Journal of Biosciences and Medicines, 2026, 14(9), 398-414
https://www.scirp.org/journal/jbm
ISSN Online: 2327-509X
ISSN Print: 2327-5081

Multidisciplinary Staged Management of an Unstable Open Pelvic Fracture with Perineal Injury: A Case Report and Literature Review

Andrés David Ahumada-Uribe[1*], Paula Chacón-Madera[1], Karla Mendoza-Leottau[1], Valentina Llerena-Montoya[1], Luisa Bello-Lopez[1], Emil Fonseca-Padilla[1], Bella Solarte-Martinez[2], Johann Ramírez-Díaz[3], Juan Pablo Pérez-Cano[3], Guillermo Caro-Narvaez[4], Stefany Reales-Muñoz[4], Camilo Blanco-Teheran[4]

[1]School of Medicine, Universidad del Sinú, Cartagena, Colombia
[2]School of Medicine, Universidad del Cartagena, Cartagena, Colombia
[3]School of Medicine, Universidad del Norte, Barranquilla, Colombia
[4]School of Medicine, Corporación Universitaria Rafael Núñez, Cartagena, Colombia
Email: *rdonadob11@gmail.com

How to cite this paper: Ahumada-Uribe, A.D., Chacón-Madera, P., Mendoza-Leottau, K., Llerena-Montoya, V., Bello-Lopez, L., Fonseca-Padilla, E., Solarte-Martinez, B., Ramírez-Díaz, J., Pérez-Cano, J.P., Caro-Narvaez, G., Reales-Muñoz, S. and Blanco-Teheran, C. (2026) Multidisciplinary Staged Management of an Unstable Open Pelvic Fracture with Perineal Injury: A Case Report and Literature Review. *Journal of Biosciences and Medicines*, **14**, 398-414.
https://doi.org/10.4236/jbm.2026.149024

Received: August 9, 2026
Accepted: September 18, 2026
Published: September 21, 2026

Abstract

Background: Open pelvic fractures accompanied by extensive perineal soft-tissue injury are uncommon but represent one of the most challenging scenarios in trauma surgery. Their management requires rapid hemorrhage control, early contamination control, staged orthopedic stabilization, and close collaboration among multiple surgical specialties. We present a case illustrating a staged multidisciplinary strategy and review the current evidence supporting this approach. **Case Presentation:** A young patient sustained a high-energy pelvic trauma resulting in an unstable open pelvic fracture associated with a large perineal wound and intra-abdominal injuries. Initial evaluation demonstrated severe disruption of the perineal soft tissues and radiologic evidence of an unstable pelvic ring injury with associated intra-abdominal pathology. Following Advanced Trauma Life Support (ATLS) principles, the patient underwent emergency damage control surgery consisting of exploratory laparotomy, control of intestinal contamination, fecal diversion, pelvic packing, and temporary hemorrhage control. Subsequent operative exploration confirmed extensive disruption of the perineal structures requiring staged debridement and reconstruction. Once physiologic stabilization was achieved, definitive internal fixation of the pelvic ring was performed successfully, followed by continued wound management until satisfactory recovery. **Conclusion:** This case highlights that survival after severe open pelvic trauma depends less on immediate definitive orthopedic reconstruction than on a carefully coordinated

staged multidisciplinary strategy. Early hemorrhage control, aggressive contamination management, repeated debridement, and delayed definitive fixation constitute the fundamental principles associated with improved outcomes in these devastating injuries.

Keywords

Open Pelvic Fracture, Damage Control Surgery, Pelvic Trauma, Perineal Injury, Multidisciplinary Management, Orthopedic Trauma

1. Introduction

Open pelvic fractures are among the most devastating injuries encountered in modern trauma surgery, representing approximately 2% - 4% of all pelvic fractures but accounting for disproportionately high rates of morbidity and mortality. Their severity results from the combination of unstable pelvic ring disruption, massive hemorrhage, extensive soft-tissue destruction, and frequent associated injuries involving the genitourinary tract, gastrointestinal tract, and major vascular structures. Despite advances in organized trauma systems and damage control resuscitation, these injuries continue to be associated with mortality rates ranging from 15% to more than 40%, depending on the mechanism of injury, degree of hemodynamic instability, extent of soft-tissue contamination, and associated visceral damage [1].

The mechanism of injury is typically high-energy blunt trauma, most commonly resulting from motor vehicle collisions, motorcycle crashes, crush injuries, or falls from height. Consequently, patients frequently present with severe multisystem trauma, reflected by high Injury Severity Scores and the need for simultaneous management of orthopedic, abdominal, vascular, urologic, and colorectal injuries. Among all patterns of pelvic trauma, unstable open fractures associated with perineal wounds represent a particularly challenging subset because direct communication between the fracture site and the external environment substantially increases the risk of bacterial contamination, pelvic sepsis, necrotizing soft-tissue infection, and multiple organ failure. The extent and anatomical location of the perineal injury have also been shown to correlate with infectious complications and overall prognosis, highlighting the importance of early recognition and appropriate classification of these injuries [2].

Historically, mortality following open pelvic fractures was primarily attributed to uncontrolled hemorrhage during the initial hours after injury. However, improvements in prehospital care, balanced massive transfusion protocols, pelvic stabilization techniques, preperitoneal pelvic packing, and selective angioembolization have significantly improved early survival. As a result, delayed complications—particularly pelvic sepsis resulting from fecal contamination, devitalized soft tissues, and missed anorectal injuries—have become increasingly important determinants of outcome. This evolution has shifted treatment priorities from iso-

lated fracture fixation toward comprehensive physiologic resuscitation and staged multidisciplinary management, in which hemorrhage control, contamination control, and repeated surgical assessment take precedence over immediate definitive orthopedic reconstruction [3].

Current management therefore relies on the principles of damage control surgery integrated with a multidisciplinary approach involving trauma surgeons, orthopedic surgeons, colorectal surgeons, urologists, plastic and reconstructive surgeons, interventional radiologists, and critical care specialists. Contemporary recommendations emphasize early adherence to Advanced Trauma Life Support (ATLS) principles, prompt hemorrhage control, aggressive debridement of contaminated tissues, selective fecal diversion according to wound characteristics, broad-spectrum antimicrobial therapy, serial wound reassessment, and delayed definitive pelvic fixation after physiologic stabilization. Although these principles are widely accepted, the rarity of open pelvic fractures has limited the availability of prospective studies, and most recommendations continue to rely on retrospective series, institutional experience, and expert consensus [4]-[6].

In this report, we describe the staged multidisciplinary management of a young patient with an unstable open pelvic fracture associated with extensive perineal soft-tissue disruption and intra-abdominal injuries. In addition to detailing the sequential surgical strategy employed, we review the contemporary evidence supporting damage control principles, contamination management, staged orthopedic stabilization, and reconstructive techniques in one of the most challenging scenarios encountered in trauma surgery.

2. Case Presentation

A 24-year-old previously healthy male was brought to the emergency department after a high-speed motorcycle collision with a truck. The patient was helmeted at the time of the accident and was transported by advanced life support ambulance as a major trauma activation approximately 45 minutes after injury. On arrival (day 0), he was hemodynamically unstable, with a blood pressure of 82/48 mmHg, heart rate of 136 beats/min, respiratory rate of 30 breaths/min, oxygen saturation of 93% while receiving oxygen through a non-rebreather mask, and a Glasgow Coma Scale (GCS) score of 13 (E3V4M6). Initial laboratory evaluation was consistent with severe hemorrhagic shock, with a hemoglobin concentration of 8.5 g/dL, serum lactate of 6.8 mmol/L, and a base deficit of −11 mmol/L. The Injury Severity Score (ISS) was calculated at 38.

Primary assessment following Advanced Trauma Life Support (ATLS) principles revealed an extensive contaminated perineal laceration extending from the perineum toward the right gluteal region, with complete disruption of the pelvic floor musculature and active hemorrhage. Palpable instability of the pelvic ring was noted, and gross contamination of the wound raised immediate concern for direct communication between the fracture hematoma and the external environment. These findings established the diagnosis of an unstable open pelvic fracture

with extensive perineal soft-tissue injury and suspected concomitant visceral trauma, representing an immediately life-threatening injury requiring multidisciplinary intervention (Figure 1).

Figure 1. Initial clinical presentation. Extensive perineal soft-tissue injury associated with an unstable open pelvic fracture following high-energy blunt trauma. The large perineal laceration demonstrates severe disruption of the pelvic floor soft tissues, highlighting the need for immediate hemorrhage control, contamination control, and a staged multidisciplinary surgical approach prior to definitive pelvic fixation.

The massive transfusion protocol was immediately activated, and balanced damage-control resuscitation with packed red blood cells, fresh frozen plasma, and platelets was initiated. A pelvic binder was applied on arrival to provide temporary mechanical stabilization. Focused Assessment with Sonography for Trauma (FAST) demonstrated free intraperitoneal fluid. Following a transient hemodynamic response to resuscitation sufficient to permit further diagnostic evaluation, urgent contrast-enhanced computed tomography (CT) was performed.

Initial anteroposterior pelvic radiography demonstrated marked pubic symphysis diastasis compatible with an unstable anteroposterior compression (APC type III) pelvic ring injury. Contrast-enhanced CT of the abdomen and pelvis demonstrated free intraperitoneal air consistent with hollow-viscus perforation. Additional findings included extensive disruption of the pelvic floor and perineal soft tissues, diffuse emphysema extending throughout the pelvic compartments, traumatic displacement of the right testicle, and active contrast extravasation consistent with ongoing pelvic arterial hemorrhage. No major thoracic injuries were identified. A closed fracture of the right tibial shaft was diagnosed during the secondary survey. Overall, imaging confirmed a complex multisystem injury involving the pelvic ring, gastrointestinal tract, genitourinary structures, and extensive perineal soft tissues (Figure 2).

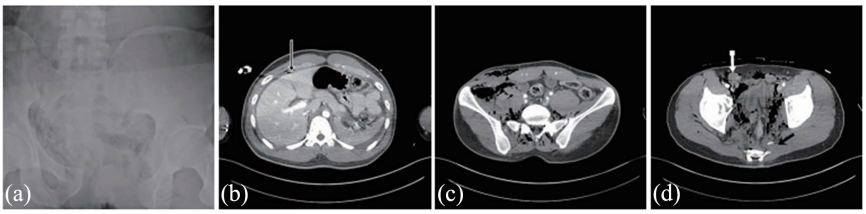

Figure 2. Initial radiologic assessment of the pelvic injury. (a) Anteroposterior pelvic radiograph obtained at admission demonstrating an unstable anteroposterior compression (APC type III) pelvic ring injury with marked pubic symphysis diastasis. (b) Axial contrast-enhanced computed tomography (CT) showing free intraperitoneal air (arrow), highly suggestive of associated hollow viscus injury. (c) Axial CT demonstrating extensive disruption of the pelvic floor and perineal soft tissues with emphysema extending through the pelvic compartments. (d) Contrast-enhanced CT revealing traumatic displacement of the testicle associated with active contrast extravasation (arrows), consistent with ongoing pelvic hemorrhage.

Given the patient's profound physiologic derangement and the need for immediate control of both hemorrhage and intra-abdominal contamination, the multidisciplinary trauma team proceeded directly to emergency damage-control surgery on day 0. Exploratory laparotomy confirmed multiple small-bowel perforations with fecal contamination of the abdominal cavity. Segmental small-bowel resection with primary stapled anastomosis was performed, followed by extensive abdominal irrigation. Because of the extensive perineal injury and substantial risk of continued pelvic contamination, a diverting sigmoid loop colostomy was created during the same operative stage. Preperitoneal pelvic packing was simultaneously performed for hemorrhage control, while temporary mechanical stabilization of the pelvic ring was maintained during the resuscitative phase.

Although CT had demonstrated active arterial contrast extravasation, immediate operative management was prioritized because of the concomitant hollow-viscus perforations, fecal contamination, severe perineal injury, and profound physiologic instability requiring urgent surgical source control. During the first 24 hours, the patient required eight units of packed red blood cells, eight units of fresh frozen plasma, and one pooled platelet concentrate. Hemodynamic stabilization was accompanied by progressive correction of metabolic acidosis, providing objective evidence of response to damage-control resuscitation.

Following the initial operation, the patient was admitted to the intensive care unit (ICU), where he remained for eight days under coordinated management involving trauma surgery, orthopedic surgery, colorectal surgery, urology, plastic surgery, anesthesiology, and critical care. During this period, priorities included correction of coagulopathy and metabolic derangement, restoration of adequate tissue perfusion, antimicrobial therapy, nutritional support, and repeated assessment of the contaminated perineal wound. Progression from damage-control management toward definitive reconstruction was based on sustained hemodynamic stability, correction of the initial metabolic derangement and coagulopathy, adequate tissue perfusion, and evidence of satisfactory local source control rather than on a predetermined time interval alone.

Broad-spectrum empirical antimicrobial therapy was initiated because of the open contaminated pelvic fracture, extensive perineal injury, and documented intestinal perforation with fecal contamination. Local control of contamination was assessed through serial operative examinations, including the absence of progressive tissue necrosis or purulent collections, removal of nonviable tissue, and progressive development of a viable wound bed.

Planned serial returns to the operating room were undertaken at approximately 48 - 72-hour intervals for meticulous irrigation, aggressive debridement of devitalized tissue, and repeated assessment of soft-tissue viability. Operative exploration demonstrated extensive disruption of the pelvic floor musculature and perineal soft tissues (**Figure 3**). Following adequate source control, subsequent examinations showed no evidence of progressive necrosis. As the wound demonstrated viable tissue and favorable evolution, negative-pressure wound therapy was incorporated to promote granulation tissue formation and optimize the wound bed for delayed reconstruction. Thus, progression between surgical stages was guided by both systemic physiologic recovery and serial confirmation of satisfactory local wound control rather than by time alone.

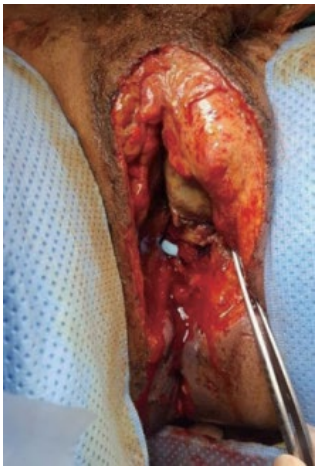

Figure 3. Intraoperative exploration demonstrating extensive disruption of the perineal soft tissues following high-energy blunt pelvic trauma. The operative findings confirmed severe involvement of the pelvic floor with complex soft-tissue injury, emphasizing the need for meticulous debridement, contamination control, serial wound assessment, and staged reconstruction before definitive orthopedic fixation.

After physiologic recovery and control of local contamination, definitive orthopedic reconstruction was undertaken during the fourth operative stage. Open reduction and internal fixation of the anterior pelvic ring was performed, achieving satisfactory reduction of the pubic symphysis. Definitive fixation of the associated right tibial shaft fracture was performed during the same surgical session, thereby restoring overall musculoskeletal stability while avoiding an additional anesthetic exposure. Postoperative radiographs demonstrated satisfactory alignment of the pelvic ring and appropriate positioning of the fixation implants without immediate mechanical complications (**Figure 4**).

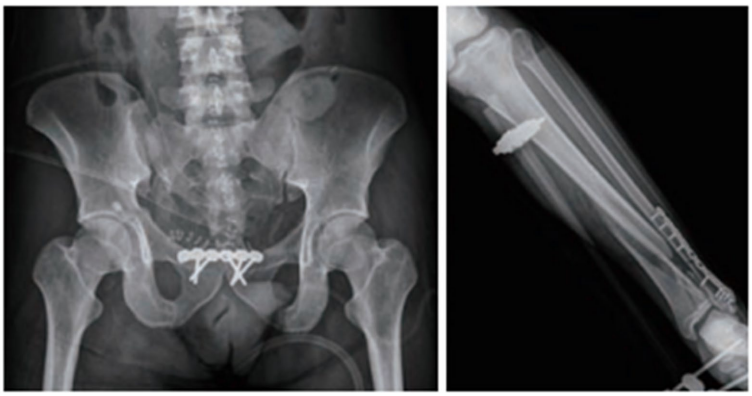

Figure 4. Postoperative anteroposterior radiograph of the pelvis and right leg following definitive surgical stabilization. Internal fixation successfully restored the integrity of the anterior pelvic ring after physiologic stabilization and completion of the damage control phase. Concomitant fixation of the associated tibial fracture was performed during the same reconstructive stage, reflecting the multidisciplinary and staged approach to complex musculoskeletal trauma.

Definitive reconstruction of the residual perineal defect was subsequently performed once serial operative assessments demonstrated adequate source control, absence of progressive necrosis or clinically evident local infection, and satisfactory development of healthy granulation tissue. Progressive wound healing occurred without evidence of recurrent pelvic sepsis or deep surgical-site infection. Early rehabilitation was initiated during hospitalization and included passive and active range-of-motion exercises, respiratory physiotherapy, and progressive mobilization. The patient was discharged home on hospital day 32 in stable clinical condition.

At six-month outpatient follow-up, the patient remained free of clinically apparent infectious complications. Serial radiographic assessment demonstrated maintained pelvic reduction and progressive osseous union of both the pelvic ring and right tibial fracture. The perineal wound had healed completely, and the patient had regained independent ambulation without assistive devices. Mild discomfort persisted during prolonged walking and strenuous physical activity, but there was no clinical or radiographic evidence of recurrent pelvic instability, chronic osteomyelitis, or recurrent soft-tissue infection. Urinary and fecal continence were preserved on clinical follow-up. The diverting colostomy had also been successfully reversed**.** Overall, the patient's course demonstrates successful staged management in which hemorrhage control, gastrointestinal and perineal contamination control, serial debridement, delayed skeletal stabilization, soft-tissue reconstruction, and rehabilitation were sequentially prioritized according to evolving physiologic and local wound conditions.

3. Discussion

3.1. Epidemiology and Prognosis

Open pelvic fractures remain among the most devastating injuries encountered in

trauma surgery despite representing only a small proportion of all pelvic fractures. Current epidemiological data indicate that these injuries account for approximately 2% - 4% of pelvic ring fractures but are associated with substantially higher morbidity and mortality than their closed counterparts because of the simultaneous occurrence of unstable skeletal disruption, major vascular injury, extensive soft-tissue destruction, and contamination from adjacent hollow viscera or genitourinary structures [7]. Mortality rates reported in the literature vary considerably, ranging from 15% to more than 40%, largely reflecting differences in injury severity, hemodynamic status at presentation, associated injuries, and institutional experience in managing complex pelvic trauma. Nevertheless, advances in trauma systems, damage control resuscitation, and multidisciplinary management have significantly improved survival over the past two decades.

Unlike isolated pelvic fractures, open pelvic injuries should be regarded as a multisystem disease rather than a purely orthopedic problem. The close anatomical relationship between the pelvic ring, pelvic vasculature, lower gastrointestinal tract, urinary tract, and perineal soft tissues explains why disruption of one compartment frequently results in injury to the others. Consequently, successful treatment depends not only on restoration of skeletal stability but also on simultaneous management of hemorrhage, contamination, visceral injuries, and soft-tissue defects. In the present case, the patient demonstrated extensive destruction of the pelvic floor associated with bowel injury, active hemorrhage, and traumatic testicular displacement, illustrating the complexity that characterizes this pattern of injury (**Figure 1** and **Figure 2**).

Several prognostic factors have consistently been associated with increased mortality following open pelvic fractures. Persistent hemodynamic instability, high Injury Severity Score (ISS), massive transfusion requirements, rectal or perineal injuries, delayed hemorrhage control, and pelvic sepsis remain the strongest independent predictors of poor outcome [8]. Importantly, while exsanguination continues to account for most deaths during the first hours after injury, patients surviving the initial resuscitative phase remain at considerable risk of infectious complications, including pelvic abscesses, necrotizing soft-tissue infections, osteomyelitis, and multiple organ dysfunction syndrome. This temporal shift in the causes of mortality has fundamentally changed the therapeutic priorities in contemporary trauma care, emphasizing aggressive control of both hemorrhage and contamination as equally important determinants of survival.

The anatomical location of the soft-tissue injury also appears to influence prognosis. Classification systems such as the Jones-Powell classification have demonstrated that perineal and transperineal wounds are associated with significantly higher rates of pelvic sepsis because they facilitate direct communication between contaminated external wounds, anorectal injuries, and the fracture hematoma. This observation has reinforced the importance of early recognition of wound location during the initial evaluation and has influenced subsequent decisions regarding fecal diversion, serial debridement, and reconstructive planning. In our patient, the extensive perineal disruption shown in **Figure 1** represented one of

the principal determinants of management, prompting immediate multidisciplinary intervention and aggressive contamination control from the earliest stages of treatment.

Although long-term functional outcomes have improved considerably, survivors frequently experience persistent physical disability, chronic pain, sexual dysfunction, urinary or fecal incontinence, and psychological impairment. Consequently, successful management should not be measured exclusively by survival but also by restoration of function and quality of life. Our patient achieved complete wound healing, fracture union, preservation of urinary and fecal continence, and independent ambulation at six months, outcomes that compare favorably with those reported in contemporary multidisciplinary series and highlight the benefits of staged management in carefully selected patients.

3.2. Hemorrhage Control and Damage Control Resuscitation

Hemorrhage remains the leading cause of preventable early death following unstable pelvic fractures. Pelvic bleeding originates from a complex combination of venous plexus disruption, cancellous bone bleeding, and arterial injury, making rapid mechanical stabilization and damage control resuscitation essential during the initial hours after trauma. Current trauma algorithms prioritize simultaneous correction of hypothermia, acidosis, and coagulopathy while minimizing delays to definitive hemorrhage control. Early activation of massive transfusion protocols using balanced blood product ratios has become a cornerstone of modern pelvic trauma management, reducing dilutional coagulopathy and improving tissue perfusion during the resuscitative phase [9].

Temporary mechanical stabilization of the pelvic ring represents one of the earliest interventions capable of reducing pelvic volume and promoting tamponade of venous bleeding. Pelvic binders have therefore become standard prehospital and emergency department interventions for suspected mechanically unstable pelvic injuries. Although binders alone rarely achieve definitive hemorrhage control, they provide valuable temporary stabilization while additional diagnostic and therapeutic procedures are organized. In our patient, immediate application of a pelvic binder was followed by rapid imaging that confirmed an APC type III injury with marked pubic symphysis diastasis and active pelvic hemorrhage, findings illustrated in **Figure 2**.

Among patients presenting with persistent hemodynamic instability, damage control surgery has progressively replaced prolonged definitive operative procedures during the initial resuscitative phase. Contemporary evidence supports preperitoneal pelvic packing (PPP) as one of the fastest and most effective techniques for controlling predominantly venous pelvic hemorrhage, particularly in institutions where immediate angioembolization is unavailable or would result in unacceptable treatment delays [10]. The recent EAST practice management guideline concluded that PPP should be strongly considered in hemodynamically unstable patients and that persistent instability following packing should prompt complementary pelvic angiography and selective embolization when arterial

bleeding remains suspected.

The relationship between PPP and angioembolization should not be viewed as competitive but rather complementary. PPP rapidly controls diffuse venous bleeding and hemorrhage originating from cancellous bone surfaces, whereas angiographic embolization remains the preferred strategy for persistent arterial hemorrhage demonstrated clinically or radiologically. Modern trauma centers increasingly employ sequential or combined approaches tailored to the patient's physiologic response, institutional resources, and imaging findings. Recent meta-analyses suggest that neither modality should universally replace the other; instead, optimal outcomes appear to result from individualized algorithms integrating both techniques within structured damage control pathways [11].

Our management strategy closely reflected these contemporary principles. The patient presented with profound hemorrhagic shock requiring immediate activation of a massive transfusion protocol, temporary pelvic stabilization, emergency laparotomy, and preperitoneal pelvic packing before any attempt at definitive orthopedic reconstruction. Only after correction of physiologic derangements and stabilization of the patient's metabolic status was definitive fixation undertaken. This staged sequence mirrors the evidence-based algorithm summarized in **Figure 5**, in which ATLS-guided resuscitation, early hemorrhage control, damage control surgery, and delayed definitive reconstruction constitute the fundamental principles of successful management. Likewise, the interventions performed in our patient closely follow the recommendations synthesized in **Table 1**, emphasizing that restoration of physiology should always precede definitive skeletal reconstruction in patients with severe open pelvic trauma.

Table 1. Evidence-based staged management of unstable open pelvic fractures with perineal injury.

Management Stage	Clinical Objective	Recommended Intervention	Evidence/ Recommendation	Key References
1. Initial assessment	Rapid identification of life-threatening injuries	ATLS protocol, pelvic binder, FAST examination, hemodynamic assessment	Strong recommendation	ATLS®, WSES Pelvic Trauma Guidelines
2. Hemorrhage control	Prevent exsanguination	Massive transfusion protocol, pelvic packing, external stabilization, angioembolization when arterial bleeding is suspected	Strong recommendation (moderate-quality evidence)	WSES; EAST; Coccolini *et al.*
3. Damage control surgery	Control contamination and associated visceral injuries	Exploratory laparotomy, bowel repair or resection, fecal diversion when indicated, temporary abdominal closure if necessary	Strong recommendation	EAST; WSES; Burlew *et al.*
4. Evaluation of perineal injuries	Define extent of soft-tissue and anorectal involvement	Examination under anesthesia, rectal evaluation, urologic assessment, serial debridement	Moderate recommendation	Faringer *et al.*; Grotz *et al.*
5. Infection prevention	Reduce pelvic sepsis	Broad-spectrum antibiotics, aggressive irrigation, repeated debridement, negative-pressure wound therapy (NPWT)	Moderate recommendation	WSES; Grotz *et al.*

Continued

6. Definitive orthopedic stabilization	Restore pelvic stability after physiologic recovery	Internal fixation when contamination is controlled; external fixation in selected contaminated injuries	Moderate recommendation	OTA; Tile; Leenen *et al.*
7. Reconstruction phase	Functional recovery and wound closure	Soft-tissue reconstruction, skin grafts or flap coverage, rehabilitation	Moderate recommendation	Recent multidisciplinary series
8. Follow-up	Detect complications and optimize function	Clinical assessment, radiographic follow-up, stoma management, rehabilitation, infection surveillance	Expert consensus	OTA; WSES

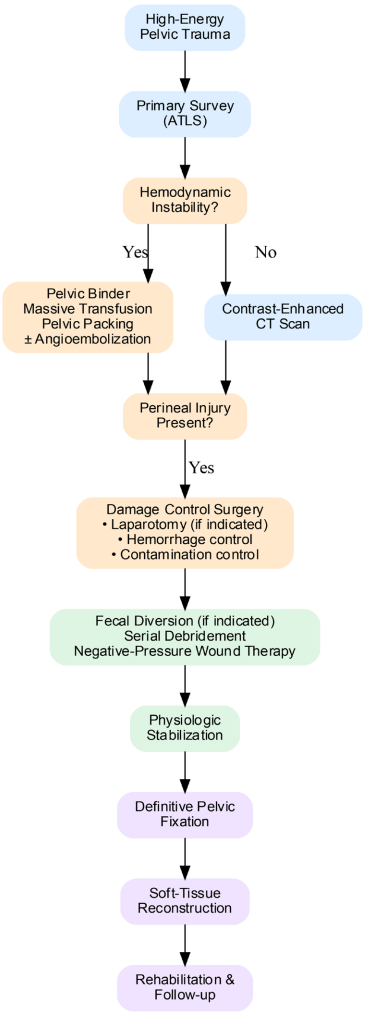

Figure 5. Evidence-based algorithm for the multidisciplinary staged management of unstable open pelvic fractures with perineal injury. Initial management prioritizes Advanced Trauma Life Support (ATLS)-based resuscitation and hemorrhage control, followed by assessment of associated perineal and visceral injuries. Damage control surgery—including hemorrhage control, contamination control, fecal diversion when indicated, serial debridement, and negative-pressure wound therapy (NPWT)—precedes definitive pelvic fixation after physiologic stabilization. The final phase focuses on soft-tissue reconstruction, rehabilitation, and long-term functional follow-up. The proposed algorithm summarizes current evidence and the multidisciplinary approach discussed in this review.

3.3. Contamination Control and Fecal Diversion

Following successful hemorrhage control, prevention of pelvic sepsis becomes the principal therapeutic objective in patients with open pelvic fractures. Extensive perineal wounds, anorectal injuries, and bowel perforations allow direct contamination of the fracture hematoma and surrounding soft tissues, substantially increasing the risk of deep pelvic infection, abscess formation, osteomyelitis, and multiple organ dysfunction. Consequently, early identification and adequate control of contamination are essential components of damage control surgery and have been consistently associated with improved survival [12].

The role of fecal diversion has evolved from routine colostomy in all open pelvic fractures to a more selective approach based on the location of the wound and the presence of rectal or colonic injuries. Current evidence suggests that diversion is particularly beneficial in patients with extensive perineal injuries or confirmed colorectal trauma, where it significantly reduces ongoing contamination and facilitates subsequent wound management. In the present case, the combination of bowel perforation and severe perineal disruption justified early diverting colostomy during the initial laparotomy, allowing effective source control before definitive pelvic reconstruction. This staged strategy is reflected in the management algorithm proposed in **Figure 5** and summarized in **Table 1**, where contamination control precedes definitive skeletal fixation.

3.4. Serial Debridement and Negative-Pressure Wound Therapy

Adequate management of soft-tissue injuries requires repeated operative assessment rather than a single definitive procedure. Serial debridement allows progressive removal of devitalized tissue, reduction of bacterial burden, and repeated evaluation of tissue viability while preserving healthy structures whenever possible. This staged approach has become a cornerstone of contemporary management, particularly in patients with extensive perineal destruction, where delayed reconstruction is associated with lower infectious complication rates [13].

Negative-pressure wound therapy (NPWT) has further improved the management of these complex wounds by promoting granulation tissue formation, reducing local edema, improving wound drainage, and facilitating delayed soft-tissue reconstruction. In our patient, repeated debridement followed by NPWT provided adequate local infection control before definitive orthopedic fixation and reconstruction of the perineal defect (**Figure 3**). This sequence closely follows the evidence-based recommendations presented in **Table 1**, emphasizing that definitive fixation should only be performed after satisfactory physiologic recovery and local control of contamination have been achieved.

3.5. Timing of Definitive Pelvic Fixation

The optimal timing of definitive pelvic fixation remains one of the most debated aspects in the management of open pelvic fractures. Although early definitive fixation has demonstrated benefits in selected hemodynamically stable patients with

closed pelvic injuries, this strategy is generally inappropriate in patients with severe contamination, ongoing physiologic derangement, or uncontrolled hemorrhage. Current damage control principles advocate delaying definitive internal fixation until adequate resuscitation has been achieved, coagulopathy has resolved, and both local and systemic contamination are satisfactorily controlled [14].

In the present case, definitive internal fixation was intentionally postponed until serial debridement, pelvic sepsis prevention, and physiologic stabilization had been successfully completed. This staged strategy minimized the risk of implant-related infection while allowing restoration of pelvic stability under more favorable biological conditions. The postoperative radiographic findings shown in **Figure 4** demonstrate satisfactory reduction and stable fixation of the pelvic ring following completion of the damage control phase. Likewise, the proposed treatment sequence closely follows the evidence-based algorithm illustrated in **Figure 5**, in which definitive fixation is performed only after successful hemorrhage and contamination control, as summarized in **Table 1**.

3.6. Multidisciplinary Management

Successful treatment of unstable open pelvic fractures requires close collaboration among multiple specialties rather than isolated orthopedic intervention. Trauma surgeons, orthopedic surgeons, colorectal surgeons, urologists, plastic and reconstructive surgeons, interventional radiologists, anesthesiologists, and intensive care specialists each contribute to different stages of management, addressing hemorrhage, visceral injuries, soft-tissue reconstruction, skeletal stabilization, and postoperative rehabilitation. Increasing evidence suggests that coordinated multidisciplinary care improves survival while reducing infectious complications and the number of unplanned reoperations [15].

The present case exemplifies this integrated approach. Initial management prioritized hemorrhage control and treatment of associated abdominal injuries, followed by fecal diversion, serial debridement, intensive care support, delayed definitive pelvic fixation, and subsequent soft-tissue reconstruction. Rather than focusing exclusively on fracture stabilization, each intervention was performed according to the patient's evolving physiologic status, reflecting the principles of modern damage control surgery. The sequence of management presented in **Figure 5** and synthesized in **Table 1** summarizes this multidisciplinary strategy, emphasizing that successful outcomes depend on careful coordination of sequential interventions rather than a single definitive procedure.

3.7. Comparison with Our Case

The present case illustrates several key principles that have emerged in the contemporary management of unstable open pelvic fractures. Rather than pursuing immediate definitive skeletal stabilization, treatment was guided by a staged multidisciplinary strategy prioritizing hemorrhage control, contamination control,

physiologic recovery, and delayed definitive fixation. This approach is consistent with current recommendations advocating damage control surgery in patients presenting with hemodynamic instability and extensive perineal soft-tissue injury [16].

A distinguishing feature of this case was the successful coordination of multiple surgical specialties throughout the patient's clinical course. Emergency laparotomy, fecal diversion, pelvic packing, serial debridement, delayed internal fixation, and definitive soft-tissue reconstruction were performed sequentially according to the patient's physiologic response rather than following a predetermined operative schedule. The favorable clinical outcome, characterized by complete wound healing, fracture union, preserved continence, and independent ambulation, supports the concept that restoration of physiology should precede definitive orthopedic reconstruction. The chronological sequence observed in this patient closely mirrors the management pathway illustrated in **Figure 5**, while each stage corresponds to the evidence-based recommendations summarized in **Table 1**.

3.8. Strengths, Limitations, and Clinical Implications

This report highlights the successful application of a structured multidisciplinary strategy for one of the most challenging injuries encountered in trauma surgery. By integrating contemporary principles of damage control resuscitation, hemorrhage control, contamination management, staged orthopedic reconstruction, and soft-tissue repair, this case demonstrates how coordinated decision-making can optimize outcomes despite the severity of injury.

The principal limitation of this report is its inherent nature as a single case, which limits the generalizability of the findings. Nevertheless, because unstable open pelvic fractures remain uncommon and prospective comparative studies are scarce, well-documented case reports continue to provide valuable clinical evidence supporting multidisciplinary decision-making. We believe that the proposed evidence-based algorithm (**Figure 5**) and the staged management strategy summarized in **Table 1** may serve as practical tools for guiding clinicians confronted with similarly complex injuries.

4. Conclusions

Open pelvic fractures associated with extensive perineal injury remain among the most complex emergencies in trauma surgery, requiring prompt recognition and coordinated multidisciplinary management. Survival depends not only on effective hemorrhage control but also on early contamination control, repeated debridement, physiologic stabilization, and appropriately timed definitive skeletal reconstruction. The favorable outcome achieved in this case supports the effectiveness of a staged damage control strategy integrating trauma, orthopedic, colorectal, urologic, reconstructive, and critical care teams.

The evidence-based management algorithm proposed in **Figure 5**, together with the staged recommendations summarized in **Table 1**, provides a practical

framework for the sequential management of these devastating injuries. Although additional multicenter studies are needed to strengthen the available evidence, adherence to these fundamental principles may contribute to reducing mortality, minimizing infectious complications, and improving long-term functional outcomes in patients with unstable open pelvic fractures and severe perineal soft-tissue injury.

Ethical Considerations

Written informed consent was obtained from the patient for the publication of this case report and the accompanying clinical images. All identifying information was removed to protect patient confidentiality. This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Institutional Review Board approval was not required for the publication of a single anonymized case report, according to local institutional policies.

Declaration of Generative AI and AI-Assisted Technologies in Manuscript Preparation

During the preparation of this manuscript, the authors used Claude (Anthropic) and ChatGPT (OpenAI) solely as AI-assisted editorial tools. Their use was limited to language and copy editing, including correction of grammar, spelling, syntax, and punctuation; refinement of selected sentences to improve semantic clarity, readability, and academic style; and assistance in improving the wording and description of the figures and their corresponding legends. These tools were not used to generate the scientific content of the manuscript, formulate the clinical interpretation or conclusions, analyze data, make diagnostic or therapeutic decisions, or generate or select references. All AI-assisted suggestions were critically reviewed, verified, and revised as necessary by the authors. The authors take full responsibility for the accuracy, integrity, and final content of the manuscript.

Author Contributions

Conceptualization, A.D.A.-U., P.C.-M., K.M.-L. and V.L.-M.; investigation, L.B.-L., E.F.-P., B.S.-M. and J.R.-D.; data curation, J.P.P.-C.; writing—original draft preparation, G.C.-N., S.R.-M. and C.B.-T.; writing—review and editing, G.C.-N., S.R.-M., C.B.-T., A.D.A.-U. and K.M.-L.; visualization, A.D.A.-U. and K.M.-L.; project administration, A.D.A.-U. and K.M.-L. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Grotz, M.R.W., Allami, M.K., Harwood, P., Pape, H.C., Krettek, C. and Giannoudis, P.V. (2005) Open Pelvic Fractures: Epidemiology, Current Concepts of Management

and Outcome. *Injury*, **36**, 1-13. https://doi.org/10.1016/j.injury.2004.05.029

[2] Cannada, L.K., Taylor, R.M., Reddix, R., Mullis, B., Moghadamian, E. and Erickson, M. (2013) The Jones-Powell Classification of Open Pelvic Fractures: A Multicenter Study Evaluating Mortality Rates. *Journal of Trauma and Acute Care Surgery*, **74**, 901-906. https://doi.org/10.1097/ta.0b013e3182827496

[3] Coccolini, F., Stahel, P.F., Montori, G., Biffl, W., Horer, T.M., Catena, F., *et al.* (2017) Pelvic Trauma: WSES Classification and Guidelines. *World Journal of Emergency Surgery*, **12**, Article No. 5. https://doi.org/10.1186/s13017-017-0117-6

[4] Giordano, V., Koch, H.A., Gasparini, S., Serrão de Souza, F., Labronici, P.J. and do Amaral, N.P. (2016) Open Pelvic Fractures: Review of 30 Cases. *The Open Orthopaedics Journal*, **10**, 772-778. https://doi.org/10.2174/1874325001610010772

[5] Dente, C.J., Feliciano, D.V., Rozycki, G.S., Wyrzykowski, A.D., Nicholas, J.M., Salomone, J.P., *et al.* (2005) The Outcome of Open Pelvic Fractures in the Modern Era. *The American Journal of Surgery*, **190**, 831-837. https://doi.org/10.1016/j.amjsurg.2005.05.050

[6] Arvieux, C., Thony, F., Broux, C., Ageron, F., Rancurel, E., Abba, J., *et al.* (2012) Current Management of Severe Pelvic and Perineal Trauma. *Journal of Visceral Surgery*, **149**, e227-e238. https://doi.org/10.1016/j.jviscsurg.2012.06.004

[7] Suzuki, T., Smith, W.R. and Moore, E.E. (2009) Pelvic Packing or Angiography: Competitive or Complementary? *Injury*, **40**, 343-353. https://doi.org/10.1016/j.injury.2008.12.006

[8] Flint, L. and Cryer, H.G. (2010) Pelvic Fracture: The Last 50 Years. *Journal of Trauma: Injury, Infection & Critical Care*, **69**, 483-488. https://doi.org/10.1097/ta.0b013e3181ef9ce1

[9] Bugaev, N., Rattan, R., Goodman, M., Mukherjee, K., Robinson, B.R.H., McDonald, A.A., *et al.* (2020) Preperitoneal Packing for Pelvic Fracture-Associated Hemorrhage: A Systematic Review, Meta-Analysis, and Practice Management Guideline from the Eastern Association for the Surgery of Trauma. *The American Journal of Surgery*, **220**, 873-888. https://doi.org/10.1016/j.amjsurg.2020.05.037

[10] Magnone, S., Coccolini, F., Manfredi, R., Piazzalunga, D., Agazzi, R., Arici, C., *et al.* (2014) Management of Hemodynamically Unstable Pelvic Trauma: Results of the First Italian Consensus Conference. *World Journal of Emergency Surgery*, **9**, Article No. 18. https://doi.org/10.1186/1749-7922-9-18

[11] Martinez, B., Breeding, T., Katz, J., Patel, H., Santos, R.G. and Elkbuli, A. (2024) Outcomes of Preperitoneal Packing and Angioembolization for Hemorrhage Control in Hemodynamically Unstable Pelvic Fractures: A Systematic Review and Meta-Analysis. *The American Surgeon™*, **90**, 455-464. https://doi.org/10.1177/00031348231216488

[12] Burlew, C.C., Moore, E.E., Smith, W.R., Johnson, J.L., Biffl, W.L., Barnett, C.C., *et al.* (2011) Preperitoneal Pelvic Packing/External Fixation with Secondary Angioembolization: Optimal Care for Life-Threatening Hemorrhage from Unstable Pelvic Fractures. *Journal of the American College of Surgeons*, **212**, 628-635. https://doi.org/10.1016/j.jamcollsurg.2010.12.020

[13] Cannada, L.K. and Hill, B.W. (2014) Osteomyelitis, Soft-Tissue Management, and Reconstruction Following Open Pelvic Fractures. *Journal of the American Academy of Orthopaedic Surgeons*, **22**, 750-758.

[14] Pape, H.C., Giannoudis, P.V., Krettek, C. and Trentz, O. (2005) Timing of Fixation of Major Fractures in Blunt Polytrauma: Role of Early Appropriate Care and Damage Control Surgery. *Journal of the American Academy of Orthopaedic Surgeons*, **13**,

152-161.

[15] Lu, S., Liu, F., Xu, W., Zhou, X., Li, L., Zhou, D., *et al.* (2022) Management of Open Tile C Pelvic Fractures and Their Outcomes: A Retrospective Study of 30 Cases. *Therapeutics and Clinical Risk Management*, **18**, 929-937. https://doi.org/10.2147/tcrm.s378740

[16] Faringer, P.D., Mullins, R.J., Feliciano, P.D., *et al.* (1994) Selective Fecal Diversion in Complex Open Pelvic Fractures from Blunt Trauma. *Archives of Surgery*, **129**, 958-964. https://doi.org/10.1001/archsurg.1994.01420330072014