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Managing severe (and open) pelvic disruption

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SUMMARY

Open pelvic fractures are a rare yet catastrophic injury pattern, often resulting from high-energy trauma such as motor vehicle collisions, motorcycle accidents, and pedestrian impacts. They account for only 2%–4% of all pelvic fractures, but their severity lies in the complex anatomy of the pelvis and its associated structures, including the vasculature, bowel, bladder, and genital organs. Mortality rates range from 15% to 50%, with some studies reporting rates as high as 70% in cases involving severe perineal or rectal injuries. These injuries pose two main risks to survival: hemorrhagic shock in the acute phase and pelvic sepsis during the later phases of recovery. Acute hemorrhage can occur from arterial injury (eg, internal iliac arteries), venous plexuses, or bony sources. Delayed deaths are often caused by sepsis due to fecal contamination of wounds or infected hematomas. Additionally, these fractures are often associated with other life-threatening injuries, including intra-abdominal trauma, genitourinary disruptions, and neurovascular compromise, further complicating their management. Management of these injuries has evolved significantly with advancements in hemorrhage control techniques such as preperitoneal pelvic packing and resuscitative endovascular balloon occlusion of the aorta. A multidisciplinary approach is essential to address the multifaceted challenges posed by these injuries.

INTRODUCTION

Open pelvic fractures are a rare yet catastrophic injury pattern, often resulting from high-energy trauma, such as motor vehicle collisions, motorcycle accidents, and pedestrian impacts. Accounting for 2%–4% of all pelvic fractures, their potential for severity lies in the complex anatomy of the pelvis and its associated structures, including the vasculature, gastrointestinal, urinary, and genital organs.[1] Mortality rates reach as high as 45%, with some studies reporting rates as high as 70% in cases involving severe perineal or rectal injuries.[2]

These injuries pose two main risks to survival: hemorrhagic shock in the acute phase and pelvic sepsis during the later phases of recovery. Acute hemorrhage can occur from injury to arterial structures, venous plexuses, or fractures. Fecal contamination of wounds or infected hematomas often leads to sepsis and death.[1] Further complicating their management, pelvic fractures are often also associated with other life-threatening injuries, including intra-abdominal trauma, genitourinary disruptions, and neurovascular compromise.

Management of these injuries has evolved significantly with advancements in hemorrhage control techniques such as preperitoneal pelvic packing (PPP) and, more recently, resuscitative endovascular balloon occlusion of the aorta (REBOA). A multidisciplinary approach is essential to address the multifaceted challenges posed by these injuries. This may include the collaboration of trauma, orthopedic, urology, and colorectal specialties.

PREDICTORS OF MORTALITY

Mortality in pelvic trauma is influenced by a combination of injury-associated physiological derangements, injury complexity, and the timing and quality of care provided. Early identification of these predictors is critical for improving outcomes and guiding treatment decisions in these critically injured patients.

Physiological derangements

One of the strongest indicators of mortality is the degree of hemodynamic instability at presentation. Patients who arrive in shock, defined by a systolic blood pressure (SBP) <90 mm Hg, are at significantly higher risk of death. In trauma, this is initially assumed to be due to hemorrhage. The extent of shock is a direct measure of the severity of the injury, and patients with an SBP <80 mm Hg are particularly vulnerable to early mortality due to catastrophic blood loss.

The Revised Trauma Score (RTS) has proven to be a reliable tool in predicting acute mortality in patients with open pelvic fractures. By incorporating measures of SBP, respiratory rate, and Glasgow Coma Scale, the RTS provides a composite score that reflects the patient's overall physiological status. In one study, the RTS demonstrated a near-perfect ability to predict mortality. Patients in this study who scored below a critical threshold showed a 100% probability of death.[3] This emphasizes the importance of early and aggressive resuscitation to stabilize these physiological parameters.

Coagulopathy, another significant physiological predictor, exacerbates bleeding and increases the likelihood of death. Elevated international normalized ratios and prolonged activated partial thromboplastin time are common in these patients due to massive blood loss, hypothermia, and acidosis. These traditional markers of coagulopathy have been largely supplanted by more functional viscoelastic coagulation tests like thromboelastography and rotational thromboelastography. Elevated lactate levels, a marker of tissue hypoperfusion and metabolic distress, further highlight the severity of shock and predict worse outcomes if not rapidly corrected.

Injury-specific predictors and management

The anatomical complexity of open pelvic fractures contributes significantly to their lethality. Unstable

fracture patterns, such as those classified as 'windswept' or mixed-mechanism (rotationally and vertically unstable), are particularly associated with high mortality. The Jones-Powell Classification system offers added insights, categorizing open pelvic fractures into three classes based on pelvic stability and associated soft-tissue injuries. Class 3 injuries, which involve an unstable pelvic ring with rectal or perineal wounds, have the highest mortality rates—reaching 38% in some studies.[4] This highlights the role of severe pelvic disruption and contamination in driving poor outcomes.

Rectal and perineal injuries are particularly significant markers of mortality.[5] These injuries signify extensive pelvic floor damage and introduce the risk of fecal contamination and subsequent pelvic sepsis, a leading cause of delayed deaths in open pelvic fractures. Rectal lacerations, in particular, are associated with a disproportionately high risk of sepsis and multi-organ failure if not addressed properly.[6 7]

Bladder and urethral injuries, which occur in nearly 20% of cases, often require specialized urological interventions to prevent long-term complications and infection. Signs of urological trauma include hematuria, high-riding prostate, inability to pass a Foley catheter, and inability to urinate. 29% of patients with pelvic fracture and hematuria have been found to have bladder injury.[8] A retrograde cystography is recommended when urological injury is suspected with pelvic trauma. Management of bladder trauma depends on location of injury and if complicated. If intraperitoneal or complicated, it should be surgically repaired. Intraperitoneal bladder injuries usually occur in the dome of the bladder and are not likely to heal even with drainage via catheter. Uncomplicated extraperitoneal injuries, that is, those without penetration by fractured bone, should be managed with urinary drainage via catheter. Extraperitoneal bladder injuries that occur concomitantly with rectal or vaginal injuries should also be repaired to prevent fistulization. It is recommended that ureteral injuries below the level of iliac crossing be repaired with ureteroureterostomy or ureteral implantation. When such complex repairs are not to be tolerated in an emergent setting, nephrostomy tubes can be placed by interventional radiology and formal repair delayed.

A retrograde urethrogram should be performed prior to attempting foley catheter placement in the ED or OR if there is concern for urethral injury as evidenced by blood at the urinary meatus. If complete urethral disruption has occurred, suprapubic catheter insertion should be undertaken to allow for urinary drainage. Incomplete injury may be managed by Foley insertion.[9]

Blood found during a digital rectal examination may indicate rectal injury. A higher incidence of rectal injury has also been associated with widened pubic symphysis and anteroposterior pelvic fractures.[10] Intraperitoneal colorectal injuries should be managed as colon injuries with either primary repair or resection based on extent of defect. If suspected based on examination, injury pattern, or CT with rectal contrast, investigation of rectal injury should include direct visualization of the rectum via proctoscopy.[11] Current recommendations for the the management of extraperitoneal rectal injuries advise against presacral drainage and distal rectal washout, which existed in prior dogma. Proximal diversion, however, continues to be recommended in cases of rectal injury.[11 12]

Neurological injuries, such as traumatic brain injury or spinal cord injury, are similarly associated with poor outcomes, as they complicate resuscitation and limit the patient's ability to recover from additional injuries. Intra-abdominal trauma, such as bowel or liver injuries, adds another layer of complexity, increasing the likelihood of hemorrhagic shock and overwhelming the capacity for surgical management.[13]

Scant literature exists regarding the management of vaginal injuries associated with pelvic trauma. Although well-vascularized, vaginal bleeding is usually limited by smooth muscle contracture in response to trauma. Mucosal injuries may be managed with gauze packing alone, while deeper injuries should be repaired, when feasible, by an obstetrician/gynecologist.[14]

Trauma-related predictors

The predictors of mortality in open pelvic fractures rarely act in isolation. Instead, they form a complex interplay of physiological, injury-specific, and treatment-related factors. A severely injured patient presenting in shock with an unstable pelvic fracture and concurrent rectal laceration faces an extraordinarily high risk of death, particularly if resuscitation or surgical interventions are delayed. Similarly, patients with coagulopathy or elevated lactate levels may succumb even after hemorrhage control, if metabolic derangements are not corrected promptly.

Mortality in open pelvic fractures is driven by a combination of severe physiological derangements, complex injury patterns, and delays in definitive care. Early identification of high-risk factors, such as hemodynamic instability, unstable fracture patterns, and rectal injuries, is critical for tailoring interventions to individual patients. Scoring systems like the RTS and the Jones-Powell Classification provide valuable frameworks for triage and decision-making. However, improving outcomes ultimately relies on a coordinated, multidisciplinary approach that integrates rapid hemorrhage control, aggressive resuscitation, and timely surgical interventions.

MANAGEMENT DURING RESUSCITATION

The primary goal in the resuscitation phase is rapid hemorrhage control to allow for effective resuscitation and the eventual stabilization of the patient hemodynamically. Hemorrhage from pelvic fractures accounts for approximately 60% of deaths in the acute phase, with bleeding originating from venous plexuses in most cases (85%–90%) and arterial sources in 10%–15%.[15–17] Venous and osseous bleeding is often diffuse and non-compressible, making it particularly challenging to manage.

Initial stabilization

The pelvic binder has revolutionized the initial management of complicated pelvic fracture. These devices reduce pelvic volume and realign bony structures, promoting clot formation and tamponading bleeding. They are often applied in the emergency center or even in the prehospital setting as the first step in stabilization. Studies show that prompt application of a pelvic binder can significantly reduce mortality by controlling exsanguination during transport and initial resuscitation.[17 18]

Standard radiographs, including AP pelvic X-rays, help identify fractures and guide further interventions. CT scans are performed to delineate the extent of injury and associated organ damage. Focused Assessment with Sonography for Trauma may aid in detecting intraperitoneal hemorrhage but is less effective for retroperitoneal bleeding.[18]

Hemodynamic management

Large-bore intravenous access is established for aggressive resuscitation with blood products. The use of massive transfusion protocols, often employing a 1:1:1 ratio of packed red blood cells, plasma, and platelets, is essential to manage coagulopathy associated with severe hemorrhage.

REBOA AND PREPERITONEAL PACKING

REBOA: indications and application

REBOA remains controversial in most trauma settings. However, in complicated pelvic fracture, it is a life-saving intervention in patients with refractory hemorrhagic shock. By occluding the infrarenal aorta at zone III, REBOA reduces pelvic arterial bleeding while maintaining perfusion to critical organs such as the brain and heart.

Studies have shown that REBOA is most effective in patients with severe physiological derangements. In a retrospective analysis at a level 1 trauma center, REBOA was used in patients with pelvic fractures in combination with PPP. Patients in whom REBOA was used had significantly higher Injury Severity Scores (45 vs 38, $p<0.01$) and tachycardia (130 bpm vs 118 bpm, $p=0.04$) compared with those in whom only PPP was used. Despite these higher injury burdens, REBOA patients exhibited comparable survival rates to their non-REBOA counterparts.[19]

Preperitoneal pelvic packing

PPP is a rapid and highly effective method for controlling bleeding in unstable pelvic fractures. It is often used in combination with external pelvic fixation. By directly compressing bleeding vessels within the retroperitoneal space, PPP addresses venous and bony sources of hemorrhage, which account for the majority of blood loss in these injuries. The procedure involves a small lower midline incision to place surgical gauze packs around the pelvic cavity. Multiple studies have documented reduced mortality and transfusion requirements post-PPP.[20–22] This approach is particularly helpful because it does not rely on imaging or interventional radiology, making it accessible in resource-limited settings.

Indications and role of interventional radiology

Although arterial hemorrhage occurs less frequently than venous hemorrhage in pelvic fractures, it can be more difficult to control due to its poor response to PPP. In these cases, arterial embolization is often used. Indications for angiography for embolization include hemodynamic instability despite resuscitation, PPP, and pelvic fixation, hemodynamic instability in combination with pelvic hematoma, and/or contrast blush on CT. Numerous studies with conflicting results have been done to identify any fracture patterns that would be more likely to indicate arterial hemorrhage with no definitive answer ultimately determined. There are no universally accepted guidelines for the order of interventions between fixation, PPP, and angiography. Individual patient presentation, provider preference, and facility resources affect the decision-making for order of modality.

Multiple arteries are amenable to intervention, including internal iliac and its branches, superior gluteal, obturator, and internal pudendal. Embolization is not without its risks. Sequelae that may occur after intervention include gluteal necrosis, repeat bleeding, infection, necrosis of pelvic organs, and thigh/gluteal/perineal paresthesias. These adverse outcomes may also be the result of immobilization in relation to injuries and fixation as well as the patterns of injury themselves. Concern regarding increased risk of complications with embolization of bilateral vessels has been expressed and examined in multiple studies.[23] However, in a sizeable retrospective study examining non-selective bilateral internal iliac (BII) artery embolization using absorbable gelatin, no adverse effect was seen as a result of intervention. In this study, BII artery embolization was performed on a total of 61 patients over a 10-year period in patients with pelvic fractures, the majority after PPP, with 90% of patients displaying evidence of hemostasis.[24] Another study of seventy patients in which non-selective BII embolization was used with all hemodynamically unstable pelvic fractures, regardless of PPP, also used only gelatin and failed to reveal any gluteal necrosis postembolization.[25] An advantage to using gelatin is that it is a temporary occluding agent, allowing recanalization of the vessel in weeks to months.[26] Coiling is another mechanism for embolization, but is permanent and relies on the body's ability to coagulate for effectiveness. While selective and non-selective angiographic intervention can be life-saving, risks versus benefits must be considered.

Combination of REBOA and PPP

The synergy between REBOA and PPP offers comprehensive hemorrhage control. REBOA stabilizes the patient by halting arterial bleeding, allowing PPP to control venous and bony bleeding. This combination has been shown to decrease mortality directly attributable to pelvic hemorrhage in unstable patients.[19]

TIMING OF EMERGENT FIXATION AND DEFINITIVE REPAIR

Emergent fixation

The initial phase of management for open pelvic fractures focuses on stabilizing the pelvic ring and reducing bleeding. Emergent fixation is essential to control hemorrhage, decrease pelvic volume, and stabilize fracture fragments, preventing further vascular or tissue injury. External fixation is the cornerstone of early stabilization, as it provides rapid mechanical stability and can be applied at the bedside, in the emergency department, or operating room without the need for advanced imaging. Most often, the aforementioned pelvic binder does this.

External fixation typically involves anterior fixation devices, which are applied through pins inserted into the iliac crests or supra-acetabular region, which are then connected to an external frame. This technique compresses the pelvic ring, reapproximating disrupted bony surfaces to promote clot formation and tamponade venous bleeding. This reduces transfusion requirements and mitigates the risk of ongoing hemorrhage.[17]

Pelvic binders are an alternative or adjunct to external fixation, especially in the prehospital or emergency department settings. Binders are non-invasive, quick to apply, effectively reduce pelvic volume, and provide temporary stabilization. However, care must be taken to avoid complications such as skin breakdown or compression injuries if the binder is left in place for extended periods.

Role of damage control orthopedics

Emergent fixation is often part of a broader strategy of damage control orthopedics (DCO) in unstable patients. DCO prioritizes life-saving interventions over definitive repair, delaying complex procedures until the patient's physiological status stabilizes. In cases of significant hemodynamic instability or coagulopathy, temporary stabilization with external fixation or pelvic binders is preferred over internal fixation.

Timing of definitive repair

Definitive repair of pelvic fractures, including internal fixation with plates, screws, or percutaneous techniques, is typically delayed until the patient achieves hemodynamic stability, normalization of coagulation parameters, and resolution of acute complications such as sepsis or organ failure. This delay minimizes the risks associated with prolonged surgery in a critically ill patient, such as hypothermia, acidosis, and worsening coagulopathy.

The ideal timing for definitive repair depends on the patient's clinical trajectory. For patients who stabilize early, definitive fixation may be performed within 24–48 hours. Early definitive repair has been associated with reduced hospital length of stay, fewer complications, and improved functional outcomes.[27–29] In patients with ongoing instability or multiple injuries, definitive repair may be delayed by several days to weeks. Delayed fixation allows for resuscitation, correction of coagulopathy, and optimization of the patient's overall condition.

MANAGEMENT OF RECTAL AND PERINEAL INJURIES

Rectal and perineal injuries, which are common in open pelvic fractures, add a layer of complexity to the timing of definitive repair. Early management of these injuries, particularly fecal diversion, is critical to prevent pelvic sepsis.

Fecal diversion

The timing of fecal diversion in complicated or open pelvic fractures is a critical determinant of outcomes, particularly in cases involving rectal injuries or significant perineal contamination. Early diversion, typically within the first 48 hours, is associated with a substantial reduction in the risk of pelvic sepsis, a leading cause of delayed mortality in these patients. Delayed fecal diversion or the omission of diversion in the presence of gross fecal contamination has been linked to increased rates of infection, multi-organ failure, and prolonged hospital stays. However, recent evidence supports a more selective approach to fecal diversion, reserving it for cases with rectal injury, gross contamination, or pelvic floor disruption, to avoid the unnecessary morbidity associated with colostomy formation and subsequent reversal.[1] Overall, early and judicious use of fecal diversion remains a cornerstone in the management of open pelvic fractures, ensuring infection control and improved survival.[30–32]

REQUIRED: A MULTIDISCIPLINARY APPROACH

Definitive repair of pelvic fractures often requires collaboration between orthopedic surgeons, trauma surgeons, and interventional radiologists. Preoperative imaging, including CT scans with three-dimensional reconstructions, aids in surgical planning and ensures comprehensive repair of bony and associated soft-tissue injuries. For cases involving vascular compromise, angiography or embolization may precede surgical repair to control arterial bleeding.

In summary, emergent fixation plays a pivotal role in the early phase of open pelvic fracture management by addressing immediate life-threatening bleeding and instability. Definitive repair, while delayed, focuses on restoring function and minimizing long-term complications. A patient-specific approach, guided by clinical status and injury complexity, ensures optimal outcomes while balancing the risks of surgery in critically ill patients.

Associated urethral disruptions, bladder injuries, and vaginal lacerations require prompt surgical repair. Often, in these cases, suprapubic catheter placement is also indicated. For surgeons practicing in austere settings, suprapubic catheter placement is a critical skill to bridge the time to definitive care. In female patients with this injury pattern, the early involvement of a seasoned obstetrician/gynecological surgeon is imperative as aggressive debridement, antibiotic therapy, and repair/management of vaginal lacerations are critical in preventing pelvic sepsis. Vaginal lacerations in female patients require broad-spectrum antibiotic coverage to address vaginal flora.

CONCLUSIONS

Open pelvic fractures remain one of the most challenging injuries to manage, with high morbidity and mortality. Advances in hemorrhage control, particularly the use of REBOA and PPP, have significantly improved patient outcomes. Early stabilization, timely interventions, and a coordinated multidisciplinary approach are essential to optimizing survival and recovery. Future research should focus on refining protocols for hemorrhage control and addressing long-term functional outcomes in these patients.

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