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ORIGINAL ARTICLE

Indications, mortality, and long-term outcomes of 50 consecutive patients undergoing damage control laparotomy for abdominal gunshot wounds

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Abstract

Introduction: Outcomes of patients undergoing damage control laparotomy (DCL) for abdominal gunshot wounds (GSWs) remains relatively unknown. The purpose of this study was to evaluate the impact of DCL on long term morbidity and survival.

Methods: This retrospective study was conducted on patients undergoing a damage control laparotomy for abdominal GSWs. The data were collected using 50 consecutive trauma patients over a 4.5-year-period between August 1st, 2004 and September 30th, 2009. The patients were classified regarding the characteristics, such as age, perioperative physiological parameters, trauma indices, number of abdominal GSWs, critical care unit stay, hospital length of stay, morbidity, and mortality. Univariate and multivariate logistic regression was employed to compute the odds of survival and estimate the unadjusted and adjusted association between these factors.

Results: According to the results, the majority of the patients were male (96%) with a mean age of 29.7 years who had a single abdominal gunshot wound (60%). Liver injuries (58%) followed by small bowel (44%), majors venous (40%), and colonic (38%) trauma were observed in the patients. The overall mortality rate was obtained at 54%. The mean length of intensive care unit stay and mean hospital length of stay were 7 and 13 days, respectively. Factors associated with a decreased odds of survival included Penetrating Abdominal Trauma Index (PATI) > 25, intra-operative blood lactate level > 8 mmol/L, and massive transfusion >10 units packed red blood cells.

Conclusions: After controlling the confounding factors, a PATI score of > 25 was associated with a decreased odds of survival (OR: 0.20, P=0.04).

Key words: Gunshot, Laparotomy, Shock, Surgery, Traumatology

Introduction

Firearm injuries represent the sixth leading mechanism of injury managed by the Cape Town trauma system, Cape Town, South Africa (1-8). The mortality rate associated with abdominal gunshot wounds (GSWs) remains high with many deaths occurring as a result of exsanguination and irreversible shock (9-12). Damage control laparotomy (DCL) has increasingly been utilized for the management of severely injured patients with abdominal injuries (13-15). The DCL is characterized by an abbreviated initial operation that aims to rapidly and effectively control

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hemorrhage and contamination (13, 16-18). Moreover, DCL has been reported to be associated with improved survival at the expense of increased morbidity. (13, 17, 18).

Regarding several aspects of DCL, there exist considerable uncertainties. The modern-day outcomes of patients subjected to DCL for abdominal GSWs remains relatively unknown in spite of the improvements in understanding DCL complications, pre-hospital and surgical care, resuscitation strategies, adjunctive pharmacotherapy, and other aspects of injury care in recent years (12, 19, 20-26). There is currently little evidence regarding which variable may reliably predict morbidity and mortality in patients managed with damage control laparotomy for abdominal GSWs (27-31). This is especially true as many previous studies enrolled patients injured by a variety of mechanisms in addition to abdominal GSWs, several of which have been reported to be associated with different outcomes (27-31). This study aimed to evaluate the clinical characteristics as well as short- and long-term outcomes of patients managed with damage control laparotomy for abdominal GSWs.

Methods

This retrospective study was conducted on patients who underwent a damage control laparotomy for abdominal GSWs at the Trauma Center of Groote Schuur Hospital (GSH), Cape Town, South Africa, between August 1st, 2004 and September 30th, 2009.

No formal a priori sample size calculation was conducted in this study. The number of eligible patients during the study period determined the sample size. Patients who underwent damage control laparotomy for an abdominal GSW were identified and screened for eligibility. One of the authors reviewed the hospital records of eligible patients to extract the required data after obtaining ethical approval.

Variables of interest were collected using a standardized data extraction form in the Microsoft Excel spreadsheet. These variables include 1) age, 2) gender, 3) vital signs, 4) Glasgow Coma Scale Scores, 5) number and location of abdominal GSWs, 6) whether more than one anatomical region or cavity was injured, 7) the results of pre- and intraoperative diagnostic imaging and arterial blood gas and laboratory tests, 8) core body temperatures of patients in the trauma bay and operating theatre (OT) settings, 9) whether patients were reported to have a clinically-observed coagulopathy in the OT, 10) the volume or units of crystalloids, packed red blood cells (PRBCs), fresh frozen plasma, platelets, and cryoprecipitate administered across the trauma bay and OT settings, 11) whether tranexamic acid was given or a thoracotomy was required, 12) the time interval between patient arrival in the trauma bay and the initiation of the operative procedure, 13) the exact injury pattern identified, 14) the operative procedures conducted, 15) the number of abdominal operations performed, and 16) the length of time from laparotomy to the closure of the abdominal wound.

Where possible, the data utilized in the indications for damage control laparotomy were collected in this study. Moreover, Injury Severity Scale (ISS), Revised Trauma Score (RTS), Trauma Related Injury Severity Score (TRISS), and Penetrating Abdominal Trauma Index (PATI) scores were calculated for each patient.

Outcomes of interest included the risk of mortality in the OT and within 6- or 24-hours and 30-days of operation. Morbidity was evaluated by collecting data on complications, including the open abdomen, intra-abdominal abscesses/sepsis, and entero-atmospheric fistulae. The lengths of hospital and intensive care unit stay and the long-term risk of mortality, small bowel obstruction, and ventral hernia were also determined in this study.

Continuous variables were grouped to form new categorical variables, based on previous studies and clinical relevance. The clinical characteristics and outcomes of patients who underwent damage control laparotomy for abdominal GSWs will be summarized using proportions, mean±SD, and medians with interquartile ranges (IQRs) as appropriate. Initial data exploration was conducted using cross-tabulation and the Mantel-Haenszel test. Following this, logistic regression was used to compute the unadjusted estimates with 95% confidence intervals for the association between each of the variables and the odds of survival after DCL for abdominal GSWs. Variables for the inclusion in the multivariate logistic regression were selected based on previous literature and clinical grounds. These variables included proxies for the "Lethal Triad" that were found to be associated with the outcome on univariate analysis (i.e., hypothermia [temperature dichotomized at 32 degrees Celsius], acidosis [lactate dichotomized at 8mmol/L intraoperative], and coagulopathy [massive transfusion of greater than 10 units PRBCs]).

Furthermore, the trauma scoring system was included with the strongest association between mortality and PATI. Age was considered as *a priori* confounder. The data were analyzed in Stata MP (version 13.1, Stata Corp., College Station, TX,

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U.S.A). Proportions, odds ratios, 95% confidence intervals, and p-values are reported to two decimal places. All p-values in the logistic regression models were derived from the Likelihood Ratio Test.

The study protocol was approved by the Human Research Ethics Committee of the University of Cape Town, Cape Town, South Africa, in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards (UCT HREC ref.:455/2016).

Since this study was conducted based on a retrospective chart/database review design, no consent was taken from the patients, and they were grouped according to standard unit protocols. All data were collected by the first and last authors on a password-protected computer and Excel sheet. None of the patients could be identified in the database as they were numbered consecutively from 1-50. It should be noted that the participants were all informed of the privacy and confidentiality of data.

Results

In total, 82 potentially eligible patients were identified from the GSH trauma database prior to the submission of the study protocol for ethics review. Out of this population, 32 cases were excluded from the study due to the following reasons:

- Patients' death in the emergency room prior to being taken to the operating room (n=12)
- Lack of damage control laparotomy (n=10)
- Damage control laparotomy for injuries other than GSWs to the abdomen (n=4)
- Missed patient records (n=2)
- Erroneously duplicated patient folder numbers (n=4)

Accordingly, this study included 50 patients (48 male and 2 female) who underwent DCL for abdominal GSWs. The mean age of the participants was obtained at 29.7±10.88 years (age range: 17-62 years). Totally, 30 (60%) and 20 (40%) patients had single and multiple gunshot wounds to the abdomen, respectively. The mean values of preoperative systolic blood pressure, heart rate, respiratory rate, temperature, and Glasgow Coma Scale were 90.4 mmHg, 112 beats/per min, 19 breaths/per min, 35.6 degrees Celsius, and 12 with an IQR of 13 to 15, respectively.

According to the results obtained from pre-operative blood investigations, the mean values of hemoglobin concentration, pH, base deficit, and lactate were estimated at 8.35g/dl, 7.21, -9.71 mEq/L, and 5.25 mmol/L, respectively. This study computed four trauma indices, including ISS, RTS, TRISS, and PATI with the mean values of 27.12, 6.65, 82.36%, and 34.5, respectively. Intra-operatively, the mean values of temperature, pH, base deficit, and lactate were obtained at 35 degrees Celsius, 7.07, -14.41 mEq/L, and 7.95 mmol/L, respectively (Table 1).

The index procedure was terminated due to the presence of metabolic acidosis (n=46), increasing ionotropic support (n=39), rising lactate (n=34), and diffuse hemorrhage (n=28) in the patients. Hypothermia was noted as a reason for the termination of the index procedure (n=16), and disseminated intravascular coagulopathy (n=16).

Table 1: Demographic characteristics of the patients (n=50) who underwent damage control laparotomy at Groote Schuur Hospital between August 1st, 2004 and September 30th, 2009

Gender	
Male	48 (96%)
Female	2 (4%)
Mean Age (year)	29.7±10.88
Number of Gunshot Wounds	
Single	30 (60%)
Multiple	20 (40%)
Pre-operative Vital Signs	
Systolic blood pressure	90.04±35.84
Heart rate	111.92±18.71
Respiratory rate	18.98±18.98
Preoperative temperature	35.56±1.11
Glasgow Coma Scale	12.4±4.52
Blood Investigations	
Pre-operative Hb	8.35±2.70
Pre-operative pH	7.21±0.11
Pre-operative base deficit	-9.71±4.91
Pre-operative lactate	5.25±2.45
Trauma Indices	
Injury Severity Scale	27.12±15.26
Revised Trauma Score	6.65±1.75
Trauma Related Injury Severity Score	82.36±25.58
Penetrating Abdominal Trauma Index	34.5±2.02
Intraoperative parameters	
Temperature	35.0±1.19
pH	7.07±0.15
Base deficit	-14.41±5.01
Lactate	7.95±2.54

Most patients received either two (42% of the patients) or three (38% of the patients) liters of crystalloids and one (34% of the patients) to two (40% of the patients) units of packed red cells pre-operatively. In addition, most patients received intra-operatively between one and six litres of crystalloids (78% of the patients), four to ten units of packed red cells (60% of the patients), between two and six units of fresh frozen plasma (85% of the patients), and one unit of platelets (32% of the

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Table 2: Pre- and intra-operative fluid resuscitation

Preoperative	N (%)
Units of packed red cells	
0	5 (10)
1	17 (34)
2	20 (40)
3	5 (10)
4	2 (4)
5	1 (2)
Intra-operative	**N (%)**
Units of crystalloids	
0-1	1 (2)
1.1-4	20 (40)
4.1-6	19 (38)
6.1-8	4 (8)
8.1-10	3 (6)
Units of packed red cells	
0-4	6 (12)
4.1-10	30 (60)
10.1-15	10 (20)
15.1-20	4 (8)
Units of fresh frozen plasma	
0-2	9 (18)
2.1-4	15 (30)
4.1-6	14 (28)
6.1-8	9 (18)
8.1-10	3 (6)
Units of platelets	
0	5 (10)
1	26 (32)
2	11 (22)
3	1 (2)
4	4 (8)
5	0
6	3 (6)
Units of crystalloids	
1	1 (2)
2	21 (42)
3	19 (38)
4	7 (14)
5	2 (4)

patients) (Table 2).

In total, 40 (80%) patients had extra-abdominal GSWs. The GSWs were located at posterior torso (n=24, 48%), epigastrium (n=12, 24%), right iliac fossa (n=12, 24%), left iliac fossa (n=8, 16%), right upper quadrant (n=6, 12%), and left upper quadrant (n=5, 10%).

Out of 50 patients, five cases underwent thoracotomy in the operating room at the time of laparotomy. The most common injuries noted at laparotomy were liver (28%), small bowel (44%), major venous injuries (40%), colon (38%), major arterial injuries (22%), and pancreas (20%) (Table 3).

The mean time for operation and the mean duration of surgery were 141±80.3 and 141±59.8 min, respectively. In total 27 (54%) patients died in the first six hours (n=14), between six and 24 hours (n=60), between 24 hours and seven days (n=3), and between seven to 30 days (n=4). Moreover, out of 27 deaths, 1,10, and 16 cases occurred in the operating room, the ward after ICU discharge, and the ICU, respectively. The mean length of stay in the ICU amongst the patients who survived the index procedure was 7.64±7.90 days. Out of those patients who survived ICU, the mean stay was 12.38±10.22 days. Moreover, the mean total length of hospital stays amongst those patients who survived the index procedure was 16.64 ±15.33 days.

The most common short-term complications documented in the ICU were an acute renal failure (n=10), multi-organ dysfunction (n=10), DIC (n=7), and abdominal compartment syndrome (n=7).

Table 3: Description of injuries found at damage control laparotomy

Variable	N (%)
Gunshot Wounds Site	
Epigastric	12 (24)
Right upper quadrant	6 (12)
Right iliac fossa	12 (24)
Left iliac fossa	8 (16)
Left upper quadrant	5 (10)
Suprapubic	0 (0)
Back	24 (48)
Extra abdominal	40 (80)
Thoracotomy	
No	45 (90)
Yes	5 (10)
Organ injuries noted	
Pericardium	1 (2)
Lung	1 (2)
Diaphragm	6 (12)
Oesophagus	1 (2)
Liver	29 (28)
Spleen	4 (8)
Pancreas	10 (20)
Bladder	4 (8)
Kidney	8 (16)
Stomach	9 (18)
Small Bowel	22 (44)
Colon	19 (38)
Rectum	5 (10)
Retroperitoneal	5 (10)
Venous	20 (40)
Arterial	11 (22)
Mesentery	3 (6)
Neurological	1 (2)

Other complications included prolonged intubation requiring tracheostomy, ventilator-associated pneumonia, superficial wound sepsis, intra-abdominal sepsis, anastomotic leak, deep vein thrombosis, limb ischemia, hypoglycemia, and gastrointestinal bleeding.

Amongst those patients who survived ICU, the most common complications noted in the ward were superficial wound sepsis (n=5), open abdomen (n=5), paralytic ileus (n=4), and wound dehiscence (n=4). Other complications included atelectasis, pleural effusion, acute kidney injury, pancreatic fistula, and a high output ileostomy.

Table 4 summarizes the Clavien-Dindo Classification of all complications mentioned above. Long-term complications were noted in seven patients, and three patients presented with adhesive small bowel obstruction at 3 months, 1 year, and seven years, respectively, after the index operation. Furthermore, three patients presented with elective ventral hernia repair at 9 months, 1 year, and 6 years, after the index operation. One patient known with a ventral hernia lost the follow-up.

Univariate analysis of the association between the variables is listed in Tables 5 and 6. The mortality rate revealed strong evidence that PATI of less than 25, pre-operative infusion of greater than 3 liters of crystalloids, intra-operative lactate level of less than 8mmol/L, and intra-operative transfusion of fewer than 10 units of PRBCs increased the odds of survival.

In this study, there is significant evidence (P=0.01) that the odds of survival are 81% lower in

Table 4: Number and frequency of complications after damage control laparotomy categorised by Clavien-Dindo classification

Grade	N (%)	Observed complications
I	5 (10)	Atelectasis (1) Hypoglycemia (1) Paralytic ileus (3)
II	6 (12)	Prolonged ileus requires TPN (1) Pulmonary edema (1) Small-intraabdominal collection (1) Pneumonia (1) Ventilated associated pneumonia (1) High output ileostomy (1)
IIIa	1 (2)	Wound dehiscence repaired by secondary closure
IIIb	5 (10)	Open abdomen requiring skin graft (4) intraabdominal collection (1)
Iva	2 (6)	Acute kidney injury requires dialysis
IVb	1 (2)	Acute compartment syndrome
V	27(54)	Mortality

Table 5: Univariate and multivariate association between pre-operative patient factors and the odds of survival after damage control laparotomy for abdominal gunshot wounds

Variable	Died N (%)	Survivors N (%)	Unadjusted OR (95% CI)	P-value (LRT)	Adjusted OR (95% CI)	P-value (LRT)
Age (years):						
<40	22 (44)	20 (40)	1	0.60	1	0.19
>40	5 (10)	3 (6)	0.66 (0.143.12)		0.30 (0.04-2.00)	
Gender:						
Male	26 (54)	22 (44)	1	0.90		
Female	1 (2)	1 (2)	1.18 (0.0720.01)			
Pre-operative systolic blood pressure (mmHg):						
<90	12 (24)	12 (24)	1	0.59		
>90	15 (30)	11 (22)	0.73 (0.242.23)			
Pre-operative heart rate (beats/min):						
<100	4 (8)	7 (14)	1	0.37		
≥100	23 (46)	16 (32)	0.40 (0.10-1.59)			

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Table 5 Continued.

Pre-operative respiratory rate (breaths/min):						
<20	14 (28)	13 (26)	1	0.74		
≥20	13 (26)	10 (20)	0.83 (0.27-2.53)			
Glasgow Coma Scale:						
<8	7 (14)	3 (6)	1	0.25		
≥8	20 (40)	20 (40)	2.33 (0.53-10.33)			
Injury Severity Scale						
0-24	10 (20)	14 (28)	1	0.24		
25-74	13 (26)	9 (18)	0.49 (0.15-1.60)			
75	4 (8)	0				
Revised Trauma Score						
<4	4 (8)	1 (2)	1	0.20		
≥4	23 (46)	22 (44)	3.82 (0.40-36.96)			
Trauma-Related Injury Severity Score						
<50	5 (10)	2 (4)	1	0.31		
≥50	22 (44)	21 (42)	2.39 (0.42-13.67)			
Penetrating Abdominal Trauma Index						
<25	4 (8)	11 (22)	1	0.01*	1	0.04*
≥25	23 (46)	12 (24)	0.19 (0.05-0.72)		0.20 (0.04-1.00)	
Pre-operative haemoglobin (g/dL):						
<8	14 (28)	9 (18)	1	0.37		
≥8	13 (26)	14 (28)	1.68 (0.54-5.17)			
Pre-operative red blood cells:						
<3	21 (42)	21 (42)	1	0.18		
≥3	6 (12)	2 (4)	0.33 (0.60-1.84)			
Pre-operative pH:						
<7.2	14 (28)	7 (14)	1	0.12		
≥7.2	13 (26)	16 (32)	2.46 (0.77-7.90)			
Pre-operative base deficit (mEq/L):						
< -8	18 (36)	10 (20)	1	0.10		
≥ -8	9 (18)	13 (26)	2.6 (0.82-8.2)			
Pre-operative crystalloids (litres):						
<3	16 (32)	6 (12)	1	0.02*		
≥3	11 (22)	17 (34)	4.12 (1.23-13.77)			
Pre-operative lactate (mmol/L):						
< 2.5	2 (4)	4 (8)	1	0.28		
≥ 2.5	25 (50)	19 (38)	0.38 (0.06-2.29)			

Table 6: Univariate and multivariate association between intra-operative patient factors and the odds of survival after damage control laparotomy for abdominal gunshot wounds

Variable	Died N (%)	Survivors N (%)	Unadjusted OR (95% CI)	P-value (LRT)	Adjusted OR (95% CI)	P-value (LRT)
Intra-operative pH:						
<7.2	24 (48)	18 (36)	1	0.31		
≥7.2	3 (6)	5 (10)	2.22 (0.47-10.54)			
Intra-operative lactate (mmol/L):						
< 8	9 (18)	17 (34)	1	0.01*	1	0.09
≥ 8	18 (36)	6 (12)	0.18 (0.05-0.6)		0.29 (0.07-1.24)	
Intra-operative temperature (°C):						
<32	7 (14)	2 (4)	1	0.10	1	0.42
≥32	20 (40)	21 (42)	3.66 (0.68-19.84)		2.21 (0.31-15.76)	

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Table 6 Continued.

Intra-operative crystalloids:						
<3	22 (44)	21 (42)	1	0.31		
≥3	5 (10)	2 (4)	0.42 (0.07-2.40)			
Intra-operative red blood cells:						
<10	16 (32)	20 (40)	1	0.03*	1	0.61
≥10	11 (22)	3 (6)	0.22 (0.05-0.92)		0.33 (0.07-1.62)	
Intra-operative fresh frozen plasma:						
<4	20 (40)	17 (34)	1	0.99		
≥4	7 (14)	6 (12)	1.01 (0.28-3.58)			
Thoracotomy:						
No	23 (46)	22 (44)	1	0.20		
Yes	4 (8)	1 (2)	0.26 (0.27-2.52)			
Time to surgery (min):						
<60	5 (10)	1 (2)	1	0.12		
≥60	22 (44)	22 (44)	5.68 (0.54-46.35)			
Operation time (min):						
<120	12(24)	7 (14)	1	0.31		
≥120	15(30)	16 (32)	1.83 (0.57-5.88)			

*All p-values are by the Likelihood Ratio Test. A P-value less than 0.05 is considered statistically significant.

patients with a PATI of more than 25, compared to those with a PATI of less than 25 (OR 0.19, 95% CI: 0.05-0.72).

There is also significant evidence (P=0.02) that patients who received more than three liters of crystalloids pre-operatively were four times more likely to survive, compared to those who received less than three liters of crystalloids (OR 4.12, 95% CI: 1.23-13.77). On univariate analysis, there is significant evidence (P=0.01) that patients with an intraoperative lactate level of greater than 8 were 82% less likely to survive (OR 0.18, 95% CI: 0.05-0.6), and those who had massive transfusion (≥10 units) of PRBCs intra-operatively were 78% less likely to survive (OR 0.22, 95% CI: 0.05-0.92). In addition, according to the multivariate analysis results, there is significant evidence (P=0.04) that after considering the confounding effect of age and all other variables in the regression model, a PATI of greater than 25 was associated with an 80% lower odds of survival after DCL (OR 0.20, CI 0.04-1.00); however, there is considerable uncertainty around this estimate owing to the small sample size.

Discussion

This study aimed to describe the clinical characteristics of patients managed with DCL for abdominal GSWs at GSH. The indications and long-term outcomes of patients undergoing DCL were also examined in this study. The overall mortality rate after DCL was obtained at 54%. Univariate analysis revealed that PATI of less than 25, pre-operative infusion of greater than 2 liters of crystalloids, intra-operative lactate level of less than 8mmol/L, and intra-operative transfusion of fewer than 10 units of PRBCs associated with an increase in the odds of survival after DCL.

In the same line, the multivariate analysis revealed significant evidence (P=0.04) that a PATI score of greater than 25 was associated with an 80% decrease in the odds of survival (OR 0.20, 95% CI: 0.04-1.00). After considering the confounding effect of age and all other variables in the model, there was no evidence of a correlation between intra-operative lactate and temperature or massive transfusion with the odds of survival after DCL.

Given the substantial uncertainty around the estimates demonstrated by wide confidence intervals for most of the odds ratios in the univariate analysis and most likely the small sample size, the results summarized above should be interpreted with caution.

The multivariate regression controls the confounding effect of the other variables in the model; however, the observed association between a high PATI score and a decrease in the odds of survival should not be interpreted as a causal relationship since the results may still be subject to random sampling error, selection bias, information bias, or residual confounding after analysis.

The mortality rate after DCL for abdominal GSWs was notably higher in this study than in previously published studies conducted by Rotondo et al. (18) (42%) and Brennar et al. (32) (28%). Factors contributing to this could

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anecdotally include the delay to operation and long operation time, as well as other resource-based constraints, such as the level of training of healthcare workers, access to the operating room and intensive care, as well as the availability of allied healthcare support. Not captured in the data presented here is the additional delay between injury and arrival time at GSH owing to ambulance and emergency service shortages.

The results of the univariate analyses support the hypothesis that the "Lethal Triad" (i.e., coagulopathy, acidosis, and hypothermia) contributes significantly to patient mortality following major trauma. In this study, high levels of lactate and massive transfusion were associated with a negative outcome. Frischknecht et al. identified several risk factors for early mortality, including severe head injury and the "Lethal Triad" in patients undergoing damage control procedures. (30) Similarly, Timmermans et al. demonstrated that a large base deficit, low pH, hypothermia, coagulopathy, and massive transfusion correlated with mortality in trauma patients. (27)

The incidental finding of an association between high volumes of crystalloids administered pre-operatively and an increased odds of survival should be interpreted with caution, given the wide confidence interval of the estimate probably because of the small sample size. Due to the lack of corroborative evidence, and given that the analysis is based on relatively small numbers, it is not recommended to implement any change in fluid prescribing practice on the strength of these results.

It is recommended that future studies examine the effect of the ratio of crystalloids to blood products on the odds of survival after DCL since it is hypothesized that initial permissive hypotension followed by definitive control of hemorrhage and blood product based resuscitation is associated with positive outcomes.

The multivariate analysis demonstrated significant evidence that high PATI scores are associated with increased mortality after controlling age and intraoperative factors. This finding is consistent with the results of a similar study performed by Adesanya et al. who demonstrated that a PATI score of >15 was associated with a 20-fold increase in the incidence of death (P<0.0001) (33).

There are many factors that may impact the external validity of the observed results. Notably, data on the socio-economic status, immune profile, and comorbid conditions were not collected or analyzed in this study. These factors may have a significant impact on patients' recovery after major trauma. Therefore, the observed results may not be applicable to high-income countries with different patient demographics.

Conclusions

In this limited study, the overall mortality rate of patients that required DCL for abdominal GSWs was obtained at 54%. There is significant evidence that after controlling confounding variables, the PATI score of >25 associated with decreased odds of survival (OR: 0.20, P=0.04).

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Conflict of Interest

The authors declare that they have no conflict of interest regarding the publication of the study.

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