



KOSOVA JOURNAL OF SURGERY

Volume 10, Issue 1, Part I
Focused Issue: Trauma and
Surgical Critical Care
January 2026
ISSN: 3027-5008 (Online)
ISSN: 3027-5016 (Print)

MICHEL ABOUTANOS, OMAR ROKAYAK, SAYURI P. JINADASA, ALAN P. ROSSI, JOSHUA A. COLE, KYLE J. ALEXANDER, BETH BROERING, JAMES F. WHELAN, EDGAR RODAS: Establishment of Trauma and Critical Care System in Post-Conflict and Low Resource Countries

ELLIOT HAUT, LISA KODADEK: Improving Trauma Care via Evidence-Based Medicine: Guidance, Guidelines, and Global Impact

BELINDA DE SIMONE, FAUSTO CATENA: Management of Trauma in Elderly and Frail Patients: A Master Summary of the 2023 WSES Guidelines

BLEDI BRAHIMAJ, MAREN RUKA, AURORA MUÇA, EMAL LESHA: Current Management of Traumatic Brain Injury: Time is Brain

KYLE J. ALEXANDER, EDGAR RODAS: Early Tracheostomy in Trauma and Surgically Ill Patients: Have We Made Any Progress in Identifying the Right Patients?

Pelvic Trauma Management: The Trauma Surgeon's Perspective

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Abstract

Pelvic fractures present a wide spectrum of clinical severity, ranging from minimal physiological impact to profound instability depending on the degree of associated retroperitoneal bleeding. As such, these injuries are among the most complex trauma surgeons encounter, requiring proficiency across trauma care, critical care medicine, and surgical intervention. While each case is unique, the following principles guide the management of pelvic fractures with severe physiological compromise:

- Early recognition of the fracture and its physiological impact
- Hemorrhage control through timely interventions
- Blood-based resuscitation strategies to counter coagulopathy
- Identification of associated injuries
- Optimization for definitive pelvic stabilization surgery

Pelvic fractures often result from high-energy trauma. Early recognition is essential and should follow a

standardized approach, such as the Advanced Trauma Life Support® (ATLS) primary survey, to identify and address the fracture and possible exsanguinating hemorrhage.

When bleeding is suspected, rapid intervention is critical. Pelvic binders are a first-line tool to reduce pelvic volume and tamponade retroperitoneal bleeding. When bleeding persists, additional measures are necessary. Options include external fixation, Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA), angioembolization, and preperitoneal packing.

Concurrently, a blood-based resuscitation strategy must be initiated. Whole blood is preferred when available; otherwise, massive transfusion protocols using a 1:1 ratio of RBCs to FFP, along with early platelet administration, are essential. Thromboelastography (TEG) is increasingly used to guide resuscitation by assessing clot formation, strength, and breakdown, helping tailor blood product administration.

Once stabilized, patients transition to the ICU for multidisciplinary critical care. Optimization focuses on



resolving shock, correcting coagulopathy and electrolyte imbalances, and initiating venous thromboembolism prophylaxis. Given the force required to fracture the pelvis, associated injuries must be carefully evaluated for as well—particularly injuries to the solid abdominal organs, the bladder, and urethra. Throughout the ICU phase of care close communication with the orthopedic trauma surgeon is necessary to ensure the patient is optimized for pelvic stabilization surgery, as surgery can be lengthy and at times associated with significant blood loss.

With management strategies rooted in the fundamental principles above, the Trauma Surgeon can find great reward in providing truly life-saving care to some of our sickest patients.

Key words: Pelvic trauma; Pelvic fracture; Hemorrhage;

Background

Pelvic injuries represent some of the most complex and challenging conditions encountered in trauma care, due in part to the variety in clinical presentation. While certain fracture patterns remain hemodynamically stable with minimal physiological impact, others are associated with life-threatening injuries accompanied by hemodynamic instability and retroperitoneal bleeding. As such, effective management requires prompt recognition and a coordinated multidisciplinary approach between trauma surgeons and the entire trauma team.

Findings

Demographic and Epidemiological Trends

Previous research studies have uncovered demographic and epidemiological patterns of pelvic fractures, revealing age and sex-related trends. The incidence of pelvic fractures in males occurs early in life, peaking at 20 – 24 years of age, whereas in females, the incidence of pelvic fractures occurs later in life, peaking between 80 – 84 years of age.² Despite gender differences related to when pelvic fractures are most likely to occur, physicians and researchers have observed a 115% increase overall in the incidence of pelvic fractures, with the most pronounced rise observed among older adults, in whom the incidence of pelvic fractures has increased by 265% in recent years.¹ This observed trend is largely attributed to increased life expectancy, an aging population, and regional instability, leading to a higher prevalence of fragility fractures of the pelvis.^{1,2} Ultimately, understanding the demographic and epidemiologic trends of pelvic trauma is essential to enhance trauma care.

Pelvic Trauma Injury Mechanisms

Pelvic fractures may result from either high-energy or low-energy mechanisms. High-energy mechanisms, which are more common in young males, include vehicle collisions, pedestrian-versus-vehicle accidents, sports-related trauma, and conflict-related injuries.¹⁶ High-energy mechanisms are frequently associated with multiple injuries and physiological shock, often necessitating urgent medical and surgical intervention.¹⁶ In contrast, low-energy mechanisms, which are more common in older females, include ground-level falls and have a lower likelihood of requiring surgical interventions.¹

Early Recognition of Life-threatening Pelvic Fractures & Associated Injuries— Critical Priority in the Trauma Bay

Given the high lethality associated with pelvic trauma, early recognition of pelvic fractures is critical to improving outcomes. Mortality from pelvic trauma is primarily due to bleeding and hemorrhagic shock.¹⁷ Significant hemorrhage is observed in patients with pelvic injuries when the fractures are characterized as anterior-posterior compression (APC) type III and open pelvic fractures.^{4, 16, 21} Pelvic trauma complicated by hemorrhagic shock carries a substantial risk of mortality, with rates approaching 32% among hemodynamically unstable patients.¹⁶ Moreover, “10 – 15% of patients with pelvic fractures present to the emergency department in shock, and one-third of these patients will die.”¹⁶ Effective management, therefore, depends on prompt recognition and coordinated multidisciplinary efforts to control bleeding and restore hemodynamic stability.^{7, 16, 33 - 34}

Beyond hemorrhage control, prompt recognition of solid organ injuries is essential, as these injuries can serve as an additional source of bleeding, thereby amplifying transfusion requirements and necessitating multidisciplinary management.^{3, 16} Solid organ injuries occur in approximately 26% of patients with pelvic trauma and contribute to greater pelvic fracture severity and instability.³ Solid organ injuries commonly associated with pelvic fractures include those to the liver, spleen, and kidneys, with hepatic injury being the most frequent in adults, followed by splenic and renal involvement.^{3, 18} Comprehensive assessment and management of all bleeding sources, especially those related to solid organ injuries, are essential for optimal patient survival.

Soft tissue involvement is also an important consideration in pelvic trauma, as external wounds can

represent an additional and sometimes overlooked source of hemorrhage. Two notable soft tissue injuries observed in pelvic trauma patients are external wounds and Morel-Lavallée lesions. External wounds are clinically significant as they increase the risk of infection and have the potential to serve as a source of bacterial contamination, which could require surgical debridement and antibiotic therapy. “Morel-Lavallée lesions are closed internal degloving injuries caused by shearing forces that separate the subcutaneous tissue from the underlying fascia, creating a potential space with blood, lymph, and necrotic fat, due to the disruption of subcutaneous vascular and lymphatic structures.”^{22–25} Morel-Lavallée lesions are often missed during initial trauma assessment, and delayed diagnosis may lead to complications, such as infection, chronic seroma formation, skin necrosis, delayed wound healing, and contour deformity.^{22, 23, 26, 27}

Advanced Trauma Life Support® – Primary Survey

Identifying life-threatening pelvic trauma early is the most important responsibility of the trauma surgeon, and using a standardized team-based approach to examine the injured patient is critical to success. The Advanced Trauma Life Support® primary survey process provides an effective strategy to identify possible sources of life-threatening hemorrhage through the circulation and exposure components of the initial exam.¹⁶ Assessment of circulation is a high priority as pelvic fractures can cause significant hemorrhage from arterial, venous, and osseous sources, and early recognition of hemorrhagic shock with prompt resuscitation are critical to reducing pelvic fracture mortality.¹⁶ Likewise, assessment of exposure is important to identify external wounds, open fractures, perineal and genitourinary injuries, and soft tissue damage is important to reduce the risk of infection and streamline management.¹⁶

Stopping the Bleed – Critical Interventions in the Trauma Bay

The initial approach to hemorrhage control in pelvic trauma depends largely on the resources available, which can vary across geographic and clinical environments. When accessible, angioembolization (AE) is the first-line therapy and current standard of care for managing vascular injury in pelvic trauma due to its demonstrated ability to reduce mortality.^{7, 21} AE involves the targeted occlusion of injured vessels and can be performed in a selective manner, where a specific bleeding artery is embolized, or non-selectively,

where the main trunk of the internal iliac artery is embolized.^{7, 16, 21, 31} The vessels most frequently targeted “for angioembolization, in decreasing order of occurrence, are the internal iliac artery and its branches, followed by the superior gluteal, obturator, and internal pudendal arteries.”²⁹ Despite being the standard of care, angioembolization is not without consequences, which may include wound complications, ischemia or necrosis of pelvic structures, arterial injuries, and impotence.³⁰ In terms of selective and non-selective embolization, both techniques carry the same complication profiles.⁸ When there is ongoing concern for pelvic bleeding after AE, preperitoneal packing serves as a secondary or fallback intervention for controlling hemorrhage.⁹

In clinical or geographic settings where AE is not immediately available, preperitoneal packing becomes the first line intervention to achieve hemostasis. Although PPP is effective in controlling bleeding, this technique is limited by its estimated 25% risk of persistent bleeding, as arterial injuries may not be appropriately managed with PPP therapy alone.⁹ If PPP is utilized and is unsuccessful in achieving hemostasis, angioembolization is the preferred bailout therapy.¹⁰ The greatest risk associated with PPP is venous thromboembolism, with research studies demonstrating a higher incidence of venous thromboembolism with PPP therapy when compared with AE.³² Overall, patients with arterial injuries will benefit most from “AE as a form of source control, whereas patients with pelvic fractures in the absence of arterial bleeding may respond more favorably to PPP and skeletal stabilization.”⁹

Is There a Role for Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA)?

Current evidence does not support the routine use of REBOA in the management of pelvic fracture hemorrhage. Studies have demonstrated that REBOA is associated with higher morbidity and mortality when compared with the standard of care.^{11, 12} The patients undergoing REBOA therapy exhibit increased risk of mortality and an increased risk of acute kidney injury and lower extremity complications, including amputation, when compared with patients who do not undergo REBOA.^{11, 12} As a result, the risk profile of REBOA outweighs the benefits when utilized in the setting of pelvic trauma.

Is There a Role for External Fixators and Pelvic Binders?

Traditionally, pelvic binders and external fixation have been used as first-line interventions for pelvic fractures

based on the principle that these techniques reduce pelvic volume and promote tamponade of retroperitoneal bleeding. Their role, however, remains an area of active research, with recent studies calling their effectiveness into question by demonstrating no mortality benefit or reduction in red blood cell transfusion requirements compared with other stabilization methods.^{6, 16, 28} In light of these findings, pelvic binders should be used with caution, and efforts should be prioritized to either remove the binder or transition to external fixation within 24 hours of initial application to avoid pressure injuries as external fixation provides superior mechanical stability and is best employed in more unstable injury patterns, when resources allow timely application. While pelvic volume reduction will continue to be a valid adjunct to the early management of pelvic fractures (13), the trauma surgeon should maintain AE and PPP as their priority interventions for hemorrhage control.

Damage Control Resuscitation (DCR) – Critical Skill for the Trauma Surgeon

Simultaneously with interventions to stop bleeding, the trauma surgeon must work to address the physiological consequences of large volume blood loss. There are several important principles involved. First, one must become comfortable with permissive hypotension. Permissive hypotension, which is characterized as tolerating a lower mean arterial pressure until hemorrhage control is achieved, involves establishing lower blood pressure goals to reduce the rate of active bleeding. In the absence of traumatic brain injury, systolic blood pressure should be maintained between 80 and 90 mmHg to reduce coagulopathy aggravation and clot formation disruption.¹⁴

The second important principle of DCR is the limitation or avoidance of crystalloid administration. Excess crystalloid is associated with an increased risk of acute respiratory distress syndrome and potentially worse outcomes.¹⁴ Instead, a blood-based resuscitation strategy should be utilized, with a focus on using whole blood or a balanced ratio of blood components. Although whole blood provides a survival advantage over component therapy, it remains a limited resource and is not universally available. Current transfusion protocols recommend a “1:1 ratio of red blood cells to fresh frozen plasma, with the early administration of platelets in a 1:1:1 ratio of red blood cells, fresh frozen plasma, and platelets.”¹⁴ The administration of blood and blood components has been shown to improve hemostasis and improve the patient’s

likelihood of survival, even in the setting of ongoing hemorrhage.

The third important principle of DCR is correction of coagulopathy. Blood loss is a dynamic process, and with large volume hemorrhage the body’s coagulation factors will deplete. The trauma surgeon must be diligent in monitoring all the components of blood clotting to reverse the progression of hemorrhagic shock. Timely and recurring evaluation should include the international normalized ratio (INR), fibrinogen concentration, and consideration of viscoelastic testing to guide transfusion strategy. Viscoelastic testing, such as thromboelastography or rotational thromboelastography can be particularly valuable as it provides a comprehensive picture of the coagulation cascade to facilitate specific factor replacement, and can also identify unwanted hyperfibrinolysis that may be amenable to treatment with Tranexamic Acid.¹⁴ Tranexamic Acid (TXA) can be used in injured patients with bleeding to reduce trauma-induced hyperfibrinolysis when administered within three hours of injury.¹⁴ Delayed administration beyond three hours is associated with increased mortality.¹⁴

Together, the strategies of permissive hypotension, avoiding crystalloids, and a blood-based resuscitation strategy guided by laboratory data define damage control resuscitation and are crucial to improving outcomes in patients who present with hemorrhage and pelvic fractures.¹⁴

Optimization for and Timing of Surgery – Attention to Detail: A Critical Skill in the Intensive Care Unit (ICU)

With control of bleeding the care of the patient transitions to the ICU where ongoing treatment of hemorrhagic shock and subsequent definitive care of the pelvis and associated injuries will be the priorities. The determination of timing for surgical intervention of the pelvis is a critical component of management during the ICU phase. The decision on when best to operate on the pelvis encompasses an assessment of both physiological stabilization and the management of all associated injuries. Physiologic optimization includes correcting acidosis, coagulopathies, and hypothermia, as well as the management of preexisting chronic medical conditions, and the consideration of deep vein thrombosis (DVT) prophylaxis. Patients with pelvic fractures have a 34% increased risk of DVT and are at a 12% increased risk of a pulmonary embolism (PE).⁴⁶ As a result, a coordinated “multidisciplinary approach involving

trauma surgeons, orthopedic specialists, and critical care teams” is essential to initiate pharmacologic prophylaxis for DVT within 48 hours of injury and subsequently hold in the perioperative setting.⁴⁶ Evidence suggests that surgical management in pelvic trauma patients with minimal physiologic derangement should be performed within 48 hours post-injury.¹⁵ In contrast, surgical management in pelvic trauma patients with severe physiologic derangement should be performed four to seven days post-injury.¹⁶ Adherence to these timing principles has been shown to reduce postoperative complications and improve outcomes. Conversely, delays in surgical management are linked to higher rates of sepsis, DVT, acute kidney injury, myocardial infarction, pneumonia, multiorgan failure, and even death.³⁷

The identification and treatment of all associated injuries is equally important in determining when a patient is optimized for pelvic stabilization surgery. The Trauma Tertiary Survey process is a structured and comprehensive re-examination performed on trauma patients after the appropriate resuscitation and stabilization measures have been implemented.^{43 - 45} Ideally this exam occurs in the first 48 hours of admission. Key elements of the tertiary survey include a detailed physical examination, reviewing the mechanism of injury, reassessing the patient’s medical history, imaging, and laboratory studies, and ordering additional testing when indicated.^{43 - 45} The tertiary survey process is particularly useful in pelvic trauma cases, as the process facilitates the identification of injuries that may have been overlooked during the primary or secondary survey.^{43 - 45}

Associated injuries in pelvic trauma may be local or distant, each carrying important implications for bleeding risk that must be considered and evaluated for during the initial patient assessment. Local injuries most commonly affect the urethra, genitalia, and anorectal region, and should be suspected when blood is observed at the urethral meatus, in the presence of perineal hematoma and perineal lacerations, scrotal and perineal ecchymosis, and when patients are unable to void.^{16, 35 - 36} Distant injuries, which are typically observed in high-energy trauma, most commonly affect solid organs, ribs, extremities, and the brain.¹⁶

High-Functioning Teams in the Trauma Bay and Associated Outcomes

The successful management of patients with pelvic trauma depends on the presence of a coordinated and

multidisciplinary trauma team. High-functioning trauma teams that implement a multidisciplinary approach are consistently associated with reduced mortality, fewer complications, and improved outcomes.^{16, 38 - 42} Furthermore, the implementation of performance improvement programs that specifically target hemorrhage protocols and evidence-based decision-making algorithms has been shown to enhance the quality of care trauma patients receive.^{16, 38 - 42} Performance improvement programs assist in reducing clinical errors, enhancing hemorrhage control protocols, and improving outcomes in the survival of hemodynamically unstable pelvic fracture patients.^{16, 38 - 42}

Conclusions

Early recognition of pelvic fractures and their physiological consequences remain fundamental to effective management. Timely hemorrhage control, integrated with principles of damage control resuscitation, is critical to reducing mortality and improving patient outcomes. Equally important is the prompt identification of associated injuries and optimization of physiological status prior to definitive pelvic stabilization. As the incidence of pelvic fractures continues to rise, evolving injury patterns and treatment algorithms highlight the importance of a high-functioning trauma team continually refining management strategies to achieve optimal patient outcomes.

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