Vol.19, No.4, Page 282- 291, 2025 http://dx.doi.org/10.59628/jchm.v19i4.1810 ISSN 2958-7476 JMCH

Sana'a University Journal of Medical and Health Sciences

Penetrating Rectal Trauma: Management and Outcomes at a Tertiary Military Hospital in Sana'a, Yemen

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Abstract

Background: Penetrating rectal trauma (PRT) presents a formidable challenge in conflicting settings. This study aimed to evaluate the management and outcomes of PRT at a tertiary military hospital in Yemen.
Methods: A retrospective review of 32 patients who underwent PRT was conducted between January 2019 and March 2022. We analyzed the data on patient demographics, injury patterns, management strategies, and clinical outcomes.
Results: All patients were male (93.8%) aged < 30 years. The injuries were caused by gunshots (62.6%) or bombs (37.4%). The majority (53.2%) presented > 24 hours post-injury. Most injuries were extraperitoneal (62.5%) and American Association for the Surgery of Trauma (AAST) Grade II (96.9%), with pelvic fractures being the most commonly associated injury (53.1%). Management predominantly involves a diversion colostomy. Complication rates were high, including rectocutaneous fistula (34.1%) and necrotizing fasciitis (31.0%). The overall mortality rate was 6.2%. Among survivors, 31.3% experienced significant morbidity.
Conclusion: Delayed presentation is a key driver of the high complication rates observed in PRT within this conflict setting. Although fecal diversion helps to manage mortality, the burden of morbidity remains a significant concern, highlighting the challenges of trauma care in resource-limited environments.

Article Info

Keywords:
Penetrating Rectal Trauma, Military Trauma, Conflict Surgery, Yemen, Colostomy, Surgical Outcomes

Article History:
Received: 20-May-2025,
Revised: 30-May-2025,
Accepted: 9-August-2025,
Available online: 31 August 2025.

1. INTRODUCTION

Penetrating rectal trauma (PRT) is a formidable surgical challenge, particularly in military and conflict environments where it is often a consequence of gunshot wounds or explosive devices [1, 2]. These injuries are associated with a high risk of devastating complications such as sepsis, fistula formation, and long-term fecal incontinence, along with potential mortality [3]. Epidemiological data from military conflicts indicate that colorectal injuries account for approximately 5% of all trauma cases, with the vast majority penetrating in nature and affecting young male personnel who frequently sustain associated injuries to other organs [1, 2]. The anatomical position of the rectum, deep within the pelvis and near vital neurovascular and urogenital structures, complicates both diagnosis and surgical management, and increases the risk of widespread contamination following injury [4]. Damage to adjacent organs is frequently accompanied by such injuries, particularly those resulting from high-energy combat mechanisms, necessitating staged multidisciplinary approaches [1, 5].

Historically, PRT management has often involved a standardized approach, including routine fecal diversion, presacral drainage, and distal rectal washout. However, contemporary understanding, supported by accumulat-

ing evidence, has shifted toward a more individualized and selective treatment strategy [6, 7]. This modern approach emphasizes careful consideration of the precise anatomical location of the injury, specifically differentiating between intraperitoneal and extraperitoneal injuries, as well as the severity and degree of contamination [7, 8].

Current guidelines and significant cohort studies, including those from military settings, advocate proximal fecal diversion (typically colostomy) for most extraperitoneal rectal injuries [9, 10, 11]. Conversely, intraperitoneal injuries, if clearly visualized and not overly destructive, may be amenable to primary repair, potentially without diversion [7, 8]. The routine application of adjunctive measures such as presacral drainage and distal rectal washout has been largely abandoned, with military studies noting their infrequent use and lack of clear benefits in reducing complications [3, 6, 9, 10]. This tailored approach, which distinguishes management based on anatomical injury patterns, has been associated with improved outcomes including reduced infectious morbidity [7]. Despite these advances, septic complications remain a significant concern, with reported rates in various series ranging from 9% to 19% [4, 9, 10], and some military cohorts have reported complication rates of approximately 21% [3]. Mortality rates for PRT, including in military settings, are between 10% and 18%, and are often linked to associated injuries and overwhelming sepsis [12, 13].

While these evolving principles guide care and outcome comparisons between military and civilian settings and show similarities in many management strategies [12], there is a recognized need for continued data collection from specific and often challenging environments, such as active conflict zones, where resource availability may be variable and patient presentations can be delayed. Understanding the local epidemiology of PRT, prevailing management strategies, and the resultant outcomes in these settings is key to maximizing care and developing contextually appropriate treatment strategies. The General Military Hospital in Sana'a, Yemen, plays a critical role in managing trauma in regions affected by ongoing conflict. However, specific data on PRT in this institution are limited.

Therefore, this study aimed to retrospectively analyze the demographic characteristics, injury patterns, management strategies employed, and clinical outcomes of patients treated for penetrating rectal trauma at the General Military Hospital, Sana'a, Yemen during a defined period of active conflict.

2. METHODS

2.1. Study Design and Settings

This retrospective descriptive study evaluated the management and outcomes of patients with penetrating rectal traumas. This study was conducted in the Department of General Surgery of the General Military Hospital, Sana'a, Yemen. Data were collected from patient records between January 1, 2019, and March 31, 2022. This study complied with the Declaration of Helsinki and was approved by the Ethics Committee of the General Military Hospital of Sana'a. Permission was obtained from the hospital's medical record department. The requirement for informed consent was waived because of the retrospective design of the study; however, patient confidentiality was maintained through anonymized data.

2.2. Study Population

Of the 200 patients with penetrating abdominal trauma, 32 with confirmed PRT were included in this study. The inclusion criteria were as follows: (1) PRT confirmed by clinical, radiological, or surgical findings, and (2) admission during the study period. The exclusion criteria were as follows: (1) death during initial resuscitation or surgery and (2) blunt rectal trauma.

2.3. Data Collection

Data were retrospectively collected from the patient records. The primary dependent variable was the number of patients with rectal traumas. The main outcome measures were the number of patients who died and the number of patients who survived the procedure. Nineteen independent variables were collected, including age, sex, mechanism of injury, time from injury to presentation/intervention, site of external injury, clinical presentation (vital signs, abdominal findings, and rectal examination), diagnostic methods (per-rectum examination, contrast enema radiology, and proctosigmoidoscopy), history of previous intervention in another hospital, re-intervention after previous intervention in another hospital, cause for re-intervention, anatomical site of rectal injury (extraperitoneal/intraperitoneal), grade of rectal injury associated with other organ injuries, specific management of rectal injury (e.g., diversion colostomy, primary repair, distal rectal washout, and presacral drain), type of diversion colostomy, postoperative complications, management of rectal fistula, length of hospital stay, and overall outcome of injury (survival or without morbidity and mortality).

2.4. Outcome Measures

The primary outcome was patient survival, categorized as survival without morbidity, survival with morbidity, or mortality. In this study, "survival with morbidity" was defined as the survival of patients who experienced one or more of the following major postoperative complications: rectocutaneous fistula, rectovesical fistula, necrotizing fasciitis, wound infection, or osteomyelitis. Secondary

outcomes included complication rates, length of hospital stay, and the effectiveness of diagnostic and treatment strategies, as assessed by the proportion of injuries detected and successfully managed.

2.5. Statistical Analysis

Data were analyzed using SPSS software version 26. Descriptive statistics (frequencies and percentages) were used to summarize the patient characteristics, injury patterns, management strategies, and outcomes. Comparisons between the survivor and non-survivor groups were performed using the Student's t-test for continuous variables and chi-squared tests for categorical variables. Statistical significance was set at $P < 0.05$. Patient characteristics were described using the Injury Severity Score (ISS), calculated using the MDApp medical calculator. It should be noted that because of the retrospective nature of the study and occasional incomplete documentation from the referring facilities, complete data for ISS calculation were not available for all patients; it was calculated when records were permitted.

3. RESULTS

3.1. Patient and Injury Characteristics

All 32 patients were male, with 93.8% (n = 30) aged <30 years (Table 1). Gunshot wounds caused 62.6% (n = 20) of injuries, followed by bomb explosions (37.4%, n = 12). More than half (53.2%, n = 17) of the patients presented >24 h after the injury. The gluteus muscle was the most common site of injury (38.0%, n = 12). Extraperitoneal injuries predominated (62.5%, n = 20), with 96.9% (n = 31) classified as Grade II (laceration 50% of the rectal wall circumference). Associated injuries included pelvic bone fractures (53.1%, n = 17), anal sphincter injuries (31.0%, n = 10), urinary bladder injuries (27.9%, n = 9), small bowel injuries (24.8%, n = 8), and sigmoid colon injuries (6.2%, n = 2).

3.2. Clinical Presentation and Diagnosis

Stable vital signs were observed in 68.8% (n = 22) of patients, tender abdomen in 65.9% (n = 21), and rectal bleeding in 46.9% (n = 15) (Table 2). The diagnostic methods included proctosigmoidoscopy (68.8%, n = 22), radiology with water-soluble enema contrast (68.8%, n = 22) **(Figure 1)**, and digital rectal examination (31.2%, n = 10). Previous interventions at other hospitals occurred in 46.9% (n = 15) of the patients, with 28.0% (n = 9) requiring re-intervention due to complicated (18.7%, n = 6) or missed (9.3%, n = 3) rectal injuries.

3.3. Management and Complications

Management strategies included diversion colostomy alone (62.5%, n = 20), primary repair with diversion colostomy (37.5%, n = 12), distal rectal washout (56.2%, n = 18), and presacral drainage (6.2%, n = 2) (Table 3). The colostomy types were end (Hartmann's), sigmoid (62.5%, n = 20), or loop sigmoid with distal closure (31.3%, n = 10). The complications included rectocutaneous fistula (34.1%, n = 11), necrotizing fasciitis (31.0%, n = 10), wound infection (21.7%, n = 7), and osteomyelitis (15.5%, n = 5). The fistulae were managed conservatively (n = 10, 83.3%) or surgically (n = 2, 16.7%) (Figure 2).

3.4. Outcomes

The length of hospital stay exceeded 2 weeks in 75.0% (n = 24) of patients. The outcomes included survival without morbidity (62.5%, n = 20), survival with morbidity (31.3%, n = 10), and mortality (6.2%, n = 2) (Table 4). Mortality was associated with delayed presentation and associated injuries ($P = 0.04$).

4. DISCUSSION

This retrospective study at the General Military Hospital in Sana'a, Yemen, offers vital information regarding the management and outcomes of penetrating rectal trauma in conflict settings. The predominance of young military personnel in our cohort aligns with the patterns observed in other conflict zones, as penetrating rectal trauma primarily affects young males during military operations [3, 14]. The prevalence of gunshot wounds (62.6%) and bomb explosions (37.4%) as injury mechanisms reflects the nature of combat-related trauma in Yemen, similar to patterns documented in Iraq and Afghanistan, where high-velocity penetrating mechanisms predominate [3].

A striking finding was the delayed presentation in our cohort, with over 53.2% of patients presenting more than 24 h after injury. This delay likely reflects the challenges of medical evacuation in conflict zones and represents a significant contrast to reports from established trauma systems, where patients typically arrive within hours of injury [6]. This delayed presentation undoubtedly influenced our management strategies and potentially contributed to the increased complication rates.

In our cohort, extraperitoneal injuries predominated (62.5%), with gluteal entry points accounting for 38%, reflecting anatomical vulnerability during combat operations. This distribution parallels reports from other conflict settings, where Weinberg et al. (2006) noted that 93% of penetrating rectal trauma occurred in extraperitoneal locations, with 88% occurring in the lower one-third of the rectum [7]. Our patient population showed a remarkably high proportion of Grade II injuries (96.9%). This homogeneity may indicate that standardized injury pat-

Table 1. Demographic and baseline injury characteristics

Characteristic	Frequency (n)	Percentage (%)
Age		
<30 years	30	93.8
30 years	2	6.2
Sex		
Male	32	100.0
Mechanism of Injury		
Gunshot	20	62.6
Bomb explosion	12	37.4
Time to Presentation		
24 hours	15	46.8
>24 hours	17	53.2
Site of the Injury		
Gluteus	12	38.0
Sacrum	6	18.6
Perineum	5	15.5
Others	9	27.9
Location of the Rectal Injury		
Extraperitoneal	20	62.5
Intraperitoneal	12	37.5
Grade of Injury (AAST)		
Grade II (50% circumference)	31	96.9
Grade V (full thickness, perineum)	1	3.1

AAST: American Association for the Surgery of Trauma.

Table 2. Clinical Presentation and Diagnostic Modalities

Variable	Frequency (n)	Percentage (%)
Clinical Presentation		
Stable vital signs	22	68.8
Tender abdomen	21	65.9
Rectal bleeding (per rectum exam)	15	46.9
Diagnostic Methods		
Proctosigmoidoscopy	22	68.8
Radiology (enema contrast)	22	68.8
Digital rectal examination	10	31.2

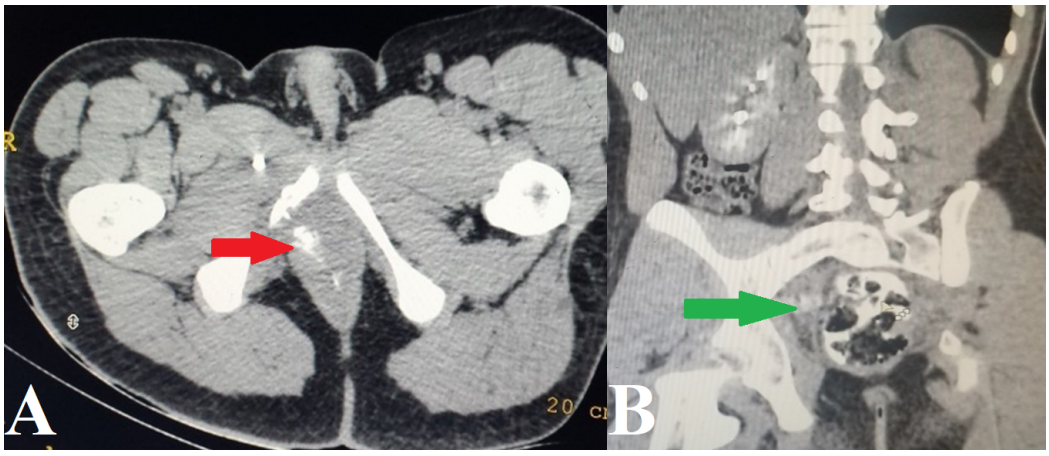

Figure 1. Computed tomography (CT) with water-soluble rectal contrast in a patient with penetrating rectal trauma. (A) Axial CT image demonstrating contrast extravasation (red arrow) into the right pelvic soft tissue, indicative of rectal wall breach. (B) Coronal CT view showing the contrast-filled rectum (green arrow), providing an anatomical context to the injury site, and demonstrating intraluminal contrast.

Table 3. Surgical management strategies and postoperative complications

Variable	Frequency (n)	Percentage (%)
Management		
Diversion colostomy alone	20	62.5
Primary repair and diversion colostomy	12	37.5
Distal rectal washout	18	56.2
Presacral drainage	2	6.2
Complications		
Rectocutaneous fistula	11	34.1
Necrotizing fasciitis	10	31.0
Wound infection	7	21.7
Osteomyelitis	5	15.5
Recto-vesical fistula	1	3.1%

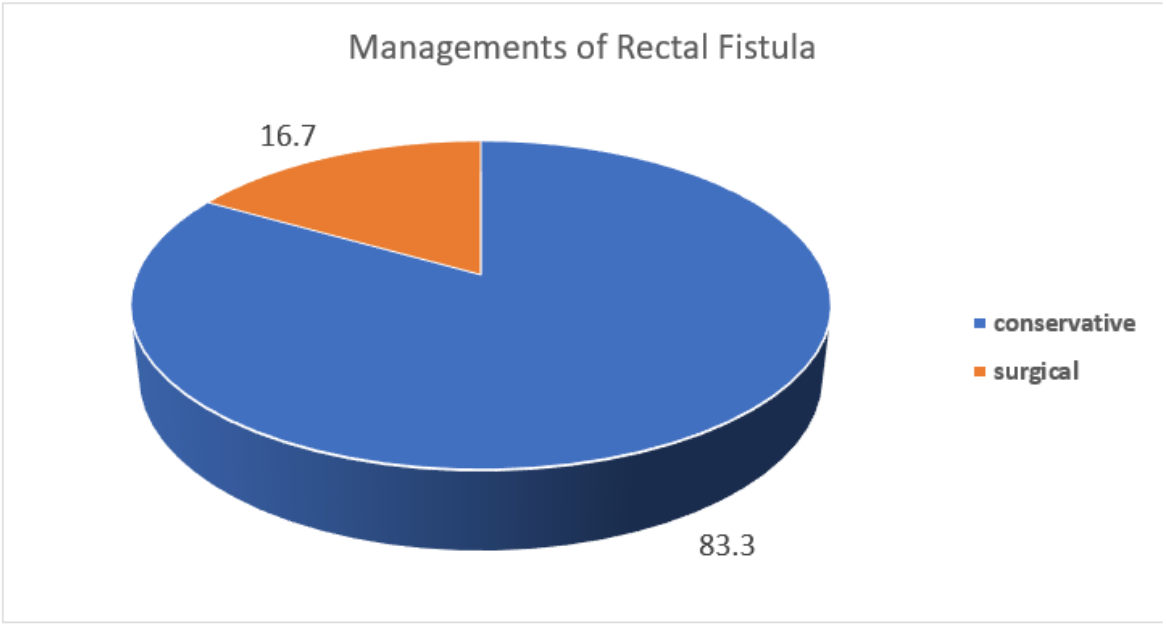

Figure 2. Management Approach of the Rectal Fistula (n = 12)

Table 4. Clinical outcomes of patients treated for penetrating rectal trauma

Outcome	Frequency (n)	Percentage (%)
Survival without morbidity	20	62.5
Survival with morbidity	10	31.3
Mortality	2	6.2

terns result from similar weapons used in this conflict. However, this may also highlight a potential limitation of the AAST grading system, which primarily focuses on the extent of circumferential laceration, but may not fully capture the severity of blast-related tissue destruction, cavitational effects, or the impact of delayed presentation on tissue viability.

The association between rectal trauma and pelvic bone fractures (53.1% in our cohort) aligns with the findings of civilian studies that demonstrated a relationship between anteroposterior pelvic compression fractures and rectal injuries[15]. This high rate of associated injuries illustrates the difficulties involved in managing these patients because pelvic fractures can compromise the blood supply to the rectum and complicate rectal repair [5].

Our management approach primarily involved diversion colostomy (62.5%) or primary repair with diversion (37.5%), departing from the recent military experience. In contrast to our practice, Brown et al. (2013) reported that in Iraq and Afghanistan, 60% of patients underwent diversion with an ostomy alone without primary repair [3]. Our higher rate of combined approaches may reflect the delayed presentation of patients in whom primary repair was attempted when feasible despite the need for fecal diversion.

The predominance of end-sigmoid colostomy (Hartmann's procedure) in our setting (62.5%) differs from some modern military reports where loop colostomy is more common [16]. This difference may reflect both the surgeon's preference and injury severity. Our approach aligns with the Eastern Association for the Surgery of Trauma Practice Management Guidelines, which conditionally recommends proximal diversion for penetrating extraperitoneal rectal injuries [6].

The selective use of distal rectal washout (56.2%) in our cohort represented an intermediate position in the management of rectal trauma. Historically established during the Vietnam War by Lavenson and Cohen (1971), distal washout was once considered mandatory, but has been questioned in recent decades [17]. Our higher utilization rate compared with reports from Iraq and Afghanistan (26% by Brown et al., 2013) may reflect both the delayed presentation of our patients and the persistence of traditional approaches in our setting [3].

We employed presacral drains sparingly (6.2%), which is significantly lower than the rates reported in Iraq and Afghanistan (21%, according to Brown et al., 2013) [3]. This practice aligns with evolving evidence, particularly a randomized prospective study by Gonzalez et al. (1998), which demonstrated no benefit or potential harm from presacral drainage [18]. Our low utilization rate suggests the early adoption of evidence-based practices in this aspect of care despite resource constraints.

The high rates of complications observed in our cohort (rectocutaneous fistula, 34.1%; necrotizing fasciitis, 31%; wound infection, 21.7%; and osteomyelitis, 15.5%) exceeded those reported in a contemporary military series. Brown et al. (2013) reported a complication rate of 21% among soldiers with penetrating rectal injuries in Iraq and Afghanistan. Several factors likely contribute to elevated complication rates [3].

First, delayed presentation (>24 h in 53.2% of cases) allowed bacterial proliferation and tissue compromise before surgical intervention. Second, the high rate of pelvic fractures (53.1%) in our population introduces an additional risk of infection. This relationship between pelvic fractures and infectious complications was noted by Aihara et al. (2002), who identified a three-fold increase in the risk of rectal injury with a widened pubic symphysis [15]. Third, resource constraints inherent in conflict settings are likely to limit optimal perioperative care. Challenges such as the inconsistent availability of broad-spectrum antibiotics, limited access to advanced debridement technologies (e.g., vacuum-assisted closure), and difficulties in providing sustained nutritional support can further increase the risk of infection.

The relatively high rate of rectocutaneous fistulas (34.1%) observed in our study warrants particular attention. This complication occurred despite fecal diversion in all cases, suggesting that diversion alone may be insufficient to prevent local septic complications in patients with severe injuries or a delayed presentation. This observation contrasts with the findings of the EAST guidelines, which showed lower infectious complications in diverted versus nondiverted patients (8.8% vs. 18.2%, respectively) [6].

Despite these challenging circumstances, our overall mortality rate of 6.2% compares favorably with the historical military data. During World War II, mortality rates for rectal trauma were reported to be 30-35%, decreasing to 14% during the Vietnam conflict [19] and further to 1.7% in modern military reports from Iraq and Afghanistan [6]. Our slightly higher mortality rate compared to contemporary military experiences likely reflects multiple factors, including delayed presentation, limited resources, and a high rate of complex-associated injuries.

The predominance of patients with prolonged hospital stays (> 2 weeks; 75 %) reflects both the complexity of the injuries and high complication rates. This extended hospitalization pattern differs somewhat from modern combat casualty systems, in which rapid evacuation to higher echelons of care often results in a shorter initial hospital stay at the combat support facilities. Our 31.3% survival rate with significant morbidity highlights the long-term burden of these injuries, consistent with reports by Clemens et al. (2018) [20] on the considerable impact of combat-related rectal trauma on the quality of life.

The high re-intervention rate (28%) for missed or complicated injuries in our cohort underscores the challenges in managing these patients in resource-limited settings. This rate exceeds that reported in better-resourced com-

bat environments, where secondary operations are often planned rather than reactive to complications [21].

Our findings have several important clinical implications for surgeons managing penetrating rectal traumas in conflicting settings. Despite the universal fecal diversion, the high complication rates observed suggest the need for additional measures in delayed-presenting patients with complex injuries. While recent literature has questioned aspects of the traditional "4Ds" approach (debridement, diversion, drainage, distal washout), our experience suggests that the selective application of all techniques remains valuable in certain clinical scenarios.

Second, the prevalence of rectocutaneous fistulas despite diversion emphasizes the importance of thorough debridement and careful management of soft tissue injuries around the rectum. This suggests that the technical aspects of the initial operation remain crucial, even when fecal diversion is employed.

Third, the 46.9% prior intervention rate at the referring facilities highlights the importance of establishing standardized protocols for the initial management of rectal trauma at all levels of care within conflict zones. Future efforts should focus on developing context-appropriate training for frontline medical personnel to optimize initial management before transfer to tertiary centers.

Fourth, the association between pelvic fractures and rectal injuries reinforces the need for heightened suspicion and a thorough evaluation of patients with pelvic trauma. As noted by Aihara et al. (2002) [15], anteroposterior compression pelvic fractures should be carefully investigated for occult rectal injuries.

4.1. Study Limitations

Our study has some limitations. First, the relatively small sample size (n = 32) limits the statistical power and ability to perform meaningful subgroup analyses. Nevertheless, given the rarity of rectal trauma, even in conflict settings (approximately 1–3% of civilian trauma and 5.1% of military trauma, according to Clemens et al., 2018 [20]), our study represents a significant contribution to the literature. Second, the retrospective design introduced the potential for selection bias and incomplete data capture. **Specifically, the exclusion of patients who died during initial resuscitation or surgery, while a standard approach, creates a survival bias that may lead to an underestimation of the true overall mortality associated with these severe injuries.** However, by systematically reviewing all the cases, we attempted to minimize these limitations while acknowledging their presence. Third, our reliance on handwritten, non-computerized medical records potentially introduces documentation errors and missing data points. This limitation reflects the reality of providing trauma care in a resource-limited setting. Fourth, the loss to follow-up for some patients with morbidity limits our ability to comprehensively assess long-term outcomes. Given the ongoing conflict in Yemen, a long-term follow-up is challenging. Fifth, our study represents the experience of a single tertiary military hospital, which potentially limits its generalizability to other healthcare settings. Nevertheless, the observed patterns likely reflect common challenges faced by similar conflict zones worldwide.

Future research on penetrating rectal trauma in conflict settings should focus on several factors. Prospective studies comparing management strategies, particularly regarding the necessity of various components of the traditional "4Ds" approach, would provide more definitive evidence. Additionally, investigating the optimal antibiotic regimens and durations for patients with delayed presentation would address an important knowledge gap.

The development and validation of a risk-stratification system specific to penetrating rectal trauma in conflict settings can guide management. Such a system would ideally incorporate factors, such as time from injury, mechanism, anatomical location, associated injuries, and hemodynamic status, to predict complications and guide intervention choices.

Further exploration of minimally invasive approaches, where feasible, may reduce the morbidity. Recent civilian experiences with transanal minimally invasive surgery for selected extraperitoneal rectal injuries suggest its potential applications even in resource-limited settings.

5. CONCLUSION

This study offers useful information regarding the management and outcomes of penetrating rectal trauma in contemporary conflict settings. Despite advances in trauma care, these injuries remain challenging, particularly in resource-limited environments with delayed patient presentation. Although our management approach was largely aligned with the traditional military principles of fecal diversion, we observed reduced use of presacral drainage compared with historical norms. The high complication rates despite universal diversion suggest that additional risk factors, particularly delayed presentation and associated pelvic fractures, significantly influence outcomes. Future efforts should focus on standardized protocols for early management, optimized antibiotic strategies for delayed-presenting patients, and the prospective evaluation of selective management approaches based on injury characteristics.

LIST OF ABBREVIATIONS

AAST: American Association for the Surgery of Trauma
ATLS: Advanced Trauma Life Support
DRE: Digital Rectal Examination
EAST: Eastern Association for the Surgery of Trauma
GMH: General Military Hospital
GSW: Gunshot wounds

ISS: Injury severity score
PRT: Penetrating Rectal Trauma
SPSS: Statistical Package for the Social Sciences

DECLARATIONS

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the General Military Hospital in Sana'a, Yemen. The requirement for informed consent was waived by the Ethics Committee because this was a retrospective study. The study complied with the Declaration of Helsinki and patient confidentiality was maintained through anonymized data handling.

Consent for publication

Not applicable as no identifiable patient data were included in this study.

Availability of Data and Materials

The datasets analyzed in this study are available from the corresponding author upon reasonable request and subject to ethical and institutional approval.

Competing Interests

The authors declare no competing financial or nonfinancial interests.

Funding

No specific funding for this study was received from the public, commercial, or not-for-profit sector.

Authors' Contributions

YAS, AAB, and NA contributed to the data collection and drafted the initial manuscript. YAO and HMJ designed the study, performed data analysis, and critically revised the manuscript. All authors have reviewed and approved the final manuscript.

Acknowledgements

None.

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