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VISCERAL INJURIES ASSOCIATED WITH PELVIC TRAUMA: IMPLICATIONS FOR GENERAL SURGEONS

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ABSTRACT

Introduction: *pelvic trauma is frequently associated with high-energy injuries and may result in severe complications due to the presence of vital visceral and vascular structures within the pelvic cavity. Visceral injuries related to pelvic fractures represent a major challenge in trauma management and often require multidisciplinary treatment.*

Objective: *to review the most common visceral injuries associated with pelvic fractures and analyze their implications for general surgical management.*

Methodology: *a narrative literature review was conducted using the databases PubMed, Cochrane Library, and Google Scholar. Articles published in English, Spanish, and Portuguese were considered. A total of 32 articles were initially identified, including original studies, review articles, and clinical reports. After evaluating relevance and scientific quality, 20 references were selected for inclusion in the present review.*

Results: *Pelvic fractures are frequently associated with injuries to the bladder, urethra, rectum, and pelvic vascular structures. These injuries significantly increase morbidity and mortality, particularly in patients with unstable pelvic fractures and hemodynamic instability. Early diagnosis using imaging techniques such as computed tomography and CT angiography, along with prompt multidisciplinary management, is essential to improve patient outcomes.*

Conclusions: *Visceral injuries associated with pelvic trauma represent a significant challenge for trauma care. Early recognition, appropriate diagnostic evaluation, and coordinated multidisciplinary management are essential to reduce complications and improve survival in these patients.*

KEYWORDS: *pelvic trauma, pelvic fractures, visceral injuries, bladder injury, rectal trauma, trauma surgery.*

INTRODUCTION

Pelvic trauma represents a severe form of injury frequently associated with high-energy mechanisms such as motor vehicle collisions, falls from height, and penetrating trauma. Although pelvic fractures account for a relatively small proportion of all skeletal injuries, they are associated with significant morbidity and mortality due to the complex anatomical structures contained within the pelvic ring and the potential for severe hemorrhage and associated visceral damage. The pelvis houses critical urogenital, gastrointestinal, vascular, and reproductive organs, making traumatic injuries in this region particularly challenging for multidisciplinary management.

Previous studies have extensively described the epidemiology, mechanisms of injury, classification systems, and general management of pelvic fractures. However, the clinical impact of associated visceral injuries remains a critical determinant of patient outcomes. Pelvic fractures can be accompanied by

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injuries to the bladder, urethra, rectum, bowel, and pelvic vascular structures, which may significantly increase morbidity, mortality, and the need for urgent surgical intervention.

The mechanism of trauma plays a fundamental role in determining the pattern and severity of both skeletal and visceral injuries. High-energy blunt trauma, such as that seen in traffic accidents, often results in unstable pelvic fractures that may disrupt surrounding organs and vascular structures. In contrast, penetrating trauma introduces additional mechanisms of tissue damage through kinetic energy transfer, cavitation effects, and direct organ perforation, potentially leading to complex intra-abdominal and pelvic injuries.

Early identification and management of these associated injuries are critical and rely on systematic trauma assessment protocols such as those established by the Advanced Trauma Life Support guidelines. These protocols emphasize rapid evaluation, hemodynamic stabilization, and timely diagnostic imaging, including computed tomography, which has become the cornerstone in detecting visceral injuries in pelvic trauma.

In severe cases, particularly when patients present with hemodynamic instability and multisystem trauma, damage control principles may be required to prioritize rapid hemorrhage control and contamination management before definitive surgical repair. The involvement of multiple specialties—including trauma surgeons, orthopedic surgeons, urologists, and interventional radiologists—is often essential to optimize patient outcomes(1–3).

Despite advances in trauma care, visceral injuries associated with pelvic trauma remain a major challenge for general surgeons due to their diagnostic complexity and potential for life-threatening complications. Therefore, a comprehensive understanding of the types of visceral injuries, their mechanisms, diagnostic approaches, and surgical implications is essential for effective management.

The aim of this study is to review the visceral injuries associated with pelvic trauma and to analyze their diagnostic and therapeutic implications for general surgeons involved in the management of trauma patients.

METHODOLOGY

This study corresponds to a narrative literature review focused on visceral injuries associated with pelvic trauma and their implications for general surgical management. A comprehensive search of the scientific literature was conducted using the databases PubMed, Cochrane Library, and Google Scholar.

The search strategy included articles published in English, Spanish, and Portuguese. The following keywords and combinations were used: *pelvic trauma*, *pelvic fractures*, *visceral injuries*, *bladder injury*, *rectal trauma*, *vascular injury*, *pelvic hemorrhage*, and *trauma surgery*. Boolean operators (AND, OR) were applied to refine the search strategy.

A total of 32 scientific articles were initially identified, including review articles, original research studies, and clinical reports related to pelvic trauma and associated visceral injuries. After evaluating the relevance and scientific quality of the studies, 20 references were selected for inclusion in this review, while the remaining articles were excluded due to lack of relevance to the objectives of the study.

The selected literature was analyzed to identify key aspects related to the epidemiology, mechanisms of injury, anatomical considerations, diagnostic approaches, and surgical management of visceral injuries associated with pelvic fractures. The information obtained was organized into thematic sections to facilitate a comprehensive understanding of the topic.

DEVELOPMENT

Anatomy of the Pelvis and Relationship with Visceral Structures.

The pelvis is a complex anatomical structure composed of osseous, vascular, neural, and visceral components that together provide structural stability and protection for vital organs. The pelvic ring is formed by the sacrum and the two innominate bones, each consisting of the ilium, ischium, and pubis. These structures are connected through strong ligamentous complexes, including the sacroiliac, sacrospinous, and sacrotuberous ligaments, which contribute significantly to pelvic stability.

From an anatomical perspective, the pelvis can be divided into the greater (false) pelvis and the lesser (true) pelvis. The greater pelvis forms part of the lower abdominal cavity and supports abdominal organs, whereas the lesser pelvis contains most of the pelvic viscera. Within this confined space lie several critical organs, including the urinary bladder, urethra, rectum, and reproductive organs. The close anatomical relationship between these visceral structures and the pelvic bones explains the high incidence of associated visceral injuries in pelvic trauma.

The urinary bladder is particularly vulnerable to injury in the setting of pelvic fractures due to its anatomical position within the anterior pelvis, where it is closely related to the pubic symphysis and superior pubic rami. Disruption of the pelvic ring, especially fractures involving the anterior arch, may lead to bladder rupture or urethral injury. In males, the membranous urethra is especially susceptible to trauma due to its fixed position between the prostate and the urogenital diaphragm.

Posteriorly, the rectum lies in close proximity to the sacrum and coccyx. High-energy pelvic trauma may result in rectal injuries, particularly in cases involving open pelvic fractures or penetrating trauma. Although less common than urogenital injuries, rectal injuries are associated with significant morbidity due to the risk of pelvic sepsis and contamination.

The pelvic vascular system also plays a critical role in the pathophysiology of pelvic trauma. The internal iliac artery and its branches supply most pelvic organs and soft tissues. Injury to these vessels can result in massive hemorrhage, which is one of the leading causes of early mortality in patients with unstable

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pelvic fractures. Venous bleeding from the extensive presacral and pelvic venous plexuses may also contribute significantly to hemodynamic instability.

Additionally, an important vascular anatomical variation known as the *corona mortis* represents a communication between the obturator and external iliac or inferior epigastric vessels. Injury to this vascular structure during pelvic trauma or surgical procedures can lead to significant bleeding and may complicate surgical management.

Understanding the anatomical relationships between the pelvic skeleton and the surrounding visceral and vascular structures is essential for trauma surgeons and general surgeons involved in the management of pelvic injuries. This anatomical knowledge facilitates early recognition of associated visceral injuries and guides appropriate diagnostic and surgical interventions(1).

Figure 1. Anteroposterior radiograph taken after pelvic trauma shows a sacroiliac screw on the right, a screw in the right ilium, as well as a plate and screws in the pubis.

Source: The Authors.

Mechanisms of Injury and Pelvic Fracture Patterns.

Pelvic trauma is commonly associated with high-energy mechanisms such as motor vehicle collisions, falls from significant height, and crush injuries. These mechanisms generate substantial forces that disrupt the pelvic ring and frequently result in concomitant injuries to adjacent visceral and vascular structures. The severity of pelvic fractures and their associated injuries is strongly influenced by the direction and magnitude of the applied forces.

Several classification systems have been developed to describe pelvic fracture patterns and to predict the likelihood of associated complications. Among the most widely used are the Young–Burgess and Tile classifications. The Young–Burgess classification categorizes pelvic fractures according to the direction of the traumatic force, including lateral compression, anteroposterior compression, vertical shear, and combined mechanisms. Each pattern produces characteristic disruptions of the pelvic ring and varying degrees of instability.

Lateral compression injuries are the most common type and typically occur in side-impact motor vehicle collisions. These injuries may produce fractures of the pubic rami and sacral compression fractures. Although often associated with lower hemodynamic instability compared with other patterns, lateral compression injuries may still result in damage to pelvic organs due to displacement of bone fragments.

Anteroposterior compression injuries are frequently associated with high-energy trauma and may produce an “open book” pelvis characterized by separation of the pubic symphysis and disruption of the anterior sacroiliac ligaments. This mechanism significantly increases pelvic volume and can lead to severe vascular injury and hemorrhage.

Vertical shear injuries result from axial forces transmitted through the lower extremities, such as those occurring in falls from height. These injuries involve vertical displacement of one hemipelvis and extensive ligamentous disruption, making them highly unstable and frequently associated with major vascular and visceral injuries.

Similarly, the Tile classification focuses on the stability of the pelvic ring and categorizes fractures into three main types: Type A (stable fractures), Type B (rotationally unstable but vertically stable), and Type C (both rotationally and vertically unstable). Unstable fractures, particularly Tile Type C injuries, are

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associated with a significantly higher risk of severe hemorrhage and visceral damage.

Understanding the mechanism of injury and the resulting fracture pattern is crucial for trauma surgeons because it allows early anticipation of associated complications, including injuries to the bladder, urethra, rectum, and pelvic vessels. Early identification of unstable pelvic fracture patterns is essential for prompt resuscitation, hemorrhage control, and multidisciplinary management(1,4–6).

Visceral and Vascular Injuries Associated with Pelvic Trauma.

Pelvic fractures are frequently associated with injuries to adjacent visceral organs and vascular structures due to the close anatomical relationship between the pelvic bones and the surrounding soft tissues. These associated injuries significantly increase morbidity and mortality and represent a major challenge for trauma surgeons.

Genitourinary injuries are among the most common visceral complications of pelvic trauma. Bladder injuries are particularly associated with fractures involving the anterior pelvic ring, such as fractures of the pubic rami or disruption of the pubic symphysis. Bladder rupture may be classified as extraperitoneal or intraperitoneal, with extraperitoneal rupture being more common in the context of pelvic fractures. Urethral injuries also occur frequently, particularly in males, where disruption of the membranous urethra may occur due to displacement of the pelvic ring.

Rectal injuries, although less frequent, are clinically significant due to the high risk of pelvic sepsis and infectious complications. These injuries are more commonly observed in open pelvic fractures or penetrating trauma. Early recognition is essential to prevent severe complications such as pelvic abscesses and systemic infection.

In addition to visceral damage, vascular injury is a critical determinant of patient outcomes in pelvic trauma. Hemorrhage from pelvic vessels is one of the leading causes of early mortality in patients with unstable pelvic fractures. Vascular injuries may involve arterial disruption, venous plexus injury, or both, leading to massive hemorrhage within the pelvic cavity and surrounding soft tissues.

Clinical evidence suggests that vascular injury associated with fractures occurs in approximately 3–9% of trauma cases involving the extremities or pelvis. In a large retrospective cohort study involving trauma patients with fractures, vascular injury was identified in approximately 7% of cases. These injuries were predominantly caused by blunt trauma mechanisms such as traffic accidents and falls. Patients with vascular involvement often presented with significant blood loss, anemia, and coagulation abnormalities at hospital admission, reflecting the severity of hemorrhage.

Furthermore, pelvic fractures associated with vascular injury are linked to worse clinical outcomes compared with fractures without vascular involvement. Studies have reported an overall survival rate of approximately 80% in patients with pelvic fractures complicated by vascular injury, highlighting the significant impact of hemorrhagic complications. These patients often require aggressive fluid resuscitation, blood transfusion, and early intervention to control bleeding.

Advances in trauma management have introduced minimally invasive techniques for hemorrhage control. Endovascular interventions, particularly transcatheter arterial embolization, have become the preferred approach for managing arterial bleeding in pelvic trauma. In contrast, vascular injuries in the extremities often require open surgical repair. The integration of trauma surgery, vascular surgery, and interventional radiology has therefore become essential for optimal management of these complex injuries.

Overall, the presence of visceral and vascular injuries significantly complicates the management of pelvic trauma. Early recognition, rapid diagnostic imaging—particularly computed tomography and CT angiography—and prompt multidisciplinary intervention are critical to improving survival and reducing complications in these patients(7,8).

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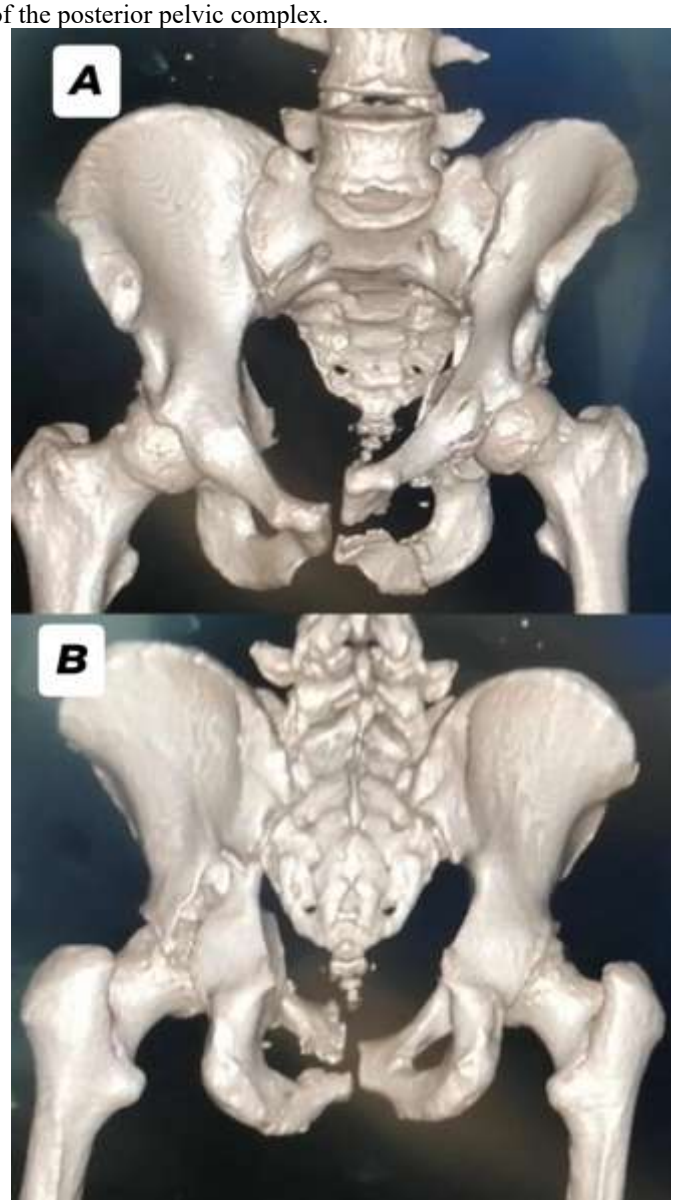
Figure 2. Three-Dimensional CT Reconstruction of Pelvic Trauma

(A) Anterior view demonstrating pubic symphysis diastasis associated with a fracture of the left ischiopubic ramus, indicating disruption of the anterior pelvic ring.

(B) Posterior view showing a clear defect involving the posterior pelvic ring with a fracture affecting the posterior column of the right acetabulum and disruption of the posterior pelvic complex.



Source: The Authors.

Diagnostic Approach in Pelvic Trauma.

Early diagnosis of pelvic trauma is critical due to the high risk of retroperitoneal hemorrhage and hemorrhagic shock associated with pelvic fractures. It is estimated that approximately 10–15% of patients with pelvic fractures present with hemodynamic instability at admission, and overall mortality in these cases may reach nearly 30%. Consequently, rapid identification of pelvic injuries and associated complications is essential to initiate timely interventions such as retroperitoneal packing or trans-arterial embolization.

The diagnostic evaluation of suspected pelvic trauma begins with the primary survey following Advanced Trauma Life Support (ATLS) principles. Initial assessment includes hemodynamic evaluation, identification of life-threatening bleeding, and rapid physical examination of the pelvis. Clinical examination typically involves inspection for deformity, ecchymosis, lacerations, or hematomas around the pelvic ring, followed by palpation to identify pain, tenderness, or instability. Assessment of pelvic stability may also include gentle compression and distraction maneuvers.

Although physical examination remains an important component of the initial trauma assessment, its diagnostic reliability has been debated. A systematic review and meta-analysis evaluating physical examination for pelvic fracture in blunt trauma patients reported a pooled sensitivity of approximately 0.86 and a specificity of about 0.92. These findings suggest that while physical examination has relatively good diagnostic performance, false-negative results may occur, particularly in patients with altered mental status or severe associated injuries.

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Level of consciousness significantly influences the diagnostic accuracy of clinical examination. Among patients with a Glasgow Coma Scale (GCS) score ≥13, sensitivity may reach approximately 0.93, whereas it decreases to around 0.76 in patients with impaired consciousness. This reduction in accuracy highlights the limitations of relying solely on clinical findings in severely injured or unconscious patients.

Because of these limitations, imaging plays a central role in the diagnostic algorithm for pelvic trauma. Plain radiography has historically been used as an initial screening tool in the trauma bay; however, computed tomography (CT) has become the gold standard for the evaluation of pelvic injuries in modern trauma centers. CT scanning allows detailed visualization of fracture patterns, associated visceral injuries, and retroperitoneal hemorrhage. Additionally, CT angiography is particularly valuable for identifying active arterial bleeding and guiding interventional management.

In many tertiary trauma centers, whole-body CT imaging is routinely performed for severely injured patients regardless of physical examination findings. This strategy aims to minimize missed injuries and expedite definitive management. However, widespread CT utilization must be balanced against concerns regarding radiation exposure and healthcare costs(9–12).

Surgical Implications for General Surgeons

The management of visceral injuries associated with pelvic trauma requires rapid decision-making and close collaboration within a multidisciplinary trauma team. General surgeons play a critical role in the early assessment and operative management of intra-abdominal and pelvic visceral injuries, particularly in hemodynamically unstable patients. In cases of severe pelvic trauma accompanied by hemorrhagic shock, damage control surgery principles are often applied, prioritizing rapid control of bleeding and contamination rather than definitive repair. Procedures such as preperitoneal pelvic packing may be performed to control venous bleeding and reduce pelvic hemorrhage, especially when interventional radiology is not immediately available. Additionally, general surgeons may be required to manage associated injuries to the bowel, rectum, or bladder, which frequently occur in high-energy trauma or penetrating pelvic injuries. Early recognition and surgical treatment of rectal injuries are particularly important to prevent pelvic sepsis and infectious complications. Similarly, bladder injuries associated with pelvic fractures require prompt identification, with extraperitoneal ruptures often managed conservatively with catheter drainage, while intraperitoneal ruptures typically require surgical repair. The integration of trauma surgery, orthopedic stabilization, and endovascular techniques such as transcatheter arterial embolization has significantly improved survival in patients with complex pelvic injuries. Therefore, general surgeons must be familiar with damage control strategies, indications for operative exploration, and coordination with orthopedic surgeons, vascular surgeons, and interventional radiologists to optimize outcomes in patients with pelvic trauma(8–10,13–15).

Associated Injuries in Pelvic Trauma.

Pelvic trauma rarely occurs as an isolated injury and is frequently associated with other musculoskeletal and intra-abdominal lesions due to the high-energy mechanisms involved. Concomitant injuries such as proximal femur fractures, open fractures of the extremities, and intestinal trauma should always be considered during the initial assessment of polytraumatized patients. Proximal femoral fractures may occur in the context of high-energy trauma or severe falls, particularly in elderly individuals, and require early orthopedic evaluation and stabilization. Similarly, open fractures represent severe injuries characterized by communication between the fracture site and the external environment, carrying a high risk of infection and soft-tissue damage. In addition, intestinal injuries may occur in association with blunt or penetrating abdominal trauma and can be difficult to diagnose early, particularly in patients with multiple injuries. These lesions are clinically relevant because delayed recognition may lead to severe complications such as sepsis, hemorrhage, or multiorgan failure. Therefore, a systematic trauma evaluation following standardized protocols is essential to identify associated injuries and ensure timely multidisciplinary management(16–18).

In addition to the visceral and vascular injuries described above, pelvic trauma may also be associated with fractures of the proximal femur, particularly intertrochanteric and femoral neck fractures. These injuries may occur as part of high-energy trauma mechanisms such as motor vehicle collisions or falls from height, which are also responsible for many pelvic fracture patterns. Intertrochanteric fractures represent nearly half of all proximal femur fractures and are typically located between the greater and lesser trochanters, involving a region rich in cancellous bone and vascular supply. Although they are more frequently observed in elderly patients following low-energy falls, high-energy trauma in younger individuals may also produce complex fracture patterns extending toward the subtrochanteric region. Similarly, femoral neck fractures are clinically significant injuries associated with substantial morbidity and mortality, particularly among older adults, where complications such as thromboembolism, pneumonia, pressure ulcers, and functional decline are common. In polytrauma patients, these fractures may coexist with pelvic injuries and contribute to hemodynamic instability, pain, and prolonged immobilization. Early recognition through appropriate imaging—typically plain radiographs supplemented by computed tomography or magnetic resonance imaging when necessary—is essential to guide treatment decisions. Surgical management aimed at stable fixation or prosthetic replacement is generally recommended to allow early mobilization and reduce complications related to prolonged bed rest. Consequently, clinicians managing pelvic trauma should maintain a high index of suspicion for associated proximal femur fractures, particularly in patients with high-energy trauma or limited ability to provide a reliable clinical history(19,20).

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Figure 3. Intraoperative pelvic fracture stabilized with external fixator, showing bladder injury.

Source: Adapted from Coello García BE et al. Pelvic fractures: epidemiology, anatomy, mechanism of injury, classification, imaging presentation, clinical presentation, management and complications. EPRA Int J Multidiscip Res IJMR. 2023;9:284–292. doi:10.36713/epra13073.

Multidisciplinary Management of Pelvic Trauma.

The management of patients with pelvic trauma and associated visceral injuries requires a coordinated multidisciplinary approach involving trauma surgeons, orthopedic surgeons, urologists, vascular surgeons, and interventional radiologists. Due to the complexity of these injuries, early collaboration between specialties is essential to ensure appropriate diagnostic evaluation and timely therapeutic interventions. Orthopedic stabilization of the pelvic ring plays a fundamental role in reducing pelvic volume and controlling hemorrhage, while interventional radiology techniques such as arterial embolization allow targeted control of active bleeding. Simultaneously, general surgeons must address associated intra-abdominal and pelvic visceral injuries when present. This integrated approach has significantly improved survival and reduced complications in patients with severe pelvic trauma.

CONCLUSIONS

Pelvic trauma represents a severe clinical condition frequently associated with high-energy mechanisms and significant morbidity and mortality. Due to the close anatomical relationship between the pelvic bones and surrounding visceral structures, pelvic fractures are often accompanied by injuries to the bladder, urethra, rectum, and pelvic vascular system.

Early recognition of these associated injuries is essential to prevent life-threatening complications such as massive hemorrhage, pelvic sepsis, and multiorgan failure. Accurate diagnosis requires a systematic trauma evaluation combined with appropriate imaging techniques, particularly computed tomography and CT angiography.

General surgeons play a key role in the management of patients with pelvic trauma, particularly in cases involving visceral injury or hemodynamic instability. The application of damage control principles, timely surgical intervention, and coordination with other specialties are fundamental to improving patient outcomes.

A multidisciplinary approach integrating trauma surgery, orthopedics, urology, vascular surgery, and interventional radiology remains essential for the optimal management of these complex injuries.

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