ORIGINAL ARTICLE

Indications, risk factors, and clinical outcomes of relaparotomy after abdominal trauma surgery

Mehmet Bahadir Demir, Suleyman Utku Celik, Sahin Kaymak

Department of General Surgery, University of Health Sciences, Gülhane Training and Research Hospital, Ankara-*Türkiye*

ABSTRACT

BACKGROUND: Relaparotomy following abdominal trauma surgery is a critical intervention associated with significant morbidity and mortality. However, data on relaparotomy in trauma patients remain limited. This study aimed to evaluate the impact of relaparotomy-related factors on prognosis in patients undergoing relaparotomy after abdominal trauma surgery.

METHODS: This retrospective study analyzed adult patients who underwent relaparotomy following abdominal trauma surgery at a single center between December 2016 and December 2022. Demographic characteristics, trauma-related features, and perioperative clinical findings were recorded. Statistical analyses were conducted to identify factors associated with in-hospital mortality.

RESULTS: Among 300 patients who underwent abdominal trauma surgery, 106 (35.3%) required relaparotomy. The in-hospital mortality rate was 9.4%. Major indications for relaparotomy included hemorrhage control, hemodynamic instability, and intestinal leaks. Factors significantly associated with increased mortality included age ≥50 years (p=0.020), female sex (p=0.031), blunt trauma (p=0.020), multiple relaparotomies (p=0.023), active hemorrhage during relaparotomy (p<0.001), and fresh frozen plasma transfusion (p=0.046). Additionally, non-survivors demonstrated significantly lower blood pressure (p<0.001) and higher heart rates (p<0.001). They also presented with decreased levels of hemoglobin (p=0.015), platelet counts (p=0.001), and albumin (p<0.001), along with elevated international normalized ratio (INR) (p<0.001) and lactate levels (p<0.001).

CONCLUSION: This study highlights key factors associated with mortality in patients undergoing relaparotomy after abdominal trauma surgery. Early recognition and optimization of risk factors, along with the management of active hemorrhage, careful monitoring of vital signs and laboratory parameters, and special attention to high-risk groups such as older patients and those with blunt trauma, may improve outcomes in this vulnerable population.

Keywords: Abdominal injury; laparotomy; mortality; reoperation; trauma.

INTRODUCTION

Trauma accounts for nearly 9% of global death and represents the most significant cause of disability-adjusted life-years lost among adolescents and young adults worldwide.[1] Advancements in trauma interventions, spanning from pre-hospital care to rehabilitation, have profoundly impacted the management of traumatic injuries. The integration of evidence-based practices, advanced technologies, and multidisciplinary collaboration has resulted in improved patient outcomes, reduced complications, and enhanced quality of life for trauma survivors. However, despite these significant achievements, challenges in the management of trauma patients persist, and trauma remains a leading cause of morbidity and mortality globally.[2]

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Address for correspondence: Mehmet Bahadir Demir

Department of General Surgery, University of Health Sciences, Gülhane Training and Research Hospital, Ankara, Türkiye

E-mail: mbrdemir@gmail.com

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The abdomen is one of the most commonly injured regions in trauma patients.[3] Most abdominal injuries result from blunt trauma.[4] Patients with blunt trauma often sustain more severe injuries compared to those with penetrating trauma due to the high-energy impact that causes widespread damage to multiple organs and systems, as well as complex injury patterns that complicate diagnosis and treatment. Additionally, the initial signs of blunt trauma may be less apparent, potentially leading to delayed diagnosis and unfavorable outcomes.[5,6] In the field of abdominal trauma, encompassing both blunt and penetrating injuries, trauma laparotomy stands as the most frequently performed surgical procedure. It serves not only to access and address identified injuries to intra-abdominal and pelvic organs—such as life-threatening hemorrhage from vascular structures or solid organs and contamination resulting from injuries to hollow viscera—but also as a means of diagnostic exploration when cross-sectional imaging is not readily accessible or feasible.[1]

Unforeseen complications or deterioration in clinical status following laparotomy may necessitate relaparotomy. Additionally, damage control resuscitation, which consists of staged surgery applied to the management of trauma patients, often requires a planned relaparotomy. Relaparotomy is associated with significantly high morbidity and mortality rates, underscoring the critical importance of accurately identifying patients who require this intervention and understanding the factors associated with adverse clinical outcomes in the context of trauma surgery.[7,8] However, data on relaparotomy in patients with abdominal trauma remain quite limited. Therefore, this study aims to analyze patients who underwent relaparotomy following abdominal trauma surgery and evaluate the impact of relaparotomy-associated factors on prognosis.

MATERIALS AND METHODS

All procedures performed in this study involving human participants were conducted in accordance with the ethical standards of the institutional and/or national research committees and the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Ethical approval was obtained from the Health Sciences University Gülhane Training and Research Hospital Clinical Research Ethics Committee (Approval Number: 2022/118, Date: 14.09.2022).

The study included adult patients (aged >18 years) who underwent relaparotomy following abdominal trauma surgery at the Gülhane Training and Research Hospital, Department of General Surgery, between December 2016 and December 2022. Patients with incomplete data or those for whom trauma-related data were inaccessible were excluded from the study.

Patient data were retrospectively reviewed using the hospital electronic database and patient files. In addition to recording the demographic characteristics of the patients, trauma-related features and perioperative clinical findings were documented. The index operation was defined as the first laparotomy performed following abdominal trauma, while relaparotomy was defined as a laparotomy performed within 60 days after the index abdominal surgical operation.[7]

Statistical Analysis

Statistical analyses were performed using Jamovi software, version 2.3.2.0 (The Jamovi Project, Sydney, Australia). Descriptive statistics were presented as counts, percentages, means, standard deviations, and medians. The normality of variable distributions was assessed through visual methods (histograms and quantile-quantile plots) and analytical methods (Shapiro-Wilk test). Numerical variables meeting normal distribution criteria were compared between two groups using the independent samples t-test. For numerical variables that did not demonstrate normal distribution, the Mann-Whitney U test was employed. Nominal data were compared using the chi-square or Fisher's exact test. A two-tailed p-value of less than 0.05 was considered statistically significant in all analyses.

RESULTS

A total of 300 patients were included in the study, comprising 202 patients who were transferred to the hospital after undergoing their initial laparotomy at an external center due to abdominal trauma, and 98 patients who had their first abdominal surgical intervention performed at our clinic. Of these patients, 106 (35.3%) required relaparotomy. The mean age of the patients was 37.5±16.9 years (range: 18-80 years), with 79.2% being male and 20.8% female.

The mechanism of trauma was penetrating in 81.1% of cases (n=86) and blunt in 18.9% (n=20). Among the penetrating injuries, 67.4% (n=58) were classified as low kinetic energy, while 32.6% (n=28) were categorized as high kinetic energy injuries. For blunt injuries, 60% (n=12) resulted from in-vehicle incidents, 20% (n=4) were due to out-of-vehicle traffic accidents, and 20% (n=4) were associated with falls from height. The types of index operations, ranked by frequency, included bowel resection (49.1%), packing (32.1%), hemorrhage control (25.5%), primary intestinal repair (22.6%), and splenectomy (17.9%) (Table 1).

Approximately three-quarters of the relaparotomies were performed under emergency conditions (n=77; 72.6%). The major indications for relaparotomy were hemorrhage control (29.2%), bleeding or hemodynamic instability (23.6%), leak after operative repair (14.24%), and wound or ostomy problems (12.3%) (Table 2). The intraoperative findings and surgical procedures performed during relaparotomy are listed in Table 3. The primary reasons for re-explorations following relaparotomy included the control of abdominal contamination, hemorrhage management, revision surgical procedures, and definitive laparotomy. Additional relaparotomies were performed for partial liver resection in one patient, chole-

Table 1. Demographic and clinical characteristics of patients

	(n=106)
Age, years*	37.5±16.9
Gender, n (%)	
Female	22 (20.8)
Male	84 (79.2)
Mechanism of injury, n (%)	
Penetrating	86 (81.1)
Blunt	20 (18.9)
Type of index operation, (%)	
Bowel resection with or without stoma	52 (49.1)
Packing	34 (32.1)
Hemorrhage control (solid organ or vascular)	27 (25.5)
Primary intestinal repair	24 (22.6)
Splenectomy	19 (17.9)
Length of hospital stay, days†	11 (1–127)
In-hospital mortality, n (%)	10 (9.4)

*Values are presented as mean±standard deviation. †Values are presented as median, with the range in parentheses.

Table 2. Factors associated with relaparotomy

	(n=106)
Indications for relaparotomy, n (%)	
Unpacking	31 (29.2)
Bleeding or hemodynamic instability	25 (23.6)
Leak after operative repair	15 (14.2)
Wound or ostomy problem	13 (12.3)
Ileus	8 (7.5)
Anastomotic leak	6 (5.7)
Missed intestinal injury	4 (3.8)
Others	18 (17.0)
Types of relaparotomy, n (%)	
Planned	29 (27.4)
Emergency	77 (72.6)
Third laparotomy, n (%)	23 (21.7)
Forth or more laparotomies, n (%)	11 (10.3)

cystectomy in one patient, primary small bowel repair in one patient, and ileostomy revision in one patient.

A total of 89 patients (83.9%) received one or more blood transfusions before relaparotomy. All 89 patients received a red blood cell transfusion, with a median of 3 units (range: 1-9), and 63 patients received a fresh frozen plasma (FFP) transfusion, with a median of 2 units (range: 1-7). Intraoperative blood transfusions were administered to more than one-third of the patients (34.9%). The median hospital stay was 11 days (range: 1-127), and the in-hospital mortality rate was 9.4%.

Table 3. Intraoperative findings and surgical procedures performed during relaparotomy

	(n=106)
Intraoperative findings, n (%)	
Active hemorrhage	30 (28.3)
Negative re-exploration	25 (23.6)
Intestinal perforation or anastomotic leak	23 (21.7)
Stoma retraction or ischemia	13 (12.3)
Wound dehiscence	12 (11.3)
Fascial dehiscence	8 (7.5)
Omental infarct	6 (5.7)
Abdominal foreign body	3 (2.8)
Pancreatic or bile leak	2 (1.9)
Surgical procedures performed, n (%)	
Unpacking	27 (25.5)
Hemorrhage control (solid organ or vascular)	16 (15.1)
Bowel resection	13 (12.3)
Stoma revision	13 (12.3)
Primary intestinal repair	12 (11.3)
Creation of colostomy or ileostomy	7 (6.6)
Omental resection	6 (5.7)
Packing or repacking	6 (5.7)
Intestinal re-anastomosis (stoma closure)	3 (2.8)
Splenectomy	2 (1.9)

Table 4 presents a comparative analysis of patient characteristics in relation to in-hospital mortality following relaparotomy. Patients aged ≥50 years (p=0.020) and female patients (p=0.031) demonstrated higher mortality rates. Blunt trauma (p=0.020) and multiple relaparotomies (p=0.023) were also associated with increased mortality. Additionally, all non-survivors (100.0%) received red blood cell transfusions compared to 82.3% of survivors (p=0.359). Fresh frozen plasma transfusion was significantly associated with mortality, with 90.0% of non-survivors receiving it compared to 68.4% of survivors (p=0.046). While emergency relaparotomy was not found to be statistically significantly associated with increased mortality, active hemorrhage as an intraoperative finding was significantly more prevalent in non-survivors (90.0% vs. 21.9%, p<0.001). Pre-relaparotomy vital signs differed significantly between groups, with non-survivors exhibiting lower blood pressures (p<0.001) and higher heart rates (p<0.001). Laboratory values prior to relaparotomy showed significant differences, with non-survivors demonstrating lower hemoglobin levels (p=0.015), platelet counts (p=0.001), and albumin levels (p<0.001), as well as higher international normalized ratio (INR) (p<0.001) and lactate levels (p<0.001).

Table 4. Comparative analysis of patient characteristics with respect to in-hospital mortality following relaparotomy

	Hospital Mortality		p-value
	Deceased Patients (n=10)	Surviving Patients (n=96)	
Demographics and Trauma-Related Data			
Age, years*	47.5±24.4	36.5±15.7	0.195
Aged ≥50 years, n (%)	6 (60.0)	22 (22.9)	0.020
Female gender, n (%)	5 (50.0)	17 (17.7)	0.031
Systemic disease, n (%)	6 (60.0)	46 (47.9)	0.522
Blunt trauma, n (%)	5 (50.0)	15 (15.6)	0.020
Emergency relaparotomy, n (%)	9 (90.0)	68 (70.8)	0.279
Multiple relaparotomies, n (%)	5 (50.0)	18 (18.8)	0.023
Blood Transfusion Prior to Relaparotomy			
Red blood cell, n (%)	10 (100.0)	79 (82.3)	0.359
Fresh frozen plasma, n (%)	9 (90.0)	54 (68.4)	0.046
Intraoperative Findings			
Intestinal perforation/leak, n (%)	5 (50.0)	18 (18.8)	0.060
Active hemorrhage, n (%)	9 (90.0)	21 (21.9)	<0.001
Vital Signs Prior to Relaparotomy			
Systolic blood pressure, mmHg*	105±8	120±7	<0.001
Diastolic blood pressure, mmHg*	77±9	86±6	<0.001
Heart rate, bpm*	112±12	99±11	<0.001
Laboratory Values Prior to Relaparotomy			
Hemoglobin, g/dL*	8.9±1.6	10.5±0.5	0.015
Platelet, $10^3/\mu L^{\dagger}$	147 (76–213)	210 (83–513)	0.001
International normalized ratio (INR)*	1.8±0.2	1.3±0.3	<0.001
Lactate, mmol/L†	5.3 (2.8–14.4)	3.1 (0.8–9.5)	<0.001
Albumin, g/dL*	1.9±0.7	3.1±0.6	<0.001

*Values are presented as mean±standard deviation. †Values are presented as median with range in parentheses.

DISCUSSION

This study investigated the impact of relaparotomy-related factors on the prognosis of patients undergoing relaparotomy following abdominal trauma surgery. Our findings highlight key variables associated with poor outcomes, providing critical insights into the management of trauma patients requiring secondary surgical interventions.

The incidence of relaparotomy due to complications from abdominal surgery is estimated to range from 1.6% to 9%.[7,9] Unlike standard abdominal surgeries, trauma surgery involves the complex and severe nature of traumatic injuries, which present unpredictable and rapidly evolving conditions that require immediate and decisive intervention. This not only complicates the operative course but also increases the risk of adverse outcomes and sometimes necessitates additional surgical interventions. However, limited research has been conducted on reoperations in trauma surgery. The high rate of relaparotomy (35.3%) in our cohort underscores the frequency of this intervention in abdominal trauma patients. Based on prior studies in this field, the overall rate of unplanned reoperations for abdominal trauma surgery is estimated to be approximately 10–20%.[10-12] However, these studies did not include planned relaparotomies. Similarly, in our study, when planned relaparotomies were excluded, the rate of unplanned relaparotomy after trauma was 25.7%. This relatively high rate may be attributed to the inclusion of data from a referral hospital that receives military casualties (wounded military personnel) transferred from operational zones within the referral chain.

The major indications for relaparotomy included hemorrhage control, hemodynamic instability, and intestinal leaks, which are consistent with previous studies on trauma-related relaparotomy.[4,7,10,11] Our data emphasized the critical role of active hemorrhage as a key factor in predicting mortality. Patients with intraoperative active hemorrhage during relaparotomy were significantly more likely to succumb to their

injuries (p<0.001), underscoring the need for meticulous hemostatic control in trauma surgery. This finding aligns with previous reports indicating that uncontrolled hemorrhage is a primary driver of adverse outcomes in trauma patients.[4]

The mechanism of injury appears to play a crucial role in patient outcomes. Penetrating trauma cases were more prevalent in our relaparotomy cohort, with a predominance of low kinetic energy injuries, though high kinetic energy injuries still accounted for a significant portion (32.6%). Notably, blunt trauma was associated with a higher mortality rate compared to penetrating injuries (p=0.020), likely due to the complex and often delayed presentation of internal injuries in these patients. This observation aligns with the World Society of Emergency Surgery (WSES) guideline, which highlights that bowel injuries in blunt abdominal trauma are frequently missed and require a high index of suspicion. As the guideline notes, delays in diagnosing such injuries are associated with increased morbidity and mortality, further explaining the higher risk associated with blunt trauma in our cohort.[6]

Preoperative clinical parameters, including vital signs and laboratory findings, provided additional prognostic information. Lower pre-relaparotomy blood pressure and higher heart rates were significantly associated with mortality, indicating ongoing shock and inadequate resuscitation prior to surgery. Additionally, laboratory markers such as lower hemoglobin levels, platelet counts, and albumin, along with elevated INR and lactate levels, were significantly associated with poor outcomes. These findings have been reported in previous studies. They suggest that a combination of coagulopathy, anemia, and malnutrition—often hallmarks of severe trauma and prolonged critical illness—contribute to the increased risk of death in this patient population.

In terms of patient demographics, age and sex were identified as significant prognostic factors. Patients aged 50 years or older had a higher risk of mortality (p=0.020), likely due to age-related declines in physiological reserve and reduced capacity to withstand surgical and hemodynamic stress. Additionally, female patients exhibited a higher mortality rate (p=0.031), a finding that warrants further investigation to determine whether sex-related physiological differences or variations in injury patterns contribute to this disparity. Another notable finding from our study was the association between the number of relaparotomies and increased mortality. Patients who underwent multiple relaparotomies had a significantly higher risk of in-hospital mortality (p=0.023). This likely reflects the severity and complexity of the underlying injury, with repeated surgeries often indicating persistent complications such as bleeding, infection, or organ failure.

The overall in-hospital mortality rate of 9.4% in our study is lower than some previously reported rates for relaparotomy after abdominal trauma, which have ranged from 12% to 20%.[11,13,14] This relatively low mortality rate may reflect advancements in perioperative care, damage control strategies, and the multidisciplinary management of complex trauma cases at our institution. Additionally, as previously mentioned, the institution's status as a reference center frequently managing such cases may contribute to these outcomes. Moreover, the lower mortality rate may be associated with the trauma population primarily consisting of relatively healthy young individuals with fewer comorbidities, a factor known to improve outcomes.

Our study has several strengths, including a relatively large sample size and a comprehensive analysis of various factors associated with mortality. However, it also has limitations. The retrospective design introduces potential bias and limits the ability to establish causal relationships. Additionally, the single-center design may restrict the generalizability of our findings to other settings with different patient populations or management protocols. Future research should focus on prospective, multicenter studies to validate these findings and potentially develop predictive models for identifying patients at the highest risk of adverse outcomes following relaparotomy.

CONCLUSION

Despite advancements in the management of abdominal trauma patients, a significant proportion still require relaparotomy for indications such as hemorrhage control, hemodynamic instability, and complications including leaks and wound issues. Early identification and optimization of factors linked to poor outcomes, such as deteriorating vital signs, low hemoglobin levels, platelet counts, and albumin, elevated INR and lactate levels, advanced age, blunt trauma, the need for multiple relaparotomies, and blood transfusions, are critical for improving prognosis in this vulnerable patient population. Further studies are needed to validate these findings and explore strategies for mitigating the risks associated with relaparotomy in trauma patients.

Ethics Committee Approval: Ethical approval was obtained from the Health Sciences University Gülhane Training and Research Hospital Clinical Research Ethics Committee (Approval Number: 2022/118, Date: 14.09.2022).

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ORİJİNAL ÇALIŞMA - ÖZ

Abdominal travma cerrahisi sonrası relaparotomi endikasyonları, risk faktörleri ve klinik sonuçlar

AMAÇ: Abdominal travma cerrahisi sonrası uygulanan relaparotomi, belirgin morbidite ve mortalite ile ilişkili kritik bir girişimdir. Ancak, travma hastalarında relaparotomi ile ilgili veriler sınırlıdır. Bu çalışmanın amacı, abdominal travma cerrahisi sonrası relaparotomi uygulanan hastalarda relaparotomi ile ilişkili faktörlerin prognoz üzerindeki etkisini değerlendirmektir.

GEREÇ VE YÖNTEM: Bu retrospektif çalışmada, Aralık 2016 ile Aralık 2022 arasında tek bir merkezde abdominal travma cerrahisi sonrasında relaparotomi uygulanan yetişkin hastalar analiz edildi. Demografik özellikler, travmaya bağlı faktörler ve perioperatif klinik bulgular kaydedildi. Hastane içi mortalite ile ilişkili faktörleri belirlemek için istatistiksel analizler yapıldı.

BULGULAR: Abdominal travma cerrahisi geçiren 300 hastanın 106'sında (%35.3) relaparotomi gereksinimi oldu. Hastane içi mortalite oranı %9.4 idi. Relaparotomi için başlıca endikasyonlar kanama kontrolü, hemodinamik instabilite ve intestinal kaçaklardı. Artmış mortaliteyle anlamlı derecede ilişkili faktörlerin yaş ≥50 (p=0.020), kadın cinsiyet (p=0.031), künt travma (p=0.020), birden fazla relaparotomi (p=0.023), relaparotomi sırasında aktif kanama (p<0.001) ve taze donmuş plazma transfüzyonu (p=0.046) olduğu bulundu. Ayrıca, mortal seyreden hastalar belirgin olarak daha düşük kan basıncı (p<0.001) ve daha yüksek kalp atış hızı (p<0.001) değerlerine sahipti. Bu hastalarda ek olarak, hemoglobin (p=0.015), trombosit sayısı (p=0.001) ve albümin seviyeleri (p<0.001) düşük iken; INR (p<0.001) ve laktat seviyeleri (p<0.001) yüksekti.

SONUÇ: Bu çalışma, abdominal travma cerrahisi sonrası relaparotomi uygulanan hastalarda mortalite ile ilişkili önemli faktörleri vurgulamaktadır. Aktif kanamanın yönetimi, yaşamsal belirtilerin ve laboratuvar parametrelerinin dikkatle izlenmesi ve yaşlı hastalar ile künt travma geçirenler gibi yüksek risk gruplarına özel dikkat gösterilmesi ve ek olarak risk faktörlerinin erken tanınması ve optimize edilmesi, bu hassas popülasyonda sonuçları iyileştirebilir.

Anahtar sözcükler: Abdominal yaralanma; laparotomi; mortalite; reoperasyon; travma.

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