Pete Tilney, DO, EMT-P, and Kenneth Palazzo, FP-C, CIC

Sixty-Eight-Year-Old Woman with Pelvic Trauma

A 68-year-old woman was brought to a community hospital in the northeastern United States via local ground emergency medical service (EMS) after being knocked down by a slow-moving, large snowplow truck and subsequently backed over. First responders to the scene reported that she attempted to ambulate but could not because of severe bilateral hip and groin pain. Additionally, she attempted to refuse care and transport by EMS. With some coaxing and explanation of the potential for grave internal injury, she agreed to be transported to the local community hospital for care and evaluation. During transport, she was fully spinal immobilized, given supplemental oxygen, and started on one peripheral intravenous line with crystalloid solution.

On arrival at the community hospital emergency department (ED), the patient presented awake, alert, and oriented, with good recall of the traumatic event, and complained primarily of severe bilateral hip and groin pain with associated generalized back discomfort. She denied any associated complaints of pain, discomfort, or respiratory distress. During her initial evaluation at the ED, the patient underwent routine radiologic studies, including computed tomography (CT) scans of the head, neck, chest, abdomen, and pelvis. The studies showed right-sided hemopneumothorax, pneumoperitoneum, and an open book pelvic fracture.

A chest tube was placed on the right, initially draining 1,050 mL frank brisk blood, which subsequently abated. In an effort to stabilize her open book pelvic injury, a sheet wrap splint was placed. During her initial resuscitation, she was also noted to be significantly hypotensive, and despite aggressive fluid resuscitation with 3 L crystalloid, she remained hemodynamically unstable. With her continued low blood pressure, ED staff began initiating transfusion of packed red blood cells (PRBCs). Emergent transport to a level 1 trauma center was arranged, because the community hospital was without advanced orthopedic, vascular, or trauma capabilities.

The nearest level 1 trauma center was approximately 45 miles driving distance from the community hospital, through mountainous terrain, with a drive time longer than 1 hour. Given the prolonged out-of-hospital time during patient transfer and critical nature of her condition, rotor-wing critical care transport was requested to move the patient to tertiary care.

The nearest available aircraft (54 nautical miles from the requesting hospital) was alerted and accepted the patient mission. Approximately 40 minutes after the initial request for air medical transport, the critical care flight crew, consisting of a nurse and paramedic, were at the patient's bedside. The flight crew found the patient awake and alert with profound complaint of bilateral pelvic pain. Fentanyl IV was administered for analgesia, with a dose of Zofran for a vague complaint of nausea. The patient was re-immobilized on a long spine board with a cervical collar and moved to the aircraft for transfer. The sheet that was used for pelvic stabilization remained in the same position.

During air transport, the first unit of PRBCs was completed, and the patient's blood pressure remained 90/60. A second unit was initiated because of continued concern for hypovolemic shock. Transport was completed at the rooftop helipad of the trauma center. The patient was offloaded and moved to the ED, where the awaiting trauma team assumed her care. Her presentations remained consistent, with a total of 1,050 mL blood collected from the chest tube, blood pressure of 75/56, heart rate 81 beats per minute, SpO_2 96% with a 10 L/minute nonrebreather mask in place.

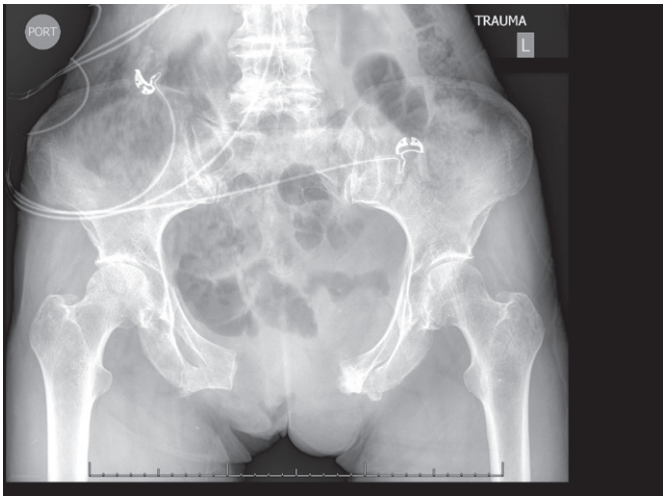
The pelvic sheet splint was found to have significant laxity and was displaced upward to the lower abdomen over the pelvic crests (Fig. 1). The sheet splint was immediately placed in the correct position, tightened, and bound with surgical clamps. The patient reported her pelvic pain as now 10/10, sharp, deep, and radiating "into her bones."

During the resuscitation in the ED, the patient received 2 additional units of PRBCs and 2 units of fresh frozen plasma, and a more comprehensive review of imaging studies was competed. The initial anterior/posterior (AP) pelvis X-ray showed a single view of the pelvis, of which there were marked diastases of the pubic symphysis separated by at least 5 cm. There were fractures of both the left superior and inferior pubic rami, which extend into the left acetabulum. Within the urinary bladder, there were multiple filling defects. Review of the abdominal CT showed grade II liver laceration and a 1-cm laceration in the mid-pole of the right kidney with a moderate amount of retroperitoneal blood. Additionally, fractures of the right transverse processes at L1, L2, L3, and L4 were identified.

Because of her continued hemodynamic instability and noted injuries on the CT scan, the patient was released to trauma surgery for emergent open laparotomy, angiography, and orthopedic intervention. On moving the patient from the ED to the operating suite, the patient remained lucid with vital signs as follow: blood pressure 116/75 mmHg; heart rate 83 beats/minute; respirations 14 breaths/minute and unlabored; SpO_2 95% with 10 L/minute nonrebreather mask.

While in the operating room, the patient underwent exploratory laparotomy and suture ligation of an involved lumbar artery. The ruptured right hemidiaphragm was repaired. The patient also underwent a repair of a ruptured perirenal hematoma, which had ruptured into the peritoneal cavity. Concurrently, she underwent an intraoperative pelvic angiogram, with successful embolization of several large veins and arteries. The bladder was noted to be ruptured but did not require any additional emergent repair. The abdomen was packed and left open for anticipated subsequent surgical repair.

Figure 1. Initial pelvis X-ray at the community hospital



After the emergent explorative laparotomy, the patient was admitted to the surgical intensive care unit and remained for the next 3 weeks. During this time, she was returned twice to the operating room for pelvic ring closed reduction, application of multiplanar external pelvic fixator, and secondary investigation of intra-abdominal hemorrhage. No complications were identified, and her abdomen was closed. She required additional evaluation and treatment for noted hemopneumothoraces, including an additional tube thorocostomy for a developed pneumothorax on the left. On week 3 in the unit, she was successfully extubated and moved to the trauma step-down unit.

The patient remained in the trauma step-down unit for the next week. Repeat pelvic X-rays showed improved degree of diastasis of pubic symphysis, measuring 2.5 cm, and it was felt the patient was stable enough for transfer to rehabilitative care. Four weeks after the trauma, she was discharged from the tertiary trauma center to an off-site rehabilitative center. She remained unable to bear weight and was wheelchair bound, pending rehabilitation.

Discussion

Patients who present with pelvic trauma provide a diagnostic and management challenge for prehospital, ED, and trauma surgery staff. The variety of pelvic injures that can occur range from a simple isolated, nondisplaced fracture to complete disruption of the pelvic girdle with hemodynamic instability. It is the role of the initial emergency provider to rapidly identify these injuries to ensure that thorough and comprehensive diagnostics with therapeutic interventions occur immediately.

Although pelvic fractures can occur during low-energy scenarios (ie, falls from standing position), these injuries are typically classed as minor fractures with minimal hemodynamic instability. Patients involved in high-energy blunt trauma, including motor vehicle crashes, falls from a height, or pedestrian versus motor vehicle accidents, can present with significant injuries with unstable vital signs. Fractures of the pelvic ring account for 0.3% to 8.2% of fractures that occur in the setting of blunt trauma.[1-4] When they are identified, they can serve as a marker of excessive force being applied to the body and are typically associated with other type of traumatic injuries. In 80% of patients with unstable pelvic ring injuries, other musculoskeletal injuries are also present.[3]

In the setting of blunt trauma, hemodynamic instability associated with unstable pelvic fractures is a relatively rare event, comprising less than 10% of all pelvic fractures presenting to level 1 trauma centers.[3] To disrupt the pelvic ring to the point that hemodynamic instability occurs, a patient must have an instantaneous deceleration of greater than 30 miles an hour or more.[5] With this significant mechanism, a variety of other significant injuries, including those to the head, neck, chest, abdomen, and pelvis, can occur simultaneously. The net result is that it becomes difficult to identify the exact source of blood loss in the initial setting. In many cases, multiple injuries are identified, resulting in continued hemorrhagic shock.

Patients with multisystem traumatic injuries with pelvic involvement have a high level of mortality, ranging from 10% to 15% in isolated pelvic disruptions to greater than 50% if the pelvic injuries are associated with intra-abdominal trauma, traumatic brain injuries, or open fractures.[3,4,6] In these cases, uncontrolled hemorrhagic shock within the first 24 hours is typically the cause of death. To minimize morbidity and mortality, a multidisciplinary approach with resources from the prehospital arena, ED staff, trauma surgery, interventional radiology, and orthopedic surgery must be used to resuscitate, treat, and stabilize these patients appropriately.

In the initial phase of the patient's resuscitation, both prehospital providers and ED staff rely on training guidelines based on the advanced trauma life support of the American College of Surgeons and other similar courses emphasizing diagnoses and interventions based on the primary and secondary assessment model. During this initial phase, not only do staff evaluate and treat the key components of the respiratory system (ie, airway and breathing) but they simultaneously evaluate the circulatory system for both internal and external sources of bleeding. Obvious sources of acute external bleeding are controlled with basic bleeding control maneuvers, but patients who demonstrate evidence of hypovolemic shock must be evaluated for internal sources of bleeding as well. High clinical suspicion with a thorough systematic evaluation can identify these other sources promptly.

Given mechanism of injury and whether the patient can guide the physical examination, a complete and detailed physical examination can provide data indicating whether there is a pelvic injury. During the examination, a careful inspection should include the region of the anterior abdomen, flanks, superpubic region, perineum, and buttocks. Ecchymosis, lacerations, and abrasions should be identified. Simultaneously, a thorough evaluation of the rectum and genitals must be completed. If blood is found at the urethral meatus or in the rectal vault, a genitourinary injury must be entertained and evaluated by the appropriate

Table 1. Tile Classification of Pelvic Fractures

Tile Classification
Type A—stable
A1 Without involvement of the pelvic ring
A2 With involvement of the pelvic ring
Type B—unstable
B1 Open book
B2 Ispilateral compression
B3 Contralateral compression
Type C—Rotationally and vertically unstable
C1 Rotationally and vertically unstable
C2 Bilateral
C3 With associated acetabular fracture
Combined mechanism (CM)

imaging, including a retrograde urethrogram before the placement of a Foley catheter. Approximately 6% of women and 11% of men experience genitourinary injuries with concomitant pelvic trauma.[5] Similar injuries are much less prevalent in children and toddlers.

Once the external evaluation is completed, an orthopedic assessment should include the identification of deformities, leg length discrepancies, or malrotation. These orthopedic abnormalities can be from not only vertical shear pelvic trauma but also hip or femur fractures. Once the gross visual examination is completed, the pelvis needs to be assessed for rotational instability by palpating for crepitus and tenderness with compression of the iliac crests and pubic symphysis. It is inappropriate to "rock the pelvis" laterally, which may result in dislodgement of a possible pelvic hematoma and subsequent additional displacement of pelvic fractures.

If the patient has noted findings on physical examination concerning pelvic instability with accompanying hemodynamic compromise, providers must assume that bleeding is occurring from the injuries in the pelvis. The first priority of the team is to externally stabilize the pelvis. In 80% of cases of pelvic trauma, the source of bleeding is the presacral venous plexus.[2,3] By stabilizing the bones of the pelvis, including the ileum, ischium, and pubis, subsequent exsanguination can be tamponaded successfully. There are cases when, despite these initial efforts, arterial bleeding continues from the iliac and hypogastric arteries and may require embolization.

In the trauma bay, initial imaging of the pelvis must be initiated. During the initial resuscitation phase, a Focused Assessment with Sonography for Trauma (FAST) examination is completed to evaluate for gross blood in the abdomen. If there is a significant amount of blood in the peritoneal cavity (>500 mL), it will be detected by adequately trained personnel. With unstable pelvic fractures, however, up to 4 L of blood can be displaced into the retroperitoneum without detection with basic ultrasound imaging. An AP pelvis film completed at the time of arrival will not only demonstrate bony abnormalities, but significant bleeding can be inferred from acutely displaced fractures of the pelvic bowl. The AP pelvis film is examined for gross fractures and vertical displacement (greater than 3 mm is considered abnormal) and widening of the pubic symphysis (greater than 5 mm is abnormal).

If the patient has been stabilized, CT scanning is required for further delineating fractures and assessing for continued bleeding in the retroperitoneum and pelvic basin. With the use of intravenous contrast, active sites of bleeding can be identified with contrast extravasation. CT scans are especially useful for detecting fractures, including sacral, sacroiliac, posterior arch, and acetabular joints. By assessing the fracture types and whether there is continued bleeding, resuscitation and orthopedic management can be individually focused to treat these identified injuries.

As noted in the introduction, in low-energy scenarios, nondisplaced fractures are common. One third of pelvic fractures are individual bone fractures without any involvement of the pelvic ring. Fractures of the superior and inferior rami simultaneously are also considered to be stable and are managed conservatively. High-energy trauma to the pelvis not only damages the bones but also can result in significant bleeding and hemodynamic compromise from injuries to adjacent vessels, organs, and other structures.

Orthopedic surgeons do have a classification scheme to delineate different types of fractures from the variety of management techniques used in their care, including tile classification (Table 1).

Severely disrupted pelvic injuries result from two primary mechanisms: anteroposterior (AP) compression and lateral compression. The AP compression or open book injuries typically result from head-on motor vehicle collisions that disrupt the symphysis pubis, whereas lateral compression results in a decreased pelvic volume but also can also require fluid resuscitation. With a variety of forces acting on the pelvic ring, there can also be continued vertical and rotational instability of the pelvis, leading to additional blood loss and hemodynamic compromise.

To manage these injuries effectively, a dual resuscitative approach must be implemented to manage the hemorrhagic shock with continued bleeding and stabilization of the pelvis concurrently. When a patient is encountered either in the field or within an ED and there is clinical suspicion based on clinical examination or history, pelvic stabilization must occur immediately.

In the acute care setting (field or ED), external stabilization is recommended for most patients, especially those with abnormal vital signs. In older literature, the initial intervention was typically the MAST trousers or pneumatic antishock garments. Initial studies demonstrated that this therapy was successful in arresting bleeding in 71% of patients with pelvic trauma,[5] but additional studies concluded that significant side effects were associated with their use, including decreased access to the patient, compartment syndrome, and decreased vital capacity. Their use is no longer recommended.

Currently, in patients who have suspected or diagnosed open book pelvic fractures (APC Type 2 fractures), the use of a sheet

Figure 2. Properly placed T- POD pelvic binder

Figure 3. Improperly Placed T- POD Pelvic Binder

wrapped around a pelvis or a pelvic binder device is indicated. Use of the external devices has demonstrated that, if appropriately applied over the greater trochanters, they improve cardiovascular function, reduce transfusion requirements, and reduce subsequent pulmonary emboli during the patient's inpatient stay (Fig. 2).[7] However, if the sheet or device is improperly positioned, the patient is at risk for additional bleeding, hemodynamic instability, and improper anatomical alignment of the pelvic ring (Fig. 3).

Several devices are commercially available for external pelvic stabilization, including a device called the T-POD or trauma pelvic orthotic device and a product called the SAM Pelvic Sling made by (SAM Medical Products, Wilsonville, OR, USA). These commercial products are as efficacious in their use as a simple sheet that is circumferentially placed over the pelvis or even more so.[7,8] The indication for these devices is strictly the anterior compression fracture, more commonly known as the open book pelvis injury. The use of binders and sheets does not add any benefit to lateral shear injuries, hip fractures, or isolated unilateral fractures.[8]

Proper placement of the device is critical to gain the benefits. Several studies have examined the placement of pelvic binders by ED and EMS personnel. Those who attempt to place the device from the inferior portion of the patient are more likely to have it in the proper position over the greater trochanters than those who slide the device from above and improperly leave the binder at the level of the iliac crests.[7,8]

External stabilization of the pelvis with sheets or commercial devices is a bridge to definitive therapy. Although there are noted benefits to their placement, they can impede continued assessments and subsequent therapy by simply blocking access to the patient. However, external fixation or the use of surgical C-clamps is not used routinely in the prehospital, community hospital, or ED setting. Definitive orthopedic treatment typically occurs within the first 24 hours after the patient has been stabilized and the initial resuscitation is completed.

Conclusion

Pelvic ring injuries continue to be encountered frequently after a variety of mechanisms occur. The identification, treatment, and management strategies depend on the presenting complaint, additional injuries, and hemodynamic status. The use of pelvic binders and additional external stabilization is indicated for those patients with anterior-compression injuries and mixed mechanisms. However, their true efficacy is only constructive if the device or sheet is placed in the appropriate position.

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Peter Tilney, DO, EMT-P, is an attending physician in the department of emergency medicine at Albany Medical Center in Albany, NY, and a medical director for LifeNet of New York. He can be reached at tilneyp@mail.amc.edu. *Kenneth Palazzo, FP-C CIC, is the medical educator for LifeNet of New York/Guthrie Air.*

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