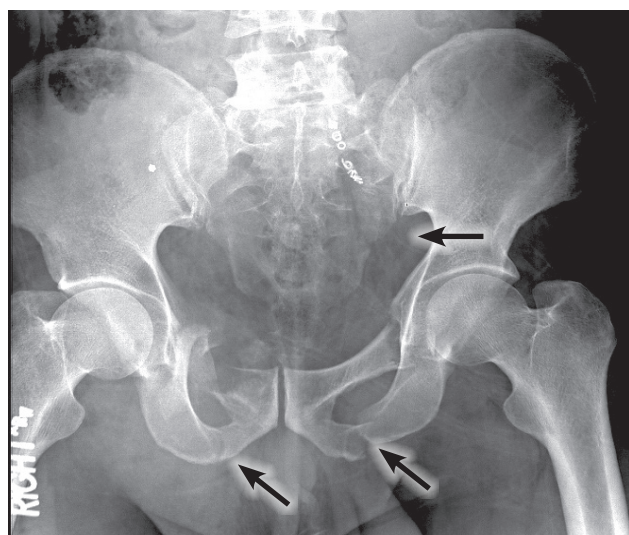
Scale C: Vertical shear fracture

Burgess AR, Eastridge BJ, Young JW, et al. Pelvic ring disruptions: effective classification system and treatment protocols. *Journal of Trauma*. 1990;30:848. Used with permission, Wolters-Kluwer, Lippincott, Williams & Wilkins.

cally unstable, the pelvis should be “wrapped” with either a sheet or a commercial pelvic binder. Wrapping the pelvis reduces pelvic volume, creating a tamponade effect; stabilizes fracture fragments to reduce bony bleeding; and improves patient comfort. Even fractures that do not have an open-book component can be wrapped, with the primary goals being fracture stabilization and patient comfort (as opposed to fracture reduction).

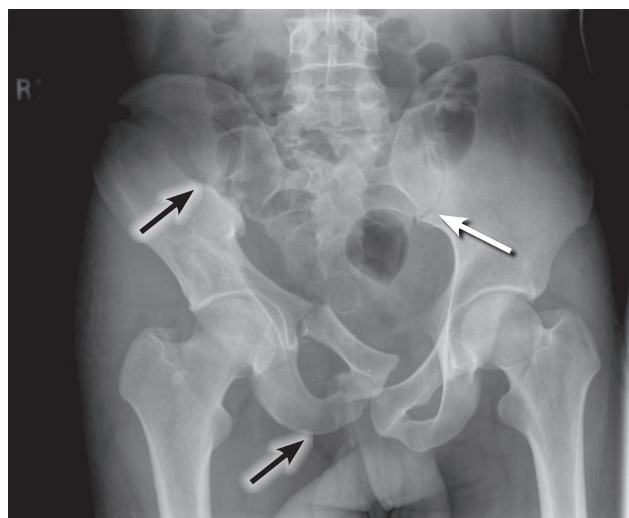
Two simple methods have been proposed to close down the pelvis: (1) taping the lower extremities in internal rotation, and (2) a circumferentially wrapped sheet.^{36,37} (See Figures 3 and 4, page 5; and Figures 15, 16, and 17.) Both of these methods are ef-

Figure 10. Lateral Compression Type I Injury



Arrows point to bilateral rami fractures and left sacral fracture.

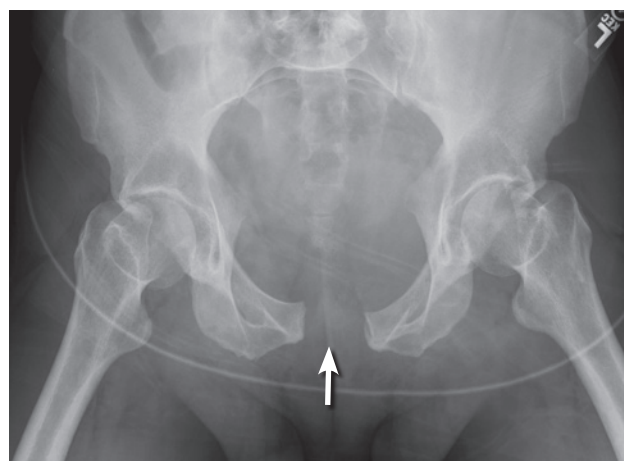
Figure 11. Lateral Compression Type III Injury (“Wind-Swept Pelvis”)



Black arrows point to the iliac and rami fractures consistent with internal rotation deformity.

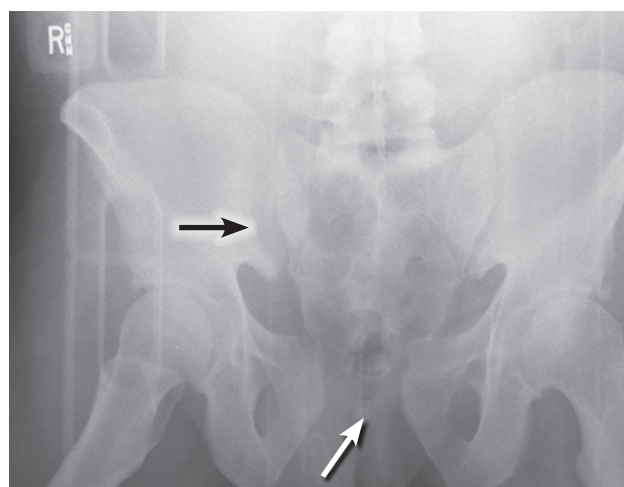
White arrow points to slight external rotation of the contralateral hemipelvis consistent with a wind-swept pelvis.

Figure 12. APC Type II Injury



Arrow points to pubic symphysis disruption with widening greater than 2 cm allowed by concomitant sacroiliac joint laxity. Posterior sacroiliac ligaments remain intact and prevent diastasis of the sacroiliac joint itself.

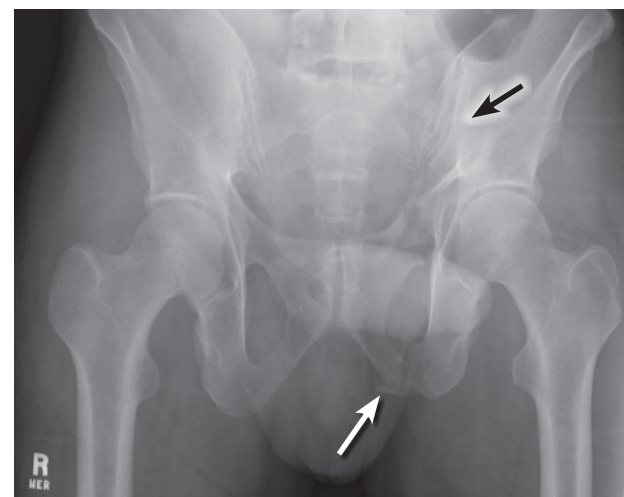
Figure 13. APC Type III Injury



White arrow points to diastasis of the pubic symphysis.

Black arrow points to diastasis of the right sacroiliac joints.

Figure 14. Vertical Shear Injury



White arrow points to pubic and ischial fracture.

Black arrow points to sacroiliac injury.

fective in reducing pelvic volume and do not hinder further trauma assessment. Commercial pelvic binders may also be used, such as the Dallas Pelvic Binder®, Geneva belt, Stuart splint, London pelvic splint, and the Trauma Pelvic Orthotic Device® (TPOD). These splints are placed around the iliac crests (Dallas and Geneva) or the greater trochanters (London, TPOD, and simple sheets). (See Figure 18, page 12.)

Care should be taken not to overreduce the fracture, especially with lateral compression injuries. Excessive reduction can increase an internal rotation deformity, exerting more strain on the posterior pelvic ligaments. This greater strain can lead to increased hemorrhage and further injury. Overreduction can be assessed clinically by the position of the legs, greater trochanters, and patellas; the lower legs and greater trochanters should be symmetric. Radiographs should be obtained after wrapping the pelvis to assess the adequacy of reduction. In severe lateral compression injuries, the sheet or splint is placed only to stabilize the pelvis, not to compress it. Two devices, the SAM Pelvic Sling II® and the pelvic circumferential compression device (PCCD), limit the amount of force that can be applied, thus reducing the chance of internal rotation even in lateral compression injuries.^{38,39}

In a recent systematic review designed to assess the effectiveness and complications of external pelvic compression in patients with unstable pelvic fractures, the authors concluded that this maneuver has 3 advantages: (1) it provides effective biomechanical stabilization to the disrupted pelvic ring, (2) it reduces blood loss, and (3) it is not associated with life-threatening or limb-threatening complications. They acknowledged that survival data are unavailable and that large randomized controlled trials are needed to obtain such data.⁴⁰ There is no evidence that commercially available products are superior to the simple application of a sheet around the pelvis.

Although sheets or commercial pelvic binders can be placed quickly and are effective, external fixators can also be applied in the ED to reduce fractures and control bleeding. The 2 primary methods are pins and bars and the pelvic C-clamp. Pins and bars require pin placement in the iliac crest or supra-acetabular area and then a bar frame. This method takes approximately 15 minutes and interferes with further abdominal surgeries. The pelvic C-clamp requires pins placed more posteriorly in the iliac crest, but the benefits of the pelvic C-clamp include being faster to place (approximately 10 minutes) and being able to rotate the clamp either cephalad or caudad for easier access during abdominal surgeries or angiographic procedures via the groin.

In addition to appropriate resuscitation, patients with open pelvic fractures require tetanus prophylaxis and treatment with broad-spectrum antibiotics. No specific guidelines have been established with

Figure 15. Position Of Folded Flat Sheet Placed Under Pelvis



Figure 16. Sheet Folded Over To Prevent Folds That Lead To Pressure Sores



Figure 17. Tension Being Applied To Pelvis With Circumferentially Wrapped Sheet



regard to antibiotic therapy, but cefazolin combined with gentamycin are currently the mainstays of open fracture treatment. Clindamycin may be added based on the presence of contamination. If rectal injuries are involved, a beta-lactam penicillin (such as piperacillin/tazobactam) or ertapenem should be substituted for cefazolin in order to improve coverage for intraabdominal flora in addition to skin flora. Open pelvis fractures generally require multidisciplinary management and extensive debridement in the operating room.

Friese et al have proposed an algorithm incorporating both FAST and DPA to evaluate patients with blunt trauma who have pelvis fractures. The first decision branch-point involves FAST: a positive result on FAST in the presence of hemodynamic instability would lead to an operation, whereas a positive result in a stable patient would lead to CT scanning. In patients with a negative FAST result and hemodynamic instability, DPA should be performed. A positive result on DPA is an indication for emergent laparotomy. If the DPA result is negative in unstable patients, emergent pelvic angiography is performed.²⁵ This protocol has been adapted and included as part of the Clinical Pathway For Managing Pelvic Ring Disruptions.

Trauma surgeons and orthopedic surgeons should be consulted early in the care of patients with significant pelvic ring disruptions. Many options for definitive treatment exist, including direct retroperitoneal packing, operative stabilization of the fracture fragments, and embolization.

Special Circumstances In Pelvic Ring Disruptions

The pregnant and the elderly populations represent 2 patient groups that require special attention. Among pregnant women who sustain pelvic fractures, mortality is high for both the mother (9%) and the fetus (35%).⁴¹ For more information on management of trauma in pregnant patients, see the July

Figure 18. Pelvic Binder Applied Over The Greater Trochanters



2008 issue of *Emergency Medicine Practice*, "Trauma In Pregnancy: Double Jeopardy."

Mortality rates are higher among elderly patients who sustain pelvic fractures. Dechert et al described a mortality rate of 20.4% in patients older than 65 years of age who had pelvic fractures as opposed to 8.3% in the nonelderly.⁴² Another large trauma study of older patients with pelvic fractures (age greater than 55 years) found mortality to be 21%, as compared with 6% in the younger group.⁴³ Although the fracture patterns were more likely to be lateral compression Type I or II injuries in the elderly group (92%), the older patients were 2.8 times more likely to require blood transfusions.⁴² Essentially, the elderly require less energy to fracture their pelvis, have more radiographically benign-appearing fractures, are more likely to require blood transfusions, and have worse outcomes.

Cutting Edge In Pelvic Ring Disruptions

Direct retroperitoneal packing, although commonly used in Europe, is only now beginning to be used more frequently in the United States.⁴⁴ The goal of this procedure is to tamponade the venous hemorrhage associated with pelvic ring disruptions, and it can be used in conjunction with pelvic angiography. The procedure involves first stabilizing the pelvis with an external fixator. Next, a suprapubic incision is made, with care being taken not to violate the peritoneum. The retroperitoneum is then packed with surgical lap packs, generally 3 per side. The lap packs are placed within the true pelvis, below the pelvic brim. In experienced hands, the procedure takes approximately 20 minutes.^{44,45,46}

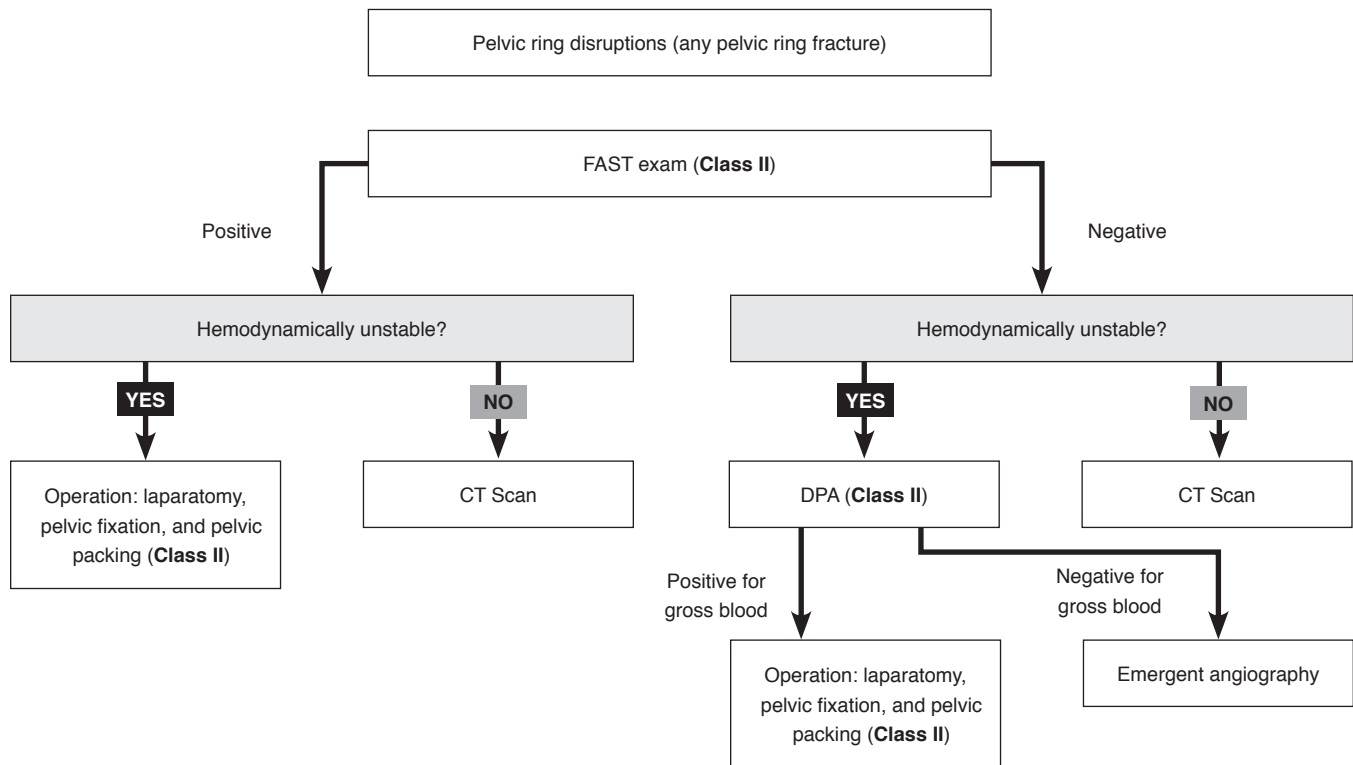
Incorporating retroperitoneal packing has been shown to be safe and effective at reducing mortality among patients with significant pelvic ring disruptions.^{44,46} The protocol with regard to retroperitoneal packing currently being followed at Denver Health Medical Center has been adapted as part of the Clinical Pathway For Managing Pelvic Ring Disruptions.

A group in France has incorporated the use of an intraaortic balloon pump into a management protocol for patients with critically uncontrollable hemorrhagic shock. The balloon pump allowed the safe transfer to the angiography suite of 12 of the 13 patients in whom a pump was placed; 92% of these patients had an arterial injury, and the survival rate was 46%.⁴⁷

Disposition For Patients With Pelvic Ring Disruptions

All patients with high-energy pelvic ring disruptions should be stabilized and transferred to a regional trauma center. Patients with isolated, low-energy pubic rami fractures may be discharged home, in consultation with orthopedic surgery, as long as the patient can ambulate and follow-up is arranged.

Clinical Pathway For Managing Pelvic Ring Disruptions



The clinical pathway is a hybrid of the protocols developed by Friese et al and the Denver Health Medical Center.^{25,46}

Abbreviations: CT, computed tomography; DPA, diagnostic peritoneal aspiration; FAST, focused assessment with sonography for trauma.

Class Of Evidence Definitions

Each action in the clinical pathways section of *Emergency Medicine Practice* receives a score based on the following definitions.

Class I

- Always acceptable, safe
- Definitely useful
- Proven in both efficacy and effectiveness

Level of Evidence:

- One or more large prospective studies are present (with rare exceptions)
- High-quality meta-analyses
- Study results consistently positive and compelling

Class II

- Safe, acceptable
- Probably useful

Level of Evidence:

- Generally higher levels of evidence
- Non-randomized or retrospective studies: historic, cohort, or case control studies
- Less robust RCTs
- Results consistently positive

Class III

- May be acceptable
- Possibly useful
- Considered optional or alternative treatments

Level of Evidence:

- Generally lower or intermediate levels of evidence
- Case series, animal studies, consensus panels
- Occasionally positive results

Indeterminate

- Continuing area of research
- No recommendations until further research

Level of Evidence:

- Evidence not available
- Higher studies in progress
- Results inconsistent, contradictory
- Results not compelling

Significantly modified from: The Emergency Cardiovascular Care Committees of the American Heart Association and representatives from the resuscitation councils of ILCOR: How to Develop Evidence-Based Guidelines for Emergency Cardiac Care: Quality of Evidence and Classes of Recommendations; also: Anonymous. Guidelines for cardiopulmonary resuscitation and emergency cardiac care. Emergency Cardiac Care Committee and Subcommittees, American Heart Association. Part IX. Ensuring effectiveness of community-wide emergency cardiac care. *JAMA*. 1992;268(16):2289-2295.

This clinical pathway is intended to supplement, rather than substitute for, professional judgment and may be changed depending upon a patient's individual needs. Failure to comply with this pathway does not represent a breach of the standard of care.

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Hip Dislocations

Traumatic hip dislocations and fracture-dislocations represent true orthopedic emergencies. A significant amount of force is required to dislocate a native hip because of its strong muscular attachments, thick joint capsule, and deep acetabulum–labrum complex. Consequently, serious concomitant injuries occur in up to 95% of patients with traumatic hip dislocations.^{48,49}

Hip dislocations can be categorized by type and by location of the femoral head. The type can be either simple or complex (associated with a fracture).⁵⁰ In a recent case series, complex dislocations were found to be more common, occurring 81.5% of the time.⁵¹ The femoral head dislocated posteriorly in about 90% of cases, anteriorly in about 10%, or inferiorly in fewer than 1%.

The direction of the hip dislocation depends on the location of the lower extremity when the injurious force is applied. Posterior dislocations overwhelmingly result from motor vehicle collisions, since the force is applied to a lower extremity that is adducted, internally rotated, and flexed at the hip. Whether or not acetabulum fracture occur depends on the position of the femoral head; if the femoral head is maximally flexed and adducted at the hip, it can become dislocated posteriorly without striking the acetabulum. (See Figure 19.)

Anterior dislocations can dislocate superiorly toward the pubis (in 10% of cases) or inferiorly toward the obturator foramen (in 90%). Superiorly directed dislocations result from a force applied to a lower extremity that is abducted, externally rotated, and extended at the hip. Inferiorly directed dislocations occur similarly except that the lower extremity is flexed at the hip. (See Figure 20.)

Although central hip dislocations have been described in the literature, they are not considered true dislocations. In these cases, the femoral head is forced centrally through the acetabulum as a result of comminuted fractures that involve the medial wall of the acetabulum.

Treatment For Hip Dislocations

The goal in treating hip dislocations is immediate reduction, certainly within 6 hours of the injury. The likelihood of avascular necrosis, traumatic arthritis, and permanent nerve palsy greatly increases as the length of time the hip remains dislocated increases.^{52,53} In the event of neurovascular compromise, reduction should be expedited.

The timing and technique of closed hip reduction depend on the overall condition of the patient, the type of dislocation, the resources available, and the operator's comfort level with the various methods. Moderate sedation should be used whenever the patient's condition allows. Multiple attempts at closed reduction should be avoided. The only

absolute contraindication to a closed hip reduction is the presence of an ipsilateral femoral neck fracture; fortunately, this injury is rare, with only 30 cases published in the literature.⁵⁴

Overall, the success rates for closed reductions are between 85% and 98%.⁵⁵ In a more recent systematic review evaluating hip reduction for dislocations and femoral head fractures, the success rate was 84.3%.⁵⁶ Reasons for irreducible dislocations include fracture fragments blocking the joint space, femoral head buttonholing through the capsule, or trapping of a tendon.

Numerous reduction techniques have been described, all of which rely on the basic reduction principle of recreating the position at which the injury occurred and then reversing the force. Subsequently, they all place the lower extremity in a

Figure 19. Left Posterior Hip Dislocation, No Acetabulum Fracture



Figure 20. Left Anterior-Inferior Hip Dislocation: Femoral Head In Obturator Foramen



flexed, adducted, and internally rotated position at the hip. The authors recommend either the Allis or the Whistler technique, as described below.

The Allis Reduction Technique

The Allis technique is the most commonly used method for hip reduction and is effective for both posterior and anterior-inferior dislocations. The technique is as follows. (See Figure 21.)

1. The patient is placed supine either on the stretcher or on the floor. If the patient remains on the stretcher, the operator will need to stand on the stretcher and have someone stand behind to act as spotter (to prevent the operator from falling off).
2. An assistant will stabilize the pelvis.
3. The knee is flexed and the hip is slowly brought to a minimum of 90° of flexion. The hip is adducted as much as possible.
4. Steady upward traction and gentle internal rotation is performed.
5. The assistant will apply counter-traction on the ipsilateral hemipelvis.
6. After reduction, the hip is extended while maintaining traction.

The Anterior-Superior Dislocation Reduction Technique

Anterior-superior dislocations cannot be reduced using the Allis technique because flexion is resisted by the anterior position of the femoral head. These dislocations can be reduced with the following steps. (See Figure 22.)

1. The patient is placed supine on the stretcher.
2. Longitudinal traction is applied in line with the femur.
3. The hip is hyperextended and internally rotated.
4. An assistant applies downward pressure on the femoral head.

Figure 21. Allis Reduction Technique In Action



The Whistler Reduction Technique

The Whistler technique is a method that does not require climbing onto the stretcher.⁵⁷ A large amount of force can be generated using the lower leg as a lever; however, this method is contraindicated in patients with injuries or fractures of the lower leg. The method is as follows. (See Figure 23.)

1. The patient is placed supine on the stretcher.
2. The uninjured leg is flexed at the knee and an assistant can hold the foot in place.
3. The operator places 1 arm under the popliteal fossa of the injured extremity, all the way to the knee of the uninjured leg, and the hand is anchored to this knee.
4. The lower leg of the injured extremity is grasped, and the hip is flexed to a minimum of 90°.
5. From this position, the injured leg can be adducted and internally rotated.
6. Traction is applied using the arm under the popliteal fossa as the fulcrum and the lower leg as the lever.

Figure 22. Reduction Technique For Anterior-Superior Dislocations



Figure 23. Whistler Reduction Technique



Variations of this method include lowering the bed as much as possible and using the operator's knee or lower leg as the fulcrum. (See Figure 24.)

After successful closed reduction, the hip should be tested for stability while the patient is still under moderate sedation. Stability is tested by flexing the hip to 90°, abducting and adducting the hip, and gently internally and externally rotating the hip. The last maneuver is to exert a posteriorly directed force with the hip in the neutral position. During these movements, any subluxation of the hip should be noted and if the hip dislocates, it should quickly be reduced again. The operator should relay this stability information to the orthopedic consultants. Postreduction instability can be an indication for surgery, especially if a posterior wall fracture is present.

After stability testing has been completed, the injured leg should be placed in a knee immobilizer and an abduction pillow should be used to prevent repeat dislocation.

Postreduction films should be obtained to check for adequacy of the reduction, joint congruency, and fractures. A CT scan should also be obtained.

Controversies/Cutting Edge For Hip Dislocations

Although no studies have been published, bedside ultrasound can be used to evaluate the hip reduction in difficult cases. The primary benefit of ultrasound is the ability to evaluate a normal or near-normal acetabulum–femoral head relationship without waiting for portable radiology or having the patient awoken from moderate sedation. (See Figure 25.)

Disposition For Hip Dislocations

The overwhelming majority of patients with hip dislocations are admitted to the hospital. For a patient to be discharged from the ED, several key elements should be met:

1. The injury should be a simple dislocation that is stable postreduction and has a normal CT scan.
2. The injury is an isolated injury.
3. The patient should be able to mobilize with

- touch-down weight-bearing restrictions
4. Orthopedic consultation has occurred.
5. Follow-up has been arranged.
6. There is a support system at home.

Patients that have undergone successful reduction of a THA dislocation may be discharged in conjunction with orthopedic consultation.

Given the likelihood of associated injuries, if orthopedic consultation is not available, the patient should be transferred to a regional trauma center. If the patient's condition allows, an attempt at closed reduction should be made, especially if there is neurovascular compromise or transport will be delayed.

Acetabulum Fractures

Fractures of the acetabulum, although not associated with the same mortality as pelvic ring disruptions, can result in significant morbidity. The rates of associated injuries are similar to those seen with pelvic ring disruptions, but fortunately the degree of life-threatening hemorrhage is less.⁵⁸

The most common classification scheme for acetabulum fractures was developed by Letournel and Judet.⁵⁹ The fractures are divided into 2 broad categories: simple and complex (a combination of simple fracture patterns). The most common fracture type involves the posterior wall, which occurs 23.3% of the time.⁶⁰ (See Figure 7, page 7.)

Treatment Of Acetabulum Fractures

The majority of these injuries will require surgery and orthopedic care at a tertiary center. Treatment should focus on stabilizing the patient and evaluating for associated injuries.

Disposition Of Patients With Acetabulum Fractures

The disposition of acetabulum fractures is the same as for pelvic ring disruptions. (See page 14.)

Figure 24. Modified Whistler Technique



Figure 25. Ultrasound Image To Evaluate Hip Reduction



White arrow points to the acetabulum.

Black arrow points to the femoral head lying within the acetabulum.

Femoral Head Fractures

Femoral head fractures are relatively uncommon, having an incidence of 6% to 16% with hip dislocations, but they almost always occur in conjunction with a hip dislocation. The fractures can be classified using the Pipkin scheme⁶²:

- Type 1: Hip dislocation with fracture below the fovea (**See Figure 8, page 7.**)
- Type 2: Hip dislocation with fracture at or above the fovea
- Type 3: Any Type 1 or 2 injury associated with a femoral neck fracture
- Type 4: Any Type 1 or 2 injury associated with an acetabulum fracture

Treatment of these fractures relies on reduction of the femoral head. The presence of a femoral head fracture is not a contraindication to reduction, but it can make the reduction more difficult and less likely to be successful. Unless the fracture is nondisplaced, the definitive treatment of these fractures will be operative.

Low Energy Injuries: Femoral Neck Fractures, Pelvic Insufficiency Fractures, Total Hip Arthroplasty Dislocations, And Avulsion Injuries

Femoral Neck Fractures

Femoral neck fractures are now being more aptly named “insufficiency” or “fragility” fractures, owing to the increasing role that osteoporosis plays in their occurrence. Osteoporosis affects millions of people worldwide. The common risk factors for osteoporosis and related fractures include older age, female sex, postmenopausal status, personal and/or family history of fragility fracture, smoking, steroid use, and low body weight. The true incidence of these fractures in the United States is unknown, but a Finnish registry found an incidence of 438 per 100,000 people.⁶³

The diagnostic work-up for femoral neck fractures can be challenging. If plain radiographs do not reveal a fracture, if the patient is unable to ambulate, or if suspicion remains high, MRI should be performed, as discussed in the Diagnostic Studies, MRI section, page 7. (**See Figure 26 on this page and Figure 27, page 18.**)

Several classification schemes have been proposed for these fractures; however, no consensus exists because of their limited clinical usefulness and poor interrater reliability. These fractures should be termed either *nondisplaced* or *displaced*. (**See Figure 26 on this page and Figure 28, page 18.**)

Treatment For Femoral Neck Fractures

In the overwhelming majority of cases, treatment will be operative and orthopedic consultation will be required. Treatment strategies include screws,

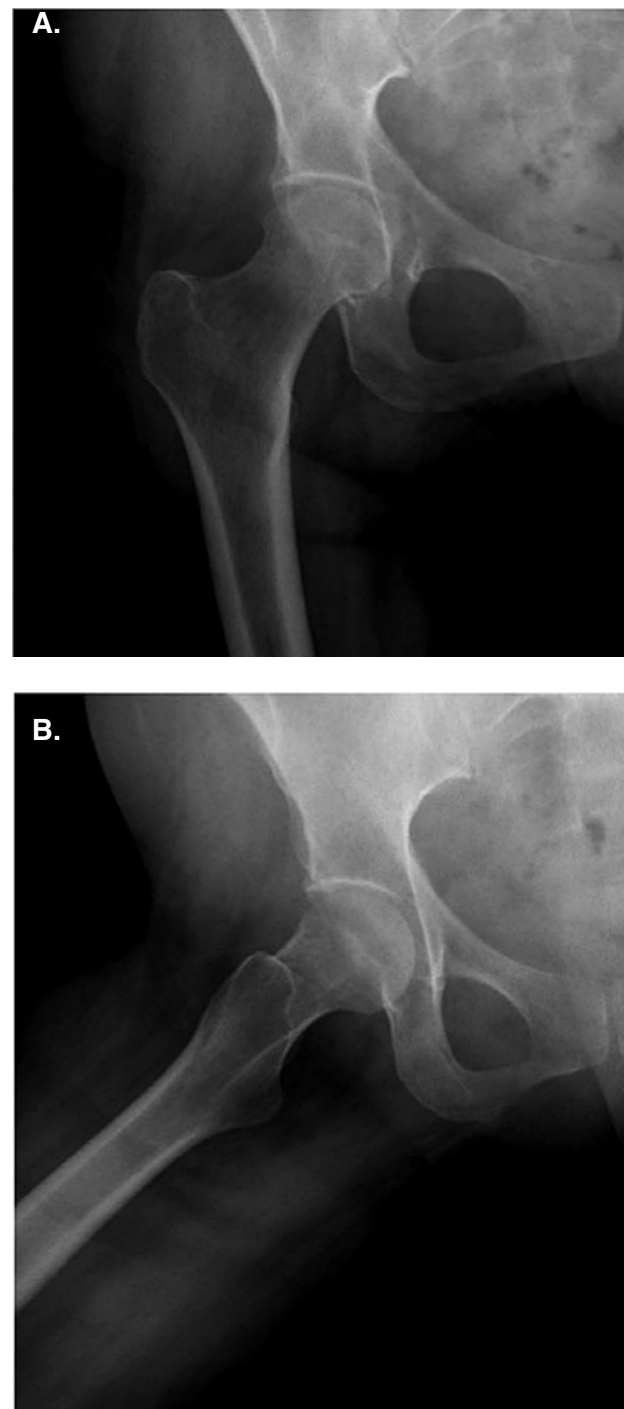
hemiarthroplasty, or total arthroplasty.

Pain control is key to management in the ED. A recent Cochrane Review found no benefit from the use of traction in patients with hip fractures.⁶⁴

Disposition For Patients With Femoral Neck Fractures

These patients will require orthopedic consultation and admission to the hospital.

Figure 26. Plain Films Of Occult Femoral Neck Fracture



A. Anteroposterior view. B. Lateral view.

Pelvic Insufficiency Fractures

Pelvic insufficiency fractures can pose a challenge for both diagnosis and treatment. They are overwhelmingly associated with osteoporosis but are less common than femoral neck insufficiency fractures, having an incidence of 92 per 100,000 (approximately one-fifth of the total number of femoral neck fractures) according to the Finnish registry.⁶⁵

The pubic rami are most commonly involved and can be isolated injuries. Rami fractures are more likely than sacral insufficiency fractures to be evident on plain radiographs; however, the miss rates remain high. In 2 radiology studies, miss rates with plain radiographs were 23% and 14%, respectively, for occult pelvic fractures, which predominantly involved the pubic rami.^{14,15} MRI remains the test of choice for patients with negative plain radiographs but for whom

Figure 27. MRIs Of Right Femoral Neck Fracture



A. T1. B. T2.

clinical suspicion of fractures remains high.

Treatment is aimed at pain control and mobilization, and hospital admission is often required. Recently, sacroplasty and ramoplasty (injection of cement into the sacral and rami fractures, respectively) have been described and used to treat these fractures.⁶⁶

Total Hip Arthroplasty Dislocations

Between 200,000 and 300,000 patients undergo THA each year in the United States. These numbers are expected to increase as the population ages. The dislocation rates for primary THA are 1% to 3%, with the rates increasing to 5% to 20% for revised THA.⁶⁷ In general, most dislocations occur within 3 months of surgery, but initial dislocations have been reported to occur more than 10 years after the operation. The majority (75% to 90%) of these dislocations are posterior.⁴⁹ (See Figure 29.)

The mechanism causing THA dislocation is of the low-energy type and usually involves some trivial movement such as rising from a seated position or leaning over to pick something up. Care should be taken when reviewing the radiographs to assess for loosening of components or periprosthetic fractures. Infection should always be considered as well, especially in patients with repeated dislocations.

Treatment for THA dislocations is the same as for native hip dislocations, and the standard techniques can be used. Timing of the reduction is not as critical as it is for other hip dislocations, since the femoral head has already been replaced; however,

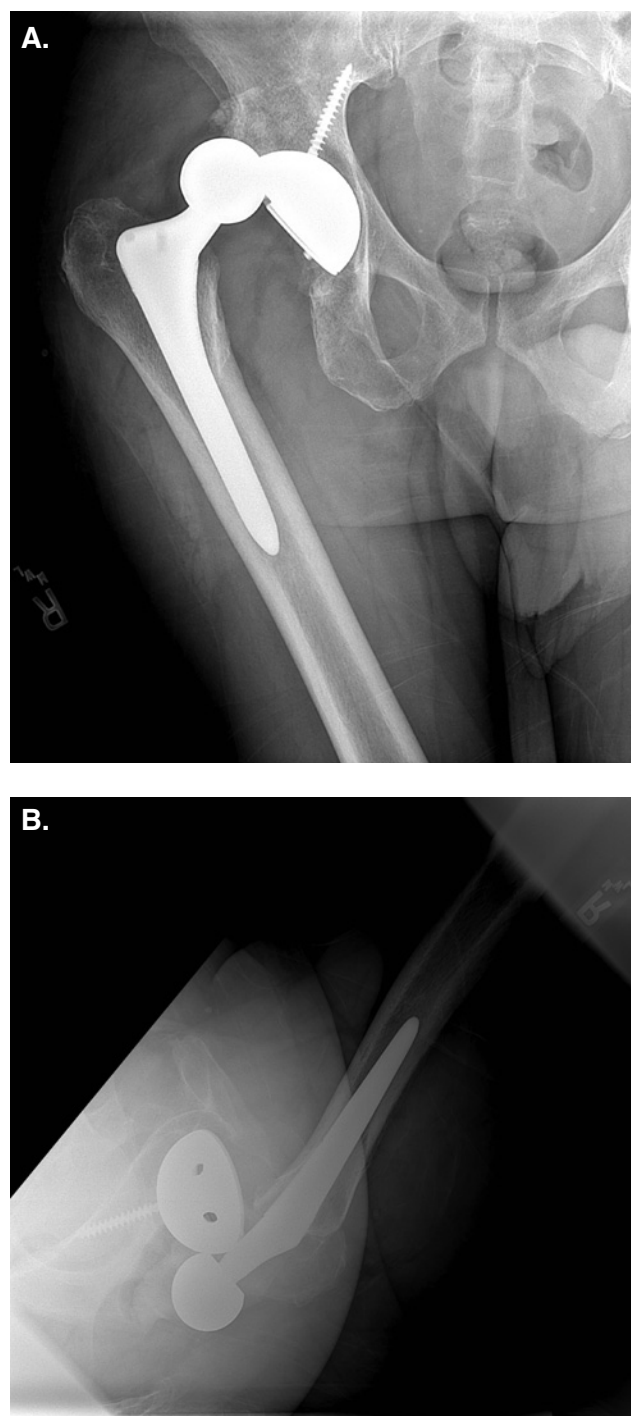
Figure 28. Displaced Left Femoral Neck Fracture



neurovascular compromise can still occur, and patient comfort should expedite the process. Complications can occur with the reduction, including loosening of the components, fractures, and movement of the acetabular cup. For these reasons, reduction of dislocation in a recent THA is best accomplished in close consultation with an orthopedic surgeon.

Orthopedic surgery should be consulted to assist with the reduction and to develop a long-term care plan for these patients.

Figure 29. Dislocated Total Hip Arthroplasty



A. Anteroposterior view. B. Lateral view.

Avulsion Injuries

Avulsion injuries occur most commonly during the forceful contraction of a muscle away from its bony origin, but they may also occur in the setting of trauma. These injuries generally occur in skeletally immature athletes from 14 to 17 years of age.⁶⁸ In adults, the occurrence of an avulsion injury in the absence of trauma should be considered pathologic until proved otherwise.

The most common sites for avulsion injuries, with the associated muscle noted, are as follows:

- Anterior superior iliac spine/sartorius (See Figure 30, page 20.)
- Anterior inferior iliac spine/rectus femoris
- Ischial tuberosity/hamstrings (See Figure 31, page 20.)
- Lesser trochanter (less commonly)/ iliopsoas

Avulsion injuries are treated with rest, ice, protected weight bearing, and anti-inflammatory agents. Surgery for these injuries is controversial; a possible indication would be ischial tuberosity avulsions that have been displaced more than 2 cm.⁶⁹

Summary

In the majority of pelvic and hip injuries, substantial forces have been involved; consequently, these patients have many associated injuries and should be managed as trauma patients. If trauma and orthopedic assistance is not available in the ED, the management goals should include stabilization and expedited transfer to a regional trauma center. Always be cognizant that any pelvic fracture can and will bleed, especially in the elderly. Hip dislocations should be reduced as soon as possible but certainly within 6 hours of the injury or sooner if there is neurovascular compromise. Attempts to reduce the dislocation should be made prior to transferring the patient. Emergency clinicians should maintain a high index of suspicion for occult femoral neck, hip, and pelvis fractures in the appropriate clinical situations. When radiographs are negative, MRI should be carried out.

Case Conclusions

On his arrival in the ED, the 20-year-old male was hypotensive and combative. You continued aggressive resuscitation and immediately secured the airway using rapid-sequence intubation, being careful with drug doses in the setting of hemorrhagic shock. Your examination of the head, neck, chest, and extremities were normal. There was bruising to the lower abdomen with blood at the urethral meatus.

A chest x-ray was normal and a pelvis x-ray revealed a severely displaced AP-compression injury with 4 cm of pubic diastasis. A FAST exam was negative for intraperitoneal fluid. Recognizing the severity of the patient's inju-

ries, you arranged for immediate transport to the trauma center. Prior to his departure, you wrapped a sheet tightly around his pelvis to reduce the diastasis, being careful to create symmetrical alignment of the lower extremities. You hung 1 unit of uncrossmatched blood and gave a second unit to the paramedics. At the trauma center, the

Figure 30. Anterior Superior Iliac Spine Avulsion

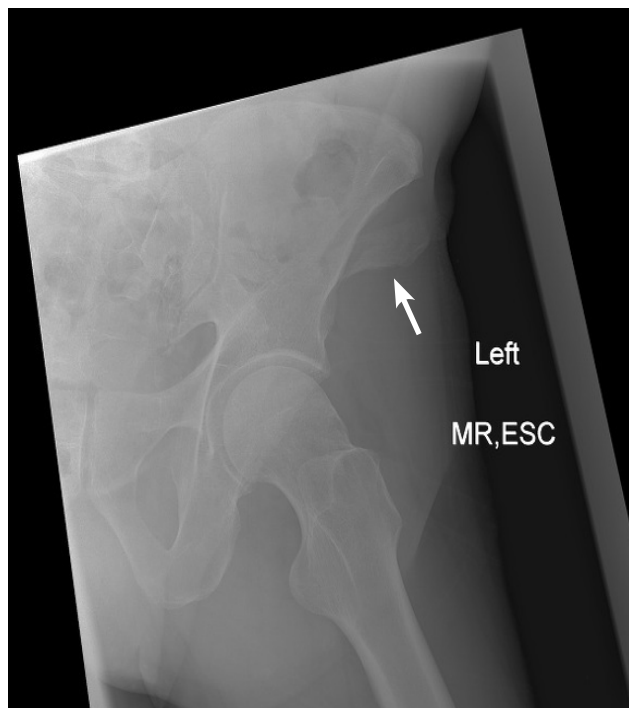


Figure 31. Ischial Tuberosity Avulsion



patient remained unstable and a repeat FAST remained negative. The patient was taken for immediate angiography and pelvic embolization.

The 14-year-old female suffered an avulsion injury to her anterior superior iliac spine. She was treated with conservative measures and was able to be discharged home.

The 80-year-old male incurred a lateral compression Type I injury. No other injuries were identified on examination or CT. When his blood pressure dropped, he was transfused and taken emergently to angiography, where his obturator artery was embolized.

Special Note

Photographs and radiographs are used with permission of James F. Fiectl, MD.

References

Evidence-based medicine requires a critical appraisal of the literature based upon study methodology and number of subjects. Not all references are equally robust. The findings of a large, prospective, randomized, and blinded trial should carry more weight than a case report.

To help the reader judge the strength of each reference, pertinent information about the study, such as the type of study and the number of patients in the study, will be included in bold type following

Cost-Effective Strategies

1. Use sheets or tape the legs to “wrap” a pelvis. Commercial binders have not been shown to reduce mortality or other clinically significant outcomes in patients with pelvic ring disruptions despite their ability to reduce pelvic volume. The pelvis should be wrapped to reduce volume and stabilize fragments, but cheaper methods — such as sheets or tape — can be used.
2. Not every trauma patient requires a pelvic radiograph. Duane et al²⁰ have identified criteria that, when all are met, indicated that a patient did not require pelvic radiographs (see page 6). These criteria are as follows:
 - a. GCS > 13
 - b. No pelvic, back, hip, or abdominal complaints
 - c. No tenderness over the bony pelvis, lower back, groin, hip, or lower abdomen
3. Consider gentle placement of a Foley catheter instead of automatic RUG. One recent case series did not find any worsening of bladder or urethral injuries after a blind, gentle attempt at Foley catheter placement.²⁴

Risk Management Pitfalls For Pelvis And Hip Injuries

1. "I'll get back to that hip reduction after these next few patients."

The incidence of avascular necrosis, posttraumatic arthritis, and permanent nerve palsy exponentially increases as the length of time the hip is left unreduced exceeds 6 hours. Hip dislocations are considered an orthopedic emergency and must be reduced as soon as possible, certainly within 6 hours.

2. "His fracture on x-ray did not look too bad."

Any pelvic fracture can and will bleed, and you must maintain a high clinical suspicion for that possibility. Elderly patients require less energy than younger patients to sustain fractures, have more benign-appearing radiographs, will need more blood transfusions, and will fare worse overall.

3. "Why do I need to hurry? It's a 'total hip' that is out."

True, a THA will not develop avascular necrosis, but the patient can still have a sacral nerve palsy requiring expedited reduction. Also, a dislocated hip hurts.

4. "The FAST was negative, so I stopped looking for intraabdominal injuries."

The sensitivity of the FAST exam ranges from 26% to 81% in blunt trauma patients with pelvic fractures. You need to keep looking, either with a CT scan or with DPA, based on the patient's hemodynamics.

5. "No big deal; I can put this THA back in place."

The reduction of THA is associated with significant complications, including movement of the acetabular cup, periprosthetic fractures, and loosening of the components. This reduction is best accomplished in close consultation with an orthopedic surgeon.

6. "Authorities say you don't need to do rectal exams in trauma patients anymore."

Assessing for open pelvic fractures via the

integrity of the rectal wall and palpable bone fragments is one of the few instances in which digital rectal examination adds to the clinical examination.

7. "X-rays look fine – that bone piece is just a growth center."

When evaluating a patient for possible avulsion injuries, obtain the AP view of the pelvis for contralateral comparison. This view may surprise you.

8. "Nice. The hip is back in, the patient woke up great. I'm done."

Failing to check postreduction stability is failing to complete the procedure. In addition, your orthopedic consultant needs this information for possible operative intervention. At the bare minimum, a painless examination under anesthesia could spare your patient a trip to the operating room.

9. "He just has an acetabulum fracture."

Fractures of the acetabulum are associated with similar rates of concomitant injuries as pelvic ring disruptions and require similar types of evaluation and management.

10. "I can't try to reduce his hip — he has a femoral head fracture."

In one case series, femoral head fractures occurred in 11.7% of hip dislocations, and the average success rate for closed hip reduction was 84.3%.⁶¹ As the patient's clinical status allows, attempt to reduce this hip. The only absolute contraindication to closed reduction attempt is a femoral neck fracture.

11. "Good news – your radiographs are negative. You probably just sprained your hip."

Plain radiographs have a miss rate of 4.4% for occult pelvis and hip fractures.¹⁶ An MRI should be performed when there is a high clinical suspicion for injury and osteoporosis or when the patient has risk factors for osteoporosis or is unable to ambulate.

the reference, where available. In addition, the most informative references cited in this paper, as determined by the authors, are noted by an asterisk (*) next to the number of the reference.

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1. What percentage of patients with a posterior hip dislocation will have a sciatic nerve palsy?
a. 1% b. 10%
c. 25% d. 50%
2. Which of the following is the test of choice to detect an occult pelvic and/or hip fracture with negative plain radiographs?
a. Judet views
b. MRI
c. CT scan
d. Bone scan
3. Which of the following is true regarding elderly patients and pelvic fractures?
a. They require greater energy to create fracture.
b. They are less likely to require blood transfusions.
c. Their fracture patterns are similar to those in young patients.
d. They will have a worse outcome overall.

4. The most common direction for a hip dislocation is which?
 - a. Posterior
 - b. Anterior
 - c. Inferior
 - d. Central
5. What is the time limit for hip reduction to reduce the likelihood of avascular necrosis?
 - a. 2 hours
 - b. 4 hours
 - c. 6 hours
 - d. 8 hours
6. What is the only absolute contraindication to closed hip reduction?
 - a. Femoral head fracture
 - b. Subtrochanteric fracture
 - c. Femoral neck fracture
 - d. Acetabulum fracture
7. Acetabulum fractures are generally benign, isolated injuries.
 - a. True
 - b. False
8. The less-common site for an avulsion injury is which?
 - a. Anterior superior iliac spine
 - b. Anterior inferior iliac spine
 - c. Lesser trochanter
 - d. Ischial tuberosity

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EVIDENCE-BASED PRACTICE RECOMMENDATIONS

An Evidence-Based Approach To Managing Injuries Of The Pelvis And Hip In The Emergency Department

Fiechtl JF, Gibbs MA. December 2010, Volume 12; Number 12

This issue of Emergency Medicine Practice discusses management of several common hip and pelvis injuries. For a more detailed discussion of this topic, including figures and tables, clinical pathways, and other considerations not noted here, please see the complete issue on the EB Medicine website at www.ebmedicine.net/topics.

Key Points	Comments
Any pelvic ring disruption can be associated with life-threatening hemorrhage.	The most common source of bleeding—and unfortunately the most difficult to control—is venous bleeding. A venous source is identified in 80% to 90% of cases. ³¹ Several case series have illustrated the need for blood transfusions in these patients: 38.5% of hospitalized trauma patients with pelvic fractures required transfusion, as did 34% of trauma patients with isolated pelvis and acetabulum fractures in another case series. ^{6,32}
Not every trauma patient requires a pelvic radiograph. Two recent studies showed plain radiographs had poor sensitivity to detect fractures (64% and 78% respectively) and resulted in no management changes ^{17,18} ; however, an important point to consider with these studies is that every patient underwent computed tomography (CT) scanning, which did guide treatment.	Duane et al suggested that pelvic radiographs might be unnecessary in patients who have a GCS > 13; have no complaints of pain in the abdomen, back, hip, or groin; and experience no tenderness in these areas or over bony landmarks. After following these patients clinically, the authors reported that the protocol had 100% sensitivity and that 273 pelvic radiographs were avoided. ²⁰
Pelvic ring disruptions with hemodynamic instability require “wrapping” and emergent trauma/orthopedic consultation. Stabilize and transfer patients expeditiously to your regional trauma center.	In a recent systematic review designed to assess the effectiveness and complications of external pelvic compression in patients with unstable pelvic fractures, the authors concluded that this maneuver has 3 advantages: (1) it provides effective biomechanical stabilization to the disrupted pelvic ring, (2) it reduces blood loss, and (3) it is not associated with life-threatening or limb-threatening complications. ⁴⁰
Posterior hip dislocations represent 90% of all hip dislocations. Significant force is required to dislocate a hip; treat these patients as major trauma patients.	Reduction should be performed within 6 hours to lessen the likelihood of avascular necrosis, permanent nerve palsy, and posttraumatic arthritis. The likelihood of complications greatly increases as the length of time the hip remains dislocated increases. ^{52,53} In the event of neurovascular compromise, reduction should be expedited.
Become familiar with the various hip reduction techniques; become an expert at 2 or 3 methods. Multiple attempts at closed reduction should be avoided.	Overall, the success rates for closed reductions are between 85% and 98%. ⁵⁵ In a more recent systematic review evaluating hip reduction for dislocations and femoral head fractures, the success rate was 84.3%. ⁵⁶

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REFERENCES

These references are excerpted from the original manuscript. For additional references and information on this topic, see the full text article at ebmedicine.net.

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