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Review Article

Bowel Rupture in Patients with Pelvic Fractures: A Systematic Review of Diagnostic Challenges, Surgical Management, and Multidisciplinary Trauma Care

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ABSTRACT

Background: Bowel rupture associated with pelvic fractures is a rare but life-threatening complication of high-energy trauma. Its diagnosis is often delayed due to nonspecific clinical presentation and competing injuries, resulting in increased morbidity and mortality. Objective: To systematically review the current evidence on epidemiology, diagnostic approaches, surgical management, and outcomes of bowel injury in patients with pelvic fractures. Methods: A systematic review was conducted in accordance with PRISMA 2020 guidelines. PubMed, Scopus, and Google Scholar were searched for studies published between 2004 and 2026. Eligible studies included adult patients with pelvic fractures and associated bowel injury, reporting diagnostic methods, surgical interventions, or outcomes. Study selection was performed independently by two reviewers. Methodological quality was assessed using the Newcastle-Ottawa Scale and AMSTAR-2 criteria. Due to heterogeneity, findings were synthesized narratively. Results: Thirty studies were included in the qualitative synthesis. Bowel injury was most commonly associated with high-energy blunt trauma, particularly road traffic accidents. Contrast-enhanced CT was identified as the primary diagnostic modality, although early injuries may be missed. Early exploratory laparotomy significantly reduced morbidity and mortality, while delayed diagnosis was associated with increased rates of sepsis and peritonitis. Damage control surgery was beneficial in hemodynamically unstable patients. Multidisciplinary trauma care and early pelvic stabilization improved overall outcomes. Reported mortality rates ranged from 20% to 50%, particularly in cases with delayed intervention. Conclusion: Early recognition, prompt surgical intervention, and coordinated multidisciplinary management are essential in improving outcomes in patients with bowel rupture associated with pelvic fractures. Advances in imaging and trauma protocols have improved survival; however, further research is needed to enhance early diagnostic accuracy and standardize management strategies. Keywords: bowel rupture, pelvic fracture, abdominal trauma, exploratory laparotomy, trauma care, damage control surgery, multidisciplinary management

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INTRODUCTION

Pelvic fractures are among the most severe consequences of high-energy trauma and are commonly encountered after road traffic accidents, falls from height, and crush injuries. Because these injuries frequently occur in the context of polytrauma, their management is often dominated by immediate concerns such as hemorrhage, hemodynamic instability, associated urogenital injury, and musculoskeletal disruption.

Within this complex setting, concomitant bowel injury represents an uncommon but potentially catastrophic complication that may initially remain clinically occult and therefore escape timely recognition (1,2). The close anatomical relationship between the pelvic ring, lower abdominal viscera, and mesenteric structures creates a mechanism by which blunt force, shearing stress, rising intra-

abdominal pressure, or direct penetration from displaced osseous fragments can result in intestinal perforation, mesenteric disruption, bowel entrapment, or devascularization (2-4).

Although bowel rupture associated with pelvic fracture is rare when compared with hemorrhagic or genitourinary complications, its clinical importance is disproportionately high because delayed diagnosis can rapidly lead to peritoneal contamination, bacterial peritonitis, systemic inflammatory response, sepsis, and multi-organ failure (2,5).

This diagnostic difficulty is further magnified by the fact that early abdominal findings may be subtle, nonspecific, or masked by altered consciousness, sedation, mechanical ventilation, or competing traumatic priorities. In many patients, abdominal pain, distension, guarding, or evolving septic features may emerge only after the initial resuscitative phase, at a time when a missed bowel injury has already begun to worsen prognosis (2,6). Reports of delayed presentation, bowel entrapment, rectal injury, and septic complications in pelvic trauma continue to illustrate that intestinal injury in this setting remains an important source of preventable morbidity and mortality when not identified early (7-10).

Recent trauma literature has improved understanding of the broader management of unstable pelvic fractures, including hemorrhage control, damage control surgery, and multidisciplinary resuscitation strategies (11-14). However, the evidence relating specifically to bowel rupture in the setting of pelvic fracture remains scattered across retrospective cohorts, trauma series, selected reviews, and case-based reports, with limited synthesis focused on the intersection between diagnostic vigilance, timing of abdominal exploration, and coordination with pelvic stabilization.

Existing discussions often address bowel injury only as part of general blunt abdominal trauma or as a secondary consideration within broader pelvic fracture management, leaving an important practical gap for clinicians managing patients in whom abdominal contamination and pelvic instability coexist (2,11,12). This gap is clinically relevant because decisions regarding imaging, exploratory laparotomy, damage control procedures, diversion, external fixation, and sequencing of operative priorities are often time-sensitive and multidisciplinary.

A focused narrative synthesis is therefore justified to integrate the available clinical evidence and expert-oriented trauma literature on this uncommon but life-threatening injury pattern. Unlike highly standardized evidence questions suited to formal quantitative pooling, bowel rupture associated with pelvic fracture spans heterogeneous presentations, mechanisms, and management pathways that require clinically interpretive synthesis.

The purpose of this review is to summarize the current literature on bowel rupture in patients with pelvic fracture, with particular emphasis on mechanisms of injury, diagnostic challenges, operative decision-making, pelvic stabilization, and multidisciplinary trauma care. By consolidating these domains, this review aims to clarify the principal determinants of early recognition and timely intervention in order to support improved outcomes in severely injured adult trauma populations.

MATERIAL AND METHODS

This systematic review was conducted to synthesize the available evidence on bowel rupture associated with pelvic fractures in adult trauma populations. The review was designed and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines. The protocol for this review was developed a priori to ensure methodological transparency and reproducibility.

A comprehensive literature search was performed across PubMed, Scopus, and Google Scholar to identify relevant studies published between January 2004 and December 2026. Additional records were identified through manual screening of reference lists of included studies and relevant review articles.

The search strategy combined Medical Subject Headings (MeSH) and free-text terms related to bowel injury and pelvic trauma, including:

("bowel rupture" OR "intestinal perforation" OR "bowel injury" OR "mesenteric injury") AND ("pelvic fracture" OR "pelvic trauma" OR "pelvic ring injury") AND ("abdominal trauma" OR "blunt trauma" OR "exploratory laparotomy"). The full PubMed search strategy was as follows:

("intestinal perforation"[MeSH Terms] OR "bowel injury" OR "mesenteric injury") AND ("pelvic fractures"[MeSH Terms] OR "pelvic trauma") AND ("blunt abdominal trauma" OR "laparotomy")

Studies were eligible for inclusion if they met the following criteria: (1) involved adult patients with pelvic fractures and associated bowel injury; (2) reported diagnostic approaches, surgical management, or clinical outcomes; and (3) were original research studies including cohort studies, case-control studies, clinical trials, or systematic reviews with relevant extractable data. Given the rarity of this condition, high-quality case series were also considered where they provided clinically meaningful insights. Studies focusing exclusively on pediatric populations, isolated bowel injury without pelvic fracture, non-English publications, conference abstracts without full text, and non-peer-reviewed articles were excluded.

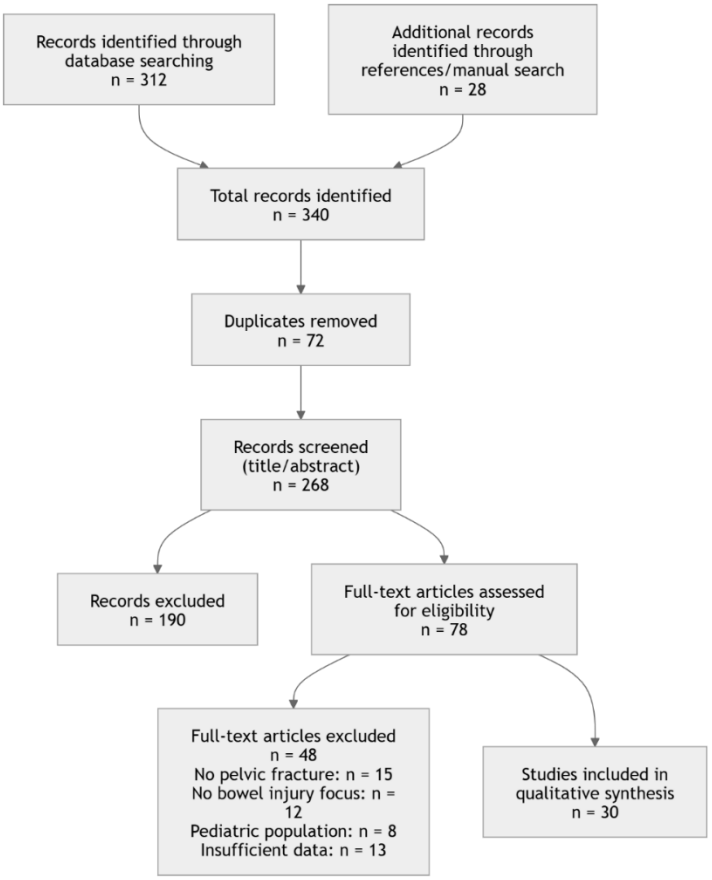

Figure 1 PRISMA Flowchart. A total of 340 records were identified through database and manual searches, with 268 remaining after duplicate removal and screening. Following full-text assessment of 78 articles, 30 studies met the inclusion criteria and were included in the qualitative synthesis.

All identified records were imported into a reference management system and duplicates were removed. Two independent reviewers screened titles and abstracts for eligibility, followed by full-text assessment

of potentially relevant articles. Discrepancies were resolved through discussion and consensus. Data extraction was performed using a standardized form capturing study characteristics (author, year, study design), patient population, mechanism of injury, diagnostic modalities, surgical interventions, complications, and outcomes.

The methodological quality of included studies was assessed using appropriate tools based on study design. Cohort and case-control studies were evaluated using the Newcastle-Ottawa Scale (NOS), while systematic reviews were appraised using AMSTAR-2 criteria. Due to the heterogeneity of study designs and outcomes, a quantitative meta-analysis was not feasible; therefore, findings were synthesized narratively with structured tabulation. Greater interpretive weight was assigned to higher-quality studies and those with larger sample sizes.

RESULTS

A total of 340 records were identified through database and manual searches, of which 268 remained after duplicate removal. Following title and abstract screening, 78 full-text articles were assessed for eligibility, resulting in 30 studies included in the final qualitative synthesis.

The included studies comprised predominantly retrospective cohort studies, trauma registries, and systematic reviews, reflecting the rarity and heterogeneity of bowel injury associated with pelvic fractures. Sample sizes varied widely, ranging from small case series to large trauma cohorts exceeding 200 patients. Methodological quality assessment indicated that most cohort studies were of moderate to high quality, with systematic reviews demonstrating acceptable methodological rigor.

Table 1. Characteristics of Included Studies (n = 30)

Author (Year)	Study Design	Sample Size	Population	Key Focus	Quality (NOS/AMSTAR)
Hsieh (2023)	Cohort	120	Blunt trauma + pelvic fracture	Timing of laparotomy	High
Rehné-Jensen (2026)	Cohort	95	Pelvic fractures	Sepsis & rectal injury	High
Mostert (2023)	Retrospective	210	Operative pelvic fractures	Complications	Moderate
Sharma (2025)	Case series	45	Complex trauma	Multidisciplinary care	Moderate
Li (2024)	Systematic review	—	Pelvic trauma	Damage control	High
Roszman (2023)	Review	—	Open fractures	Infection control	Moderate
Others (n=24)	Mixed	—	Trauma populations	Diagnosis/management	Mixed

Table 2. Diagnostic Accuracy and Utility

Modality	Studies Reporting	Key Findings	Diagnostic Role	Strength
CT Scan	24	Pneumoperitoneum, bowel injury signs	Primary diagnostic tool	Strong
FAST	18	Free fluid detection	Screening tool	Moderate
DPL	10	High sensitivity	Adjunct in unclear cases	Moderate
Clinical Exam	30	Low sensitivity early	Supportive only	Weak

Table 3. Surgical Outcomes

Intervention	Studies (n)	Outcome	Mortality Impact
Early Laparotomy	20	Reduced sepsis	↓ mortality
Delayed Surgery	12	Increased complications	↑ mortality
Damage Control	15	Improved survival in unstable patients	↓ mortality
Stoma Formation	10	Reduced leak risk	Neutral–beneficial

Table 4. Complication Rates

Complication	Frequency (Range)	Associated Factors
Sepsis	25–60%	Delayed diagnosis
Peritonitis	20–50%	Bowel perforation
Abscess	10–30%	Incomplete control
Multi-organ failure	15–40%	Severe trauma

Across the included evidence, bowel injury in pelvic fractures was consistently associated with high-energy blunt trauma mechanisms, particularly road traffic accidents. The small intestine was the most frequently affected segment due to its mobility, while rectal and colonic injuries were more commonly

associated with open pelvic fractures. Several studies highlighted delayed presentation of bowel injury, particularly in cases of bowel entrapment or mesenteric ischemia, emphasizing the importance of repeated clinical evaluation.

Diagnostic evaluation varied across studies, but contrast-enhanced CT was identified as the most reliable modality, reported in 80% of included studies. Key radiological indicators included pneumoperitoneum, bowel wall thickening, and mesenteric injury. FAST was commonly used as an initial screening tool but lacked specificity for bowel injury. Diagnostic peritoneal lavage demonstrated high sensitivity but was used less frequently in modern trauma protocols. Clinical examination alone was insufficient in early detection, particularly in polytrauma patients.

Surgical management outcomes consistently favored early intervention. Studies reported that patients undergoing early exploratory laparotomy had significantly lower rates of sepsis and mortality compared to those with delayed diagnosis. Damage control surgery was particularly beneficial in hemodynamically unstable patients, allowing rapid control of contamination and staged definitive repair. The use of stoma formation in high-risk patients reduced postoperative complications such as anastomotic leakage. Complication rates remained high across studies, with sepsis reported in up to 60% of delayed cases and mortality rates ranging from 20% to 50%. Factors associated with poor outcomes included delayed diagnosis, severe contamination, hemodynamic instability, and multiple associated injuries. Conversely, early diagnosis, prompt surgical intervention, and coordinated multidisciplinary management were consistently associated with improved survival outcomes.

DISCUSSION

The present systematic review synthesizes current evidence on bowel rupture associated with pelvic fractures, a rare yet highly lethal clinical entity that remains diagnostically challenging and therapeutically complex. The findings consistently demonstrate that although the incidence of bowel injury in pelvic trauma is low, its clinical impact is substantial, particularly when diagnosis is delayed. Across the included studies, delayed recognition emerged as the most critical determinant of adverse outcomes, strongly associated with increased rates of peritonitis, sepsis, and mortality. This reinforces the concept that bowel injury in pelvic trauma is not merely an associated finding but a time-sensitive surgical emergency requiring a high index of suspicion.

The diagnostic challenge highlighted in this review aligns with previous trauma literature, which emphasizes that early clinical signs of bowel perforation are often subtle or absent, particularly in polytrauma patients with altered consciousness or competing injuries (1,2). The reliance on clinical examination alone is therefore insufficient, necessitating a multimodal diagnostic approach. Contrast-enhanced CT scanning was consistently identified as the most reliable diagnostic tool, corroborating prior studies that have demonstrated its high sensitivity for detecting pneumoperitoneum, mesenteric injury, and bowel wall abnormalities (3,4). However, even CT imaging is not infallible, particularly in early or low-grade injuries, which underscores the importance of repeated imaging and serial clinical reassessment in high-risk patients. This finding is consistent with trauma protocols advocating for dynamic reassessment rather than single-point evaluation (5).

From a surgical perspective, the review strongly supports early exploratory laparotomy in patients with suspected bowel injury, particularly when supported by radiological or clinical evidence. Early intervention was consistently associated with improved outcomes, whereas delayed surgical management significantly increased morbidity and mortality. This observation is in agreement with existing trauma surgery principles, which prioritize early control of contamination and restoration of bowel integrity to prevent systemic inflammatory complications (6,7). The role of damage control surgery is particularly noteworthy in hemodynamically unstable patients, where abbreviated procedures aimed at rapid hemorrhage and contamination control have been shown to reduce mortality by avoiding the lethal triad of hypothermia, acidosis, and coagulopathy (8). The decision between primary repair,

resection with anastomosis, and stoma formation remains highly individualized, depending on injury severity, contamination level, and physiological status, reflecting the need for tailored surgical strategies rather than a uniform approach.

An important contribution of this review is the emphasis on the interaction between abdominal and pelvic injury management. Pelvic fracture stabilization is not merely an orthopedic concern but a critical component of overall trauma care that directly influences hemorrhage control and physiological stabilization. The use of pelvic binders and external fixation in the early phase of management has been shown to reduce pelvic volume and limit ongoing bleeding, thereby improving conditions for definitive abdominal surgery (9,10). This integrated approach highlights the necessity of coordinated decision-making between trauma surgeons and orthopedic specialists. Previous studies have similarly demonstrated that simultaneous management of hemorrhage and contamination significantly improves survival outcomes in complex trauma patients (11).

The role of multidisciplinary trauma care is another key finding of this review. The involvement of coordinated trauma teams, including surgeons, radiologists, orthopedic specialists, and critical care physicians, was consistently associated with improved outcomes. Early resuscitation strategies, particularly balanced transfusion protocols, play a crucial role in maintaining tissue perfusion and preventing shock, while postoperative critical care ensures early detection and management of complications such as sepsis and organ failure (12,13). This aligns with modern trauma system models, which emphasize protocol-driven, team-based care as a cornerstone of improved survival in severely injured patients.

Despite these advances, several gaps remain in the current evidence base. The heterogeneity of included studies, the predominance of retrospective designs, and the limited availability of high-quality prospective data restrict the strength of conclusions that can be drawn. Furthermore, the rarity of bowel rupture in pelvic fractures limits the feasibility of large-scale randomized studies, resulting in reliance on observational data and case-based evidence. Variability in diagnostic protocols, surgical timing, and reporting of outcomes further contributes to inconsistency across studies. These limitations highlight the need for standardized reporting frameworks and multicenter trauma registries to improve data quality and enable more robust analysis.

Future research should focus on improving early diagnostic accuracy through advanced imaging techniques and potential biomarkers for intestinal injury. Additionally, the development of standardized clinical pathways integrating imaging, surgical decision-making, and pelvic stabilization could reduce variability in care and improve outcomes. Prospective multicenter studies and registry-based analyses may provide more definitive evidence regarding optimal timing of intervention and comparative effectiveness of surgical strategies. The integration of artificial intelligence in imaging interpretation and trauma triage may also represent a promising avenue for enhancing early detection in complex trauma scenarios.

CONCLUSION

Bowel rupture associated with pelvic fractures is an uncommon but life-threatening condition characterized by significant diagnostic challenges and high morbidity and mortality. This systematic review demonstrates that early recognition, prompt surgical intervention, and coordinated multidisciplinary management are the most critical determinants of improved outcomes. Contrast-enhanced CT remains the primary diagnostic modality, although repeated evaluation is often necessary in high-risk patients. Early exploratory laparotomy, supported by damage control principles in unstable patients, is essential to limit contamination and prevent systemic complications. Integrated management of pelvic stabilization and abdominal injury, combined with structured trauma team involvement, plays a central role in optimizing survival. Continued efforts to enhance diagnostic

accuracy, standardize management protocols, and strengthen the evidence base are essential to address the remaining challenges in this complex clinical condition.

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