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Early recognition and treatment of pelvic fractures

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Mr. L, 25, is involved in a motorcycle crash. *The prehospital report states his vital signs as follows: temperature, 96.9° F (36.1° C); heart rate, 136 and regular; respirations, 25 breaths/min with an Spo_2 of 93% on a nonrebreather mask; BP, 88/60 mm Hg; and Glasgow Coma Scale (GCS) score, 15 (patient can spontaneously open his eyes, is oriented, and obeys all commands[1]). Mr. L had been wearing a helmet and denies loss of consciousness. In the field he complains of severe pelvic pain and his lower extremities are externally rotated. Suspecting a pelvic fracture, emergency responders apply a pelvic binder.*

After the prehospital call is accepted at the receiving facility, the trauma team assembles, reviews prehospital information, and develops a prearrival plan based on the mechanism of injury, scene assessment, and vital signs. The plan includes a focus on the potential for pelvic injury with hemorrhage into the pelvic cavity, coagulopathy, hypothermia, and immediate transport to the OR or interventional radiology (IR). The trauma nurse prepares for the administration of massive fluid and blood product resuscitation by setting up the rapid infuser and notifying the blood bank regarding the potential need for immediate type O-negative blood transfusion as well as fresh frozen plasma, platelets, and cryoprecipitate. Warming measures include increasing the room temperature, providing warm blankets, and preparing to administer warm I.V. fluids.

PELVIC FRACTURES can range from minor to complex with associated life-threatening injuries. Systematically and quickly identifying the type of pelvic fracture a patient has, along with any associated injuries, optimizes resuscitation efforts and improves long-term outcomes. This article reviews the case study of a patient who sustained a pelvic fracture and discusses his treatment along with an overview of pelvic anatomy and types of fractures.

Incidence and mortality

Pelvic fractures, which represent approximately 10% of traumatic injuries treated in urban trauma centers in North America, typically result from a high-velocity impact.[2] They can be life-threatening; overall mortality for all pelvic fractures ranges from 5% to 30%.[3] For closed pelvic fractures with hypotension, mortality ranges from 10% to 42%.[3] Higher mortality is associated with systolic BP (SBP) below 90 mm Hg on a patient's arrival at the hospital.[4-6] Mortality rises to 50% for patients with open pelvic fractures.[3] Death is usually associated with internal injuries or exsanguination following injury to the venous and arterial beds that run through the pelvis. The sharp edges of a fractured bone can easily lacerate surrounding structures, leading to further injury. When bleeding occurs, it's usually venous (85%) rather than arterial (15%).[4]

Motor vehicle collisions, including motorcycle crashes, are the most common mechanisms for pelvic fractures, followed by pedestrians being struck by motor vehicles and falls.[4] Risk factors that place a patient at greater risk for sustaining a pelvic fracture include low bone mass, smoking, and, in women, pelvic ligamentous laxity and a history of hysterectomy.[4] Older adults are at particular risk for pelvic fracture from falls due to age-related factors such as osteoporosis and stiffening of ligaments, joint capsules, and other structures.[3] Early recognition and treatment of a pelvic fracture can prevent or minimize potential complications.

Pelvic anatomy

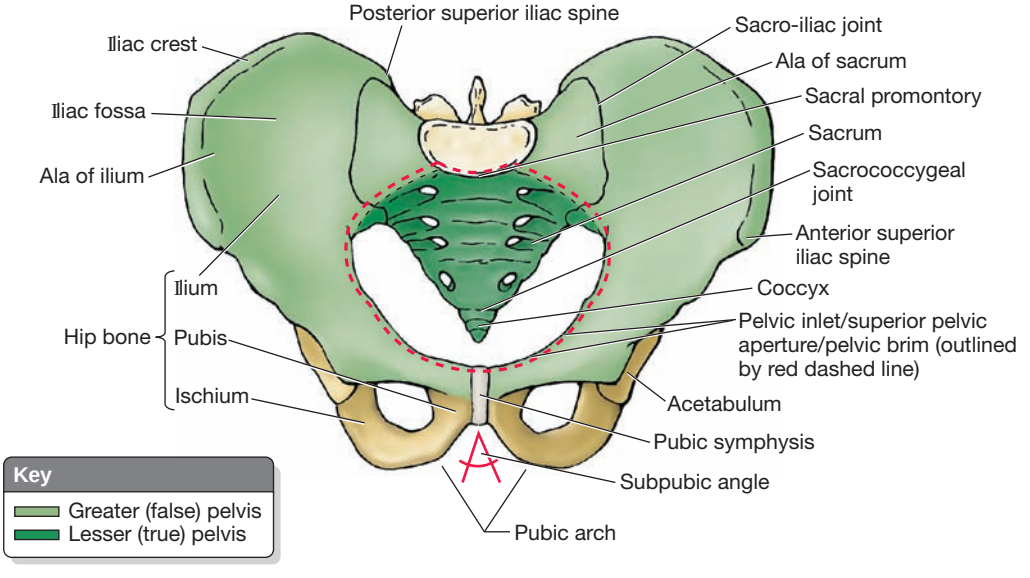
The bony pelvis is comprised of the right and left hip bones and the sacrum. (See *Reviewing pelvic anatomy: Anterior view*.) Complex ligamentous structures throughout the pelvis help the bony structures stabilize the pelvis. Disruptions of these ligaments lead to instability. If the anterior pelvic ligaments are disrupted, rotational instability occurs.[7] The ligaments in the posterior region of the pelvis are the strongest; they connect the sacrum to the innominate bones and withstand weight-bearing forces transmitted across the sacroiliac (SI) joints from the lower extremities to the spine.[7] Posterior ligamentous injury affects both rotational and vertical stability. (See *Pelvic ligaments: Posterior view*.)

The pelvis is rich with blood vessels that run within the pelvic cavity. The venous system parallels the arterial system. The thin-walled venous plexus, which lies anterior to the sacrum, is highly susceptible to injury.[4]

The common iliac, lumbar, and sacral arteries branch off the

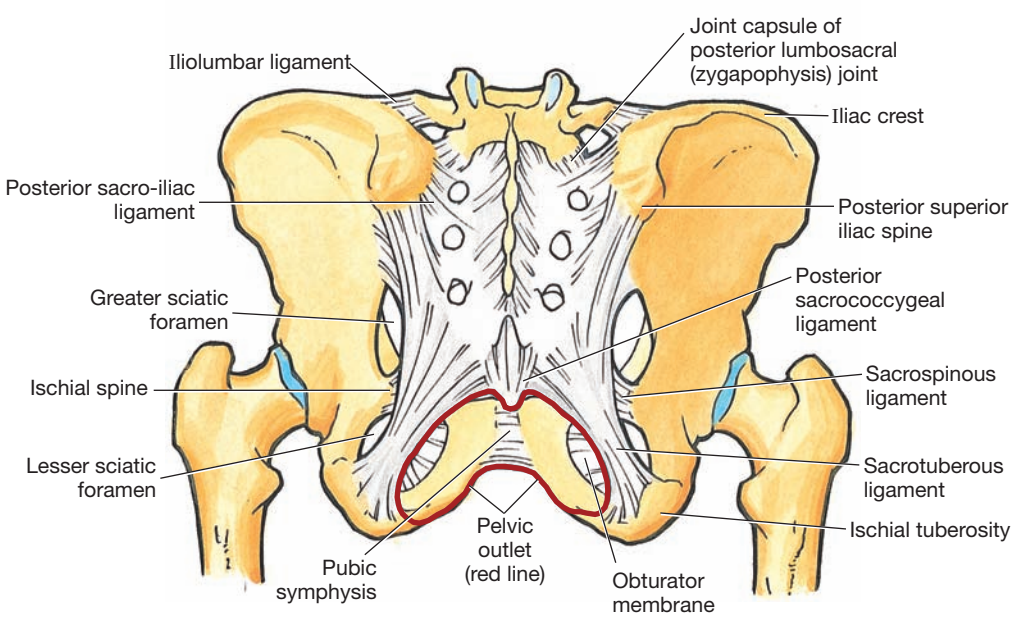
Reviewing pelvic anatomy: Anterior view

Each hip bone consists of the ilium, ischium, and pubis bones, which fuse at puberty. The sacrum is formed by the fusion of the five sacral vertebrae. Forming a bony ring called the *pelvic girdle*, the hip bones join the pubic symphysis anteriorly and the sacrum posteriorly at the sacroiliac joints.



Source: Moore KL, Agur AMR, Dalley AF. *Essential Clinical Anatomy*. 4th ed. Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams & Wilkins; 2010:206.

Pelvic ligaments: Posterior view



Source: Moore KL, Agur AMR, Dalley AF. *Essential Clinical Anatomy*. 4th ed. Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams & Wilkins; 2010:207.

abdominal aorta. The internal iliac artery branches off of the common iliac to supply blood to the pelvis wall and viscera. The external iliac artery becomes the femoral artery.[4] (See *Arteries of the male pelvis: Median section*.)

Nervous system structures within the pelvis include the sacral plexus (lumbar nerves 4 and 5, and sacral nerves 1–3), femoral nerve, sciatic nerve, obturator nerve, superior gluteal nerve, pudendal nerve (S2-S4), and autonomic nerve (S2-S4), with the latter two responsible for the erectile mechanism in men.[4] Injury to these complex nervous system structures can be functionally devastating and cause long-term complications. (See *Nerves of the pelvis: Medial view*.)

Besides the bones, ligaments, blood vessels, and nerves, many other structures are found within the pelvic ring: bladder, urethra, ureters, small bowel, sigmoid colon, rectum, female reproductive organs, and prostate. All of these structures are at risk for injury due to their close proximity to the bony structures. For example, pubic bone fractures are frequently associated with lower urinary tract injuries. In men, segments of the urethra near the pubic rami and the puboprostatic ligaments are particularly vulnerable; injury usually occurs at the junction of the membranous and bulbar urethra.[2]

Assessing pelvic stability

Pelvic stability should be assessed only if clinically necessary. It shouldn't be assessed in patients with shock and/or an obvious fracture because this could dislodge the blood clot that has already formed.[3]

If assessing pelvic stability is appropriate, it can be performed by compressing the iliac crests anteriorly to posteriorly and laterally to medially, followed by anterior to posterior compression of the symphysis pubis while assessing for pain, grinding, or movement. If any of these occur with palpation, stop and apply a pelvic binder. This exam should be performed only once by one examiner to prevent further bleeding.[1,3,8] In cases where a pelvic binder was placed in the prehospital setting, pelvic stability assessment isn't performed and the team relies on diagnostic study findings.

A pelvic binder or sheet can be applied by centering the binder/sheet over the greater trochanters, covering the buttocks, wrapping anteriorly over the pelvic region, and tightly securing. These devices have been shown to be beneficial for unstable patients by compressing the pelvis, stabilizing the bones, and limiting blood loss.[1,3,8]

Classifying pelvic fractures

Pelvic fractures are commonly classified according to the Tile or the Young-Burgess classification systems. The ***Tile classification system***, which is based on the integrity of the posterior SI complex and stability of the pelvic ring, identifies three subtypes of injuries.

- Type A: Rotationally and vertically stable. This type of pelvic fracture has an intact posterior SI complex and is treated nonsurgically.
- Type B: Rotationally unstable and vertically stable (partially stable). This may involve an anterior fracture/displacement of the pubis symphysis or rami and some rotational instability, but no vertical or posterior displacement.
- Type C: Rotationally unstable and vertically unstable (unstable).

The posterior SI complex is completely disrupted, resulting in an unstable fracture both vertically and rotationally.[9,10]

The ***Young-Burgess classification system*** is based on mechanism of injury and direction of force. The more commonly used classification system for pelvic fractures, it classifies pelvic fractures according to anteroposterior (AP) compression, lateral compression (LC), vertical shear, and combination type of injury.[11] AP compression and LC are further divided into types I, II, and III.[3] (See *Young-Burgess classification for pelvic ring fractures*).

Assessing for associated injuries

Disruption of blood vessels due to a traumatic pelvic injury can lead to significant bleeding. Indicators for hemorrhage are widening symphysis and/or SI joint, and/or vertical shear at the SI joint.[2] Factors placing a patient at higher risk for pelvic fractures with hemorrhage include age over 60 years, SI joint disruption, hypotension with a SBP less than 100 mm Hg, and female gender.[4]

Patients experiencing traumatic pelvic fractures face a slightly higher risk for associated thoracic aorta injury compared with the overall trauma population due to the higher energy of mechanism associated with pelvic fractures.[4,12] Additionally, the disruption of the pelvic bones or an untreated urologic or gynecologic injury can cause long-term consequences such as incontinence, urinary dysfunction, dyspareunia, dysmenorrhea, difficulty with vaginal childbirth, sexual dysfunction, gait disturbance, and chronic pain.[12,13]

Open pelvic fractures place the patient at risk for sepsis.[6] Suspect an open pelvic fracture if blood is noted in the vagina or rectum. A careful exam should be performed to check for associated perineal lacerations that can involve the anus, rectum, vagina, and/or urethra. The extent of injury can usually be determined by digital rectal exam (DRE) followed by sigmoidoscopy, if indicated. A vaginal exam should be performed in women.[4]

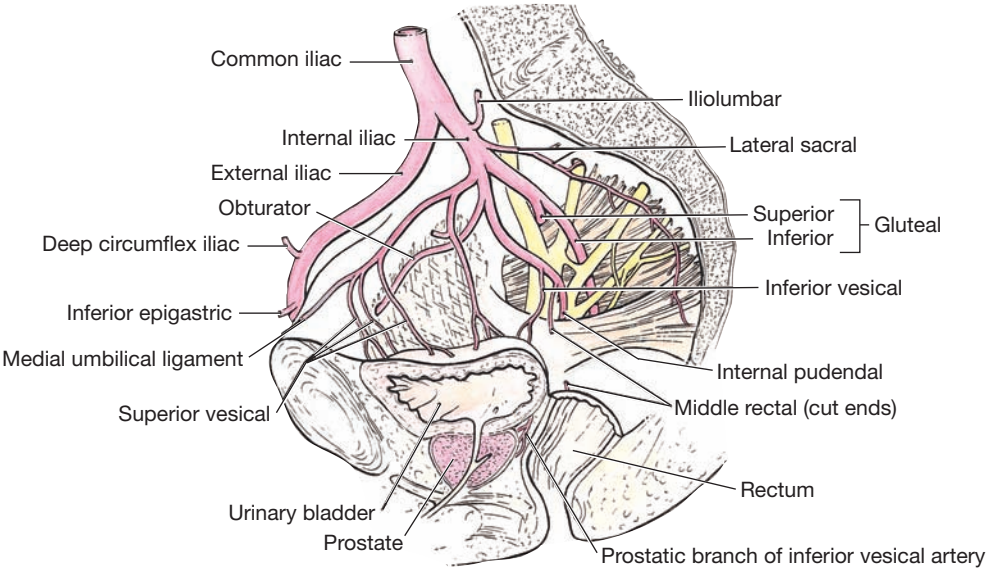
The highest risk of urethral damage is associated with straddle injuries with diastasis (separation) of the SI joint. A straddle injury most often occurs in motorcycle crashes but can also occur in bike crashes or falls where the force of impact compresses the pelvis anteriorly, posteriorly, and laterally.[1,3,4] The widening of the symphysis pubis and the SI joint are predictors of bladder injury, while fractures of the superior and inferior pubic rami and widening of the pubic symphysis are most commonly associated with urethral injuries.[2] Other indicators of genitourinary trauma are blood at the meatus, a high-riding or boggy prostate, and/or perineum ecchymosis. Although blood at the meatus can signify urethra injury, lack of blood doesn't rule it out. Bladder and reproductive organ injuries occur differently in men and women due to their anatomical differences. (See *Gender differences in genitourinary trauma.*)

On alert for associated problems

Complications associated with unstable pelvic fractures can affect the following systems.

Cardiovascular: Closely monitor vital signs and intake and output. Patients with pelvic fractures are at

Arteries of the male pelvis: Median section



Source: Moore KL, Agur AMR, Dalley AF. *Essential Clinical Anatomy*. 4th ed. Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams & Wilkins; 2010:221.

high risk for coagulopathy secondary to hypothermia and acidosis and can require several units of blood. Thrombocytopenia can occur secondary to consumptive coagulopathy. Transfusions should be 1:1 (packed red blood cells:fresh frozen plasma). For every 6 units of packed red blood cells, administer 1 unit of platelets as prescribed.[14]

Pulmonary: Monitor the patient for signs and symptoms of acute lung injury (ALI) such as worsening hypoxemia. ALI occurs from critical injury, over-resuscitation, and transfusions.

Another potential complication of pelvic fracture is venous thromboembolism (VTE) as a result of endothelial damage, immobility, and trauma-induced hypercoagulability. VTE prophylaxis, such as low-molecular-weight heparin, should be initiated as soon as the patient is hemodynamically stable.[15] If pharmacologic prophylaxis can't be initiated, an inferior vena cava filter should be considered. Computerized tomography (CT) angiography of the chest should be considered if pulmonary embolism is suspected.[16]

Fat embolism syndrome (FES) is most commonly associated with long bone and pelvic fractures. Signs and symptoms include altered sensorium, petechiae, thrombocytopenia, and pulmonary infiltrates.[17,18] If FES is suspected, treatment remains supportive and includes neurologic assessments and monitoring of oxygenation and saturation. In severe cases, the patient may require ventilatory support.[17]

Abdominal/genitourinary: Monitor the patient for delayed abdominal injury. Vulnerable abdominal structures that may be injured by pelvic trauma are the spleen, liver, and bowel. Even if a patient presents with a negative abdominal CT, clinicians should have a high index of suspicion for a bowel injury if the patient develops fever, leukocytosis, abdominal pain, and absent bowel sounds.

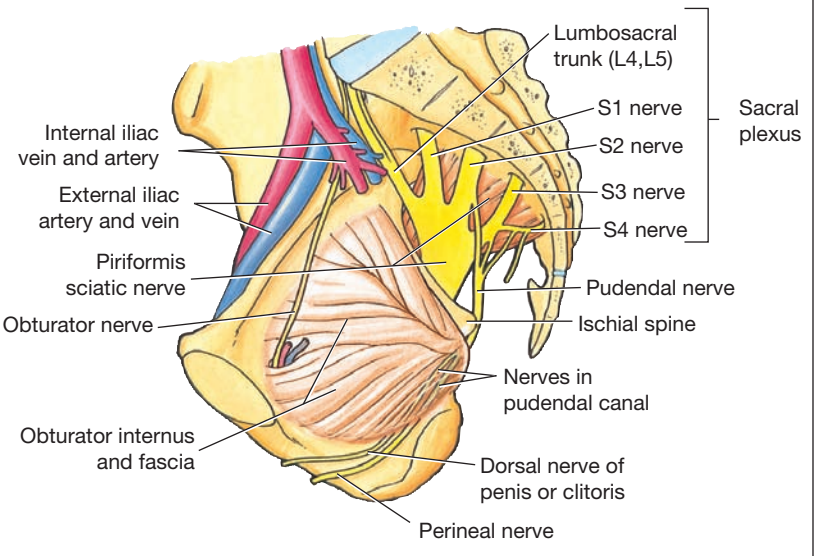
Monitor urine output and characteristics. The kidneys are very sensitive to hypovolemia and hypotension. Maintain urine output at >1 mL/kg/hour.[1,3,8]

Neurovascular: Accurately document sensory and motor function of all extremities, including grading of muscle strength. Document the presence of pulses, including grading of amplitude. Neuropathies can occur with unstable pelvic fractures and are usually associated with sacral fractures and/or high instability of the pelvic ring.[2,19,20]

Physical and occupational therapy should be consulted early to address any neurologic deficits such as peroneal nerve injury (foot drop). Administer medications as prescribed to help with neurogenic pain.

Skin: A comprehensive skin assessment should include the perineal area, groin, and buttocks. An open wound can signify an open pelvic fracture and places the patient at high risk for sepsis. Assess wounds for contamination and provide wound care per facility policy. If an external fixator is in place, assess pin sites for signs of infection or loosening per facility policy. These patients are at high risk for skin breakdown, especially if they required embolotherapy for pelvic arterial bleeding. In male patients with significant scrotal edema, use a towel roll to elevate the scrotum for comfort.[1]

Nerves of the pelvis: Medial view



Source: Moore KL, Agur AMR, Dalley AF. *Essential Clinical Anatomy.* 4th ed. Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams & Wilkins; 2010:219.

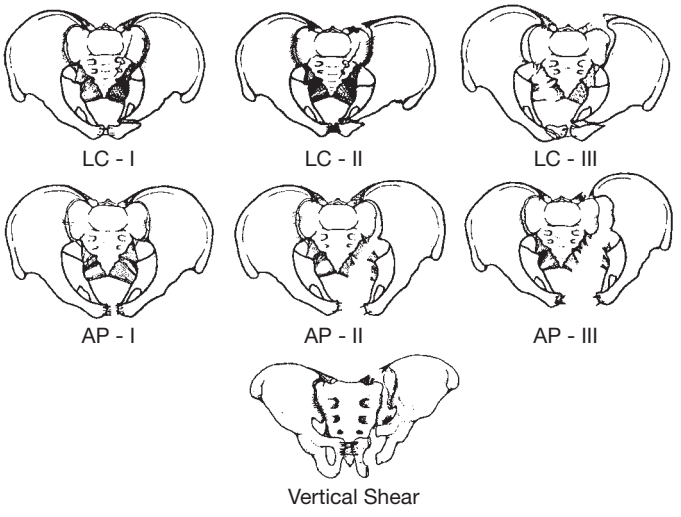
Treating pain

Untreated pain can delay recovery by limiting the patient's ability to participate in therapies. Pelvic pain that's difficult to control or that worsens postoperatively may indicate malunion or nonunion and require immediate intervention. However, chronic pelvic pain isn't uncommon, especially with more complex pelvic fractures, and may be associated with osteoarthritis of the SI joint or nerve damage.[20]

Initial care in the ED

Mr. L arrives at the hospital with a cervical collar, pelvic binder, and nonrebreather mask providing high-flow oxygen at 15 L/minute. A primary survey is conducted: A-Airway maintenance with simultaneous cervical spine stabilization, B-Breathing and ventilation, C-Circulation with hemorrhage control, D-Disability (brief neurologic exam), and E-Exposure/environmental controls.[1,3,8] The patient's airway is patent and he's awake and verbalizing severe pelvic pain with a pain intensity rating score of 10/0-10. Respirations are spontaneous with clear bilateral and equal lung sounds; no chest wall

Young-Burgess classification for pelvic ring fractures



Source: Egol K, Koval KJ, Zuckerman JD. *Handbook of Fractures.* 4th ed. Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams & Wilkins; 2010:337.

ecchymoses or other abnormalities are visible. All peripheral pulses are intact with no obvious signs of uncontrolled external bleeding.

Two large-bore I.V. catheters are placed and an I.V. infusion of warmed 0.9% sodium chloride solution is initiated to prevent further hypotension and hypothermia. Mr. L's GCS score is 15 and his pupils are equal in size and reactivity to light. Externally rotated lower extremities are noted. Vital signs are: temperature, 98.2º F (36.8º C); heart rate, 130; respirations, 24 breaths/min with an Spo_2 of 99% on a nonrebreather mask; BP, 96/62.

Mr. L is attached to a cardiac monitor, which reveals sinus tachycardia. Blood specimens are obtained for a complete blood cell count, electrolytes, coagulation profile, and type and crossmatch. Mr. L's family is notified. His pain is controlled with I.V. morphine with a pain intensity rating score of 3/0-10.

Gender differences in genitourinary trauma[6,11,13,18]

Men	Women
• Urethral trauma is more common because the urethra is longer and less protected.	• Urethral injuries are usually near the bladder neck and almost always related to pelvic injury.
• If the bladder is full and forcefully pulled during a traumatic event, the bulbous portion of the urethra frequently ruptures.	• Vaginal lacerations may also be associated with anal sphincter injuries and need to be reapproximated.
• Penile injuries can occur from straddle-type traumatic events.	• Uterus, ovaries, and vagina all lie within the pelvis. These structures need to be evaluated and injuries ruled out during the workup.
• The prostate lies between the bladder and pelvic floor and is protected by a dense fascial membrane. The urethra passes through the prostate and exits at the pelvic floor. A prostate injury associated with a pelvic fracture is rare and is caused by a high-energy force.	

A head-to-toe physical assessment is completed. Tenderness to palpation is noted in the lower abdominal quadrants without abdominal distension. A focused assessment with sonography in trauma is performed simultaneously and is negative for any free fluid.[5,8] Free fluid can signify injury to an organ such as the bowel, stomach, or bladder.

Blood is noted at the penile meatus along with scrotal edema and ecchymosis, so a urinary catheter can't be inserted until a retrograde urethrogram (RUG) is performed to prevent further injury and/or misplacement of the urinary catheter.[1,3,8] After Mr. L is log-rolled, his spine is examined, followed by a DRE that reveals a high-riding prostate without rectal blood. (The prostate surrounds the urethra just below the urinary bladder and can be palpated during a DRE. If the urethra is injured, the prostate can be displaced.[3] In this case the prostate was displaced into a higher position than normal.) No other exam findings are abnormal.

Mr. L's chest X-ray is normal but pelvic X-rays reveal an open-book pelvic fracture with a pubic symphysis widening of 4.5 cm. (An open-book pelvic fracture is a separation of the right and left side of the pelvis.[1,3]) The RUG confirms transection of the urethra and a urologist is consulted for insertion of a suprapubic catheter.[12,13]

Initiating a treatment plan

Mr. L's BP remains at 96/62 mm Hg. The decision is made to perform a CT scan of the head, cervical and lumbar spine, chest, abdomen, and pelvis. The CT scan reveals a retroperitoneal hemorrhage with an open-book pelvic fracture. Cystography shows the bladder to be intact.

Upon Mr. L's return to the trauma bay, his BP drops to 80/55 mm Hg and his heart rate increases to 140 despite infusion of 2 L of a crystalloid solution. Two units of type O-negative blood are administered and a stat consult to IR is obtained for suspected pelvic hemorrhage.

In the IR suite, embolization of the bilateral internal pudendal arteries (arteries that branch off the internal iliac

artery) is performed. Postprocedure, Mr. L's BP stabilizes at 110/60 mm Hg and his heart rate is 115. He's admitted to the ICU for continued monitoring and treatment.

The orthopedic surgeon evaluates Mr. L and places an anterior external fixator. Definitive open reduction and internal fixation of the pelvic fracture will occur after Mr. L is hemodynamically stable and the risk of pelvic bleeding decreases.

While hospitalized, Mr. L undergoes physical therapy. Three and a half weeks after his injury, he's discharged to home with appointments for outpatient physical therapy and follow-up with his orthopedic surgeon.

Fast action improves outcomes

Pelvic fractures are associated with high mortality due to hemorrhage that may occur with minimal external signs. Prompt, focused assessment for acute and chronic complications and associated injuries helps ensure that patients receive appropriate treatment quickly, improving outcomes. ■

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