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Clinical predictors of therapeutic laparotomy in anterior abdominal stab injuries: a multicenter study from low-income institutions in Ethiopia

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Purpose: Despite the high incidence of abdominal stab injuries, the rate of nontherapeutic laparotomies and the predictors of therapeutic laparotomies have rarely been studied in low-income settings.

Methods: This multicenter retrospective study involved three of the largest academic medical centers in central Ethiopia. All patients who sustained an anterior abdominal stab injury and underwent exploratory laparotomy, regardless of the intraoperative findings, were included over the 3-year course of the study.

Results: Of the 117 patients who underwent exploratory laparotomy, 35 patients (29.9%) underwent nontherapeutic laparotomies. Three factors predicted therapeutic laparotomy: hollow viscus evisceration (adjusted odds ratio [AOR], 5.77; 95% confidence interval [CI], 1.16–28.64; P=0.032), localized and generalized peritonitis (AOR, 4.77; 95% CI, 1.90–11.93; P=0.001), and white blood cell count ≥11,500/mm^3 (AOR, 2.77; 95% CI, 1.002–7.650; P=0.049). The overall positive predictive value of the therapeutic predictors was 80.2%, while the negative predictive value of all predictor-negative patients was 58.1%. The predictors would have prevented 51.4% of the nontherapeutic laparotomies.

Conclusions: Close to one-third of the patients had a nontherapeutic laparotomy. The clinical predictors of therapeutic laparotomy were shown to have a high positive predictive value despite a lower negative predictive value. Further prospective studies that involve all patients who sustain anterior abdominal stab injuries are needed to potentially improve on the negative predictive value of the predictors suggested by our study.

Keywords: Abdominal injuries; Developing countries; Emergency treatment

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INTRODUCTION

Background

Penetrating abdominal injuries constitute a substantial proportion of cases treated at urban trauma centers worldwide [1,2]. Yet, no accurate criteria are available that precisely stratify patients into those requiring exploratory laparotomy and those that can be managed conservatively. A liberal approach to surgical decision-making often leads to laparotomies with negative findings, while a conservative care approach risks missed injuries [3].

Guidelines for the selective nonoperative management of patients with penetrating abdominal injuries have been available since the early 2010s but are not widely practiced, except in select high-resource centers [4,5].

Objectives

This study was conducted at institutions with a high volume of trauma patients and limited resources. Patients with penetrating trauma, regardless of their stability and clinical findings, generally underwent exploratory laparotomy if they had a fascial breach or an equivocal examination upon exploration of the stab wound. For this reason, nontherapeutic laparotomy (NTL) was expected to be performed frequently. This study aimed to determine the rate of NTL among patients with stab injuries and the factors associated with therapeutic laparotomy (TL). We also compared the morbidities associated with NTL versus TL in this patient group.

METHODS

Ethics statement

This study was approved by the Institutional Review Board of Addis Ababa University College of Health Sciences, and copies of the document were forwarded to the hospitals included in the study. This study was conducted in accordance with the Declaration of Helsinki and with national and institutional guidelines, while keeping all patient information confidential. This was a retrospective study utilizing electronic and manual medical records, and was exempt from obtaining written consent in accordance with the national health research guidelines.

Study design and setting

We conducted a multi-institutional retrospective study across three hospitals among patients who sustained anterior abdominal stab injuries and underwent exploratory laparotomy. The study was conducted at Tikur Anbessa Specialized Hospital, Alert Hospital, and Zewditu Memorial Hospital, three large academic medical centers with high trauma volumes in Addis Ababa, Ethiopia. The hospitals have a combined capacity of over 1,500 beds and provide subspecialty level surgical care.

Study participants

The participants were all patients aged ≥18 years who underwent exploratory laparotomy for an anterior abdominal stab injury during the study period (September 2017 to June 2022). All patients who underwent exploratory laparotomy for fascial breach or equivocal results on wound examination, whether the intraoperative findings led to a therapeutic intervention or not, were included in the study.

All patients that underwent nonsurgical management because of an unequivocally negative fascial breach test, those patients with flank or back stab injuries, patients with blunt or nonstab penetrating injuries, patients who arrived with no sign of life to the emergency department, and pediatric patients aged <18 years were excluded from the study.

Variables

The independent variables of this study were age, sex, time of presentation, mechanism of the stab injury, and clinical findings at presentation. The dependent variables were the rate of TL, the intraoperative findings, the types of interventions performed, the overall outcome, and the postoperative complication rates of the patients studied.

Data source

The patients' medical record numbers were initially retrieved from the operation logbooks of all three hospitals where the study was conducted. Next, the patients' medical records were retrieved, and the data were collected.

Measurement and interpretation

TL was defined as laparotomy for an intra-abdominal injury that required a surgical intervention to achieve hemostasis or repair an injured organ. For this study, NTL was defined as either laparotomy for injuries that did not require hemostasis or repair of an organ, or laparotomy with no intra-abdominal injuries found.

Statistical analysis

Data were collected, cleaned, and coded using IBM SPSS ver. 24.0 (IBM Corp) for all analyses. Both descriptive and inferential statistics were used to interpret the collected data. Measures of central tendency and dispersion were used to analyze continuous independent variables. Categorical independent variables were analyzed using a frequency distribution table. For inferential statistics, the mean values were compared using a one-way analysis of variance (ANOVA). Categorical dependent variables were analyzed using univariable logistic regression, and values that were declared potentially significant were subjected to multivariable logistic regression.

RESULTS

A total of 117 patients who met the inclusion criteria were enrolled. Demographic data are shown in Table 1. Most patients

Table 1. Sociodemographic characteristics of patients who underwent exploratory laparotomy for an anterior abdominal stab injury (n=117)

Characteristic	No. of patients (%)
Sex	
Male	107 (91.5)
Female	10 (8.5)
Age (yr)	
18–19	18 (15.4)
20–29	70 (59.8)
30–39	20 (17.1)
40–49	5 (4.3)
50–59	3 (2.5)
≥60	1 (0.9)
Residence	
Urban	109 (93.2)
Rural	8 (6.8)
Type of instrument used	
Knife	106 (90.6)
Other	11 (9.4)
Time to presentation (hr)	
<6	106 (90.6)
≥6	11 (9.4)

were male, city dwellers, without comorbidities, stabbed with a knife, and presented within 6 hours of injury. Presenting features are shown in Table 2. Shock (defined as systolic blood pressure <90 mmHg) was present in 6.2% of patients. Stab site bleeding was the most common presenting complaint in 48 patients (41.0%), and the most common location of the injuries was the left upper quadrant (n=30, 25.6%) (Fig. 1). Alcohol intoxication was detected in 13 patients (11.1%). Gastrointestinal contents and formed fecal matter discharging from the wound were detected in two patients (1.7%) each. Signs of peritonitis were detected in 66 patients (56.4%), with generalized peritonitis in 29 patients (24.8%) and localized peritonitis in 36 patients (30.8%). The omentum was eviscerated in 28 patients (23.9%), while hollow viscus evisceration (HVE) was detected in 20 patients (17.1%). Local wound exploration detected fascial breach in 38 of the 69 patients (55.1%) without evisceration; the rest were equivocal. Soft tissue injury from stab wounds in other anatomic regions was the most common associated injury, occurring in 16 patients (13.7%), followed by hemothorax in eight patients (6.8%).

On investigation, a white cell count (WCC) ≥11,500/mm^3 was found in 43 patients (36.8%) and a hemoglobin level <12 g/dL in 16 patients (13.7%). All studied patients were taken directly to the operating theater without any imaging modalities.

Table 2. The clinical presentations of patients who underwent exploratory laparotomy for an anterior abdominal stab injury (n=117)

Variable	No. of patients (%)
Systolic blood pressure (mmHg) (n=113)[a]	
<90	7 (6.2)
≥90	106 (93.8)
Diastolic blood pressure (mmHg) (n=113)[a]	
<60	10 (8.8)
≥60	103 (91.2)
Pulse rate (beats/min)	
<100	77 (65.8)
≥100	40 (34.2)
Respiratory rate (breaths/min)	
<24	66 (56.4)
≥24	51 (43.6)
Alcohol intoxication	
Yes	13 (11.1)
No	104 (88.9)
Clinical presentation	
Stab site bleeding	48 (41.0)
Abdominal pain	11 (9.4)
Vomiting of ingested matter	6 (5.1)
Vomiting of bloody content	3 (2.6)
Failure to pass feces and flatus	4 (3.4)
Gastrointestinal content wound discharge	2 (1.7)
Formed feces wound discharge	2 (1.7)
Omental evisceration	28 (23.9)
Hollow viscus evisceration	20 (17.1)
Localized peritonitis	36 (30.8)
Generalized peritonitis	29 (24.8)
No complaints	9 (7.7)
No. of stab wounds	
Single	105 (89.7)
Multiple	12 (10.3)

[a]There were missing data because the blood pressure was not properly documented on the chart.

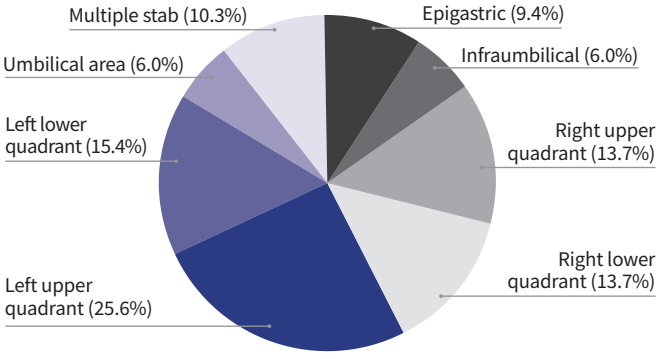

Fig. 1. The site of anterior abdominal stab injuries in 117 studied subjects.

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As shown in Table 3, a total of 118 organ injuries were detected among 82 patients with TL, with a mean of 1.4 organ injuries per patient (range, 1–4). The most frequently injured organs were the small bowel (jejunum and ileum; n = 37, 31.6%). Only one patient (0.9%) had a major vascular injury. The most common finding that did not require any intervention was hematoma collection caused by abdominal wall bleeding in seven patients (6.0%). The most common intervention was primary repair of penetrated viscus, which was performed in 52 patients (44.4%). Of the 35 NTLs, 20 (57.1%) had no intervention, and the remainder underwent interventions that were unnecessary, including hematoma evacuation.

On multivariable regression, three factors were found to be significantly associated with TL: the presence of HVE (adjusted odds ratio [AOR], 5.77; 95% confidence interval [CI], 1.16–28.64; P = 0.032), localized and generalized peritonitis (AOR, 4.77; 95% CI, 1.90–11.93; P = 0.001), and WCC ≥11,500/mm^3 (AOR, 2.77; 95% CI, 1.002–7.650; P = 0.049) (Table 4). In patients with none of these three factors, the rate of TL was 41.9%, which increased to 50% in the presence of increased WCC only. The rate of TL was 73.3% in patients with peritonitis only and 83.3% in the HVE-only group. All five patients who presented with all three factors had TLs. If patients with none of the three criteria were excluded from surgery after the initial evaluation, 18 NTL cases (51.4%) would have been avoided. The overall positive predictive value of the therapeutic predictors was 80.2%, while the negative predictive value for all predictor-negative patients was 58.1%.

Table 3. Type of injuries sustained in patients presenting with anterior abdominal stab injuries who underwent exploratory laparotomy, and the interventions performed (n=117)

Variable	No. of patients (%)
Hollow viscus injury	
Jejunum and ileum	37 (31.6)
Large bowel	26 (22.2)
Duodenum	3 (2.6)
Stomach	20 (17.1)
Urinary bladder	5 (4.3)
Solid organ injury	
Liver and biliary tract	13 (11.1)
Spleen	4 (3.4)
Pancreas	2 (1.7)
Other organs	
Major vascular injury	1 (0.9)
Omentum	3 (2.6)
Isolated hematoma	7 (6.0)
Intervention	
Primary repair of hollow viscus	52 (44.4)
Hemostasis + primary repair	14 (12.0)
Resection and anastomosis	12 (10.3)
Stoma	4 (3.4)
Nontherapeutic intervention	15 (12.8)
None	20 (17.1)

The mean duration of hospital stay was 7.2 ± 7.26 days (range, 1–70 days). The mean duration for patients with TL and NTL was 8.3 ± 8.42 and 4.62 ± 1.1 days, respectively, with the difference being statistically significant in one-way ANOVA (F (1,115) = 6.58, P = 0.012).

A total of 27 patients (23.1%) had postoperative complications. As shown in Fig. 2, the most common complication was surgical site infection (n = 16, 13.7%). Among patients who underwent an NTL, postoperative complications occurred in seven of the 35 patients (20.0%). In comparison, 20 of the 82 patients with TL (24.2%) had postoperative complications. Using univariable logistic regression, no significant difference was found in the rate of postoperative complications between TL and NTL patients (P = 0.61). Among the studied patients, one death occurred, in a patient with a major vascular injury.

DISCUSSION

Nearly a third of patients underwent an NTL. The presence of localized or generalized peritonitis, elevated WCC, and bowel evisceration had high positive predictive values for a TL, but relatively low negative predictive values when absent. Based on the initial evaluation alone, more than half of the NTLs could have been avoided.

Routine exploratory laparotomy for patients with penetrating abdominal injuries was the standard of care during the major wars

Table 4. Multivariable regression of therapeutic laparotomy in patients with anterior abdominal stab injuries (n=117)

Factor	Therapeutic laparotomy (%)	Nontherapeutic laparotomy (%)	AOR	95% CI	P-value
Localized and generalized peritonitis	84.8	15.2	4.77	1.90–11.93	0.001
Hollow viscus injury	93.3	6.7	5.77	1.16–28.64	0.032
Raised WCC (≥11,500/mm^3)	83.7	16.3	2.77	1.002–7.650	0.049

AOR, adjusted odds ratio; CI, confidence interval; WCC, white cell count.

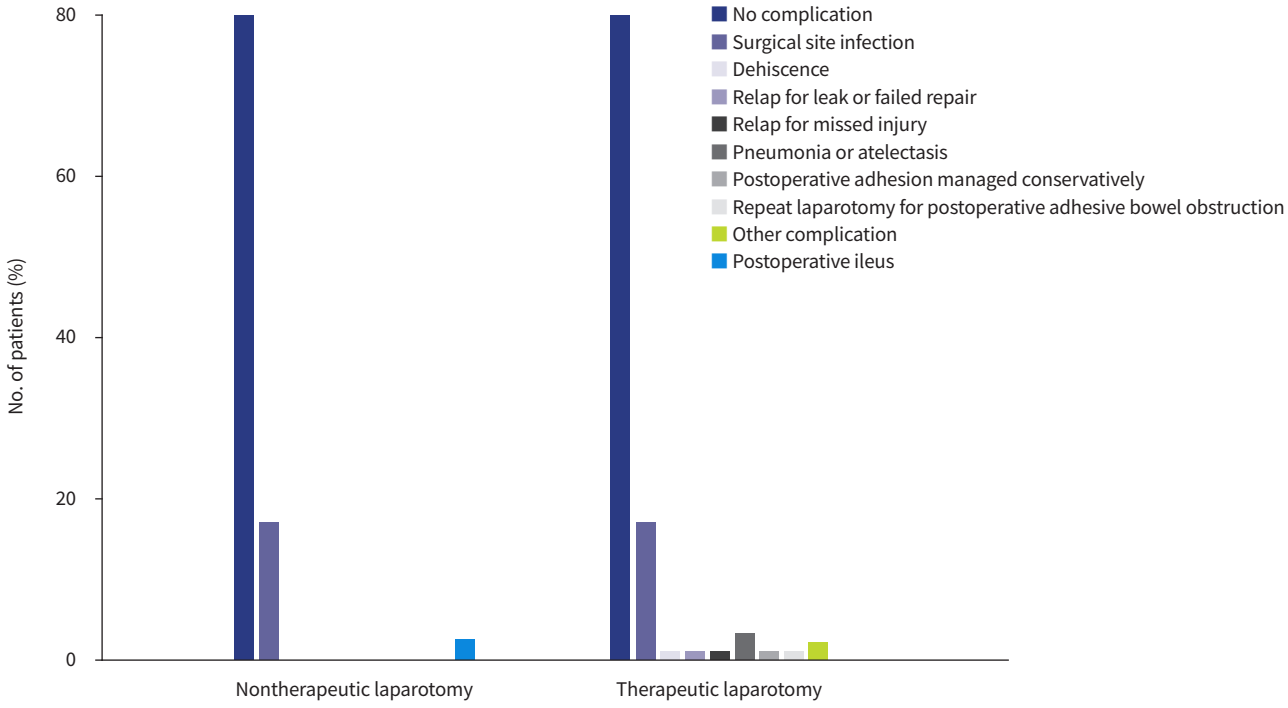

Fig. 2. Rate of postoperative complications in therapeutic and nontherapeutic laparotomies after anterior abdominal stab injury in 117 studied subjects.

and in civilian trauma practice for the first part of the 20th century [6]. Since the landmark paper by Shaftan [7] in 1960, the enthusiasm for universal exploratory laparotomy in patients with penetrating abdominal injuries has dwindled, albeit more gradually in low-resource centers [8]. The new concept of "selective conservatism" gradually gained more evidence until the 21st century, when guidelines recognized selective nonoperative management as part of the treatment algorithm for patients presenting with penetrating abdominal injury, provided that strict criteria were fulfilled [4,5,9–11]. Nonetheless, studies showed that preventing nontherapeutic surgical explorations in this population was not always possible, even in the presence of adequate resources for imaging and minimally invasive surgical interventions [12–14]. Furthermore, the availability of the necessary imaging modalities such as computed tomography (CT) scans and minimal access to surgery resources are limited in low-income countries [15]. This situation puts into question the feasibility of the existing guidelines for institutions like ours, as they depend heavily on the availability of CT scanning and minimally invasive techniques for equivocal cases [16]. For this reason, determining the clinical factors that can accurately predict TLs and, at the same time, decrease the rate of missed injuries in those undergoing nonoperative management is mandatory.

The clinical predictors of TL have rarely been studied [7,12]. A South African study showed that after considering the presence of peritonitis, organ evisceration, hemodynamic instability, and high spinal cord injury, the rate of NTL was <7%. Only an additional 10% of their cohort required delayed exploration with no additional complications [12]. These findings agree with our results, which showed that the presence of evisceration and peritonitis in a hemodynamically stable patient can reliably decrease the rate of nontherapeutic surgical explorations by utilizing physical examination findings only, with no additional imaging required. As for the correlation of WCC with the TL rate, only one other study correlated injury severity scores with WCCs [17]. To our knowledge, the correlation between WCC and the rate of TL was reported here for the first time and is a factor worth investigating further.

Most patients undergoing selective nonoperative interventions can be discharged after 48 hours of negative serial abdominal examinations, with some centers reporting an even shorter 24-hour stay, followed by discharge with written directions for patients and caretakers [16]. In our series, although the patients with NTL had comparatively shorter hospital stays than the TL group, they still had a longer hospital stay than those reported for nonoperatively managed patients [16]. The comparable rate of surgical complications between patients who had NTL versus TL in this study was largely attributed to surgical site infections. Yet, surgical morbidity and complications like surgical site infection cannot be overlooked as they can negatively influence the patient's

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physical, psychological, and financial outcome.

Limitations

The primary limitation of this study lies in its retrospective nature. Because all patients underwent exploratory laparotomy upon presentation, it was not feasible to conduct serial abdominal examinations and complete blood counts. Conducting serial examinations could have potentially enhanced the negative predictive value by facilitating the identification of more patients transitioning from expectant management to exploratory laparotomy upon developing peritoneal signs or increased WCC, as shown by other studies [18].

Conclusions

The rate of NTL in stab injury patients was nearly one-third of the studied patients. Only 41.9% of the patients with no positive predictors had TLs. Patients with all three positive predictors had a 100% rate of TL. Furthermore, more than 50% of NTL could have been prevented using only clinical parameters at presentation. This study provided further evidence for the notion that more laparotomies are done than are clinically indicated. Provided that the patient is hemodynamically stable, a reduction in the rate of NTL to an acceptable range can be done using clinical and laboratory (WCC) predictors.

ARTICLE INFORMATION

Author contributions

Conceptualization: SK, AH; Data curation: AH; Formal analysis: AH, MSG; Methodology: YMD; Project administration: YMD; Writing–original draft: SK, MSG; Writing–review & editing: all authors. All authors read and approved the final manuscript.

Conflicts of interest

The authors have no conflicts of interest to declare.

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Data availability

Data analyzed in this study are available from the corresponding author upon reasonable request.

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