

Evaluation of Risk Factors for Septic Complications after Laparotomy for Abdominal Trauma: A Longitudinal Cohort Study

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ABSTRACT

Introduction: Septic complications are the most common cause of death in trauma patients who survive beyond 48 hours. Early diagnosis and treatment of infectious complications is essential to prevent life threatening complications like Systemic Inflammatory Response Syndrome (SIRS) and Multi-Organ Dysfunction Syndrome (MODS).

Aim: To study the various risk factors for septic abdominal complications following laparotomy for trauma.

Materials and Methods: A prospective longitudinal cohort single-center study was conducted from November 2016 to March 2018. Sixty patients above the age of 12 years, who underwent laparotomy for abdominal trauma in the Surgical Department of tertiary care hospital, were included in the study. Various patient variables were compared with postoperative septic abdominal complications like wound infection, wound dehiscence, anastomotic leak and intra-abdominal abscess. Data was analysed using Statistical Package for Social Sciences (SPSS) version 21.0.

Results: In the total 60 patients (35.60±16.54), significant association was seen between wound infection and dehiscence with the time interval between trauma and surgery ($p<0.001$), lesser Revised Trauma Score (RTS) ($p<0.001$) and greater Injury Severity Score (ISS) ($p<0.001$). A significant association of all septic complications was seen with the need for Intensive Care Unit (ICU) stay ($p<0.001$) and the presence of associated injuries ($p<0.001$). Variables such as age, gender, co-morbidities, Body Mass Index (BMI), pre-hospital care received, intraoperative findings and duration of ICU stay had no association with outcomes ($p>0.05$).

Conclusion: In trauma patients, factors like low RTS score, high ISS score, need for ICU stay and the presence of associated injuries may help the surgeons to decide in which patients to go for techniques like delayed closure of the wound, stoma instead of bowel anastomosis, etc., which may help to reduce postoperative septic complications.

Keywords: Infections in trauma, Injury severity score, Intensive care unit stay, Revised trauma score, Trauma surgery

INTRODUCTION

Trauma is the major cause of mortality in population below the age of 45 years, who are the torch bearers of the economic development of every society [1]. As per the World Health Organisation (WHO) estimates, trauma will be one of the leading causes of disability adjusted life years in the middle age population [2]. Abdominal trauma constitutes about a quarter of trauma burden and about a quarter of abdominal trauma cases require surgery [2,3]. Blunt trauma abdomen is the most common mechanism of injury for abdominal trauma [2].

Baker CC et al., and Trunkey DD, classified the deaths due to trauma into immediate, early and late deaths [4,5]. Immediate deaths occurred in the field immediately after trauma and were largely unavoidable. Early deaths occurred in the hospital within the first 24-48 hours. Late deaths occurred beyond 48 hours. The proportion of early deaths was significant and that has led to the proposal of the concept of the golden hour in trauma. Improvement of the emergency medical services and the adoption of trauma management systems have led to a drastic reduction in the early deaths due to trauma. However, septic complications are the most common cause of death in trauma patients who survive beyond 48 hours [4]. Even though the incidence of infectious complications following laparotomy for trauma is less, these inimical outcomes are unacceptable to a surgeon. Septic abdominal complications range from wound infection to deep organ space infection leading

to sepsis. Early diagnosis and treatment of infectious complications is essential to prevent life threatening complications like SIRS and MODS [6].

The causes of abdominal sepsis in trauma include contamination of the peritoneal cavity with gastrointestinal tract contents, penetrating injuries, open and contaminated wounds and laparotomy in the emergency setting [7,8]. Hypoperfusion, hypothermia, placement of central lines and damage control resuscitation further increase the risk of infectious complications in trauma [7,8]. Identification of risk factors for predicting abdominal sepsis following laparotomy in trauma will help in the early diagnosis of these complications and thereby decreasing the late mortality in trauma [7-9].

The Revised Trauma Score (RTS) is a physiological scoring system in trauma based on respiratory rate, systolic blood pressure and Glasgow coma scale [10]. Each parameter is graded from 0 to 4 and then multiplied with a weighing factor. The final score ranges from 0 to 7.8408. The Injury Severity Score (ISS) is developed by Baker SP and O'Neill B is based on Abbreviated Injury Scale (AIS) [11]. The AIS score of the three most severely injured body regions was considered, the values were squared and added. The final score ranges from 1-75.

Authors hypothesised that various variables such as demographic factors, patient characteristics, scoring systems, pre-hospital care, intraoperative findings, ICU stay, etc., have a significant association with abdominal septic complications following emergency laparotomy

for trauma. The aim of the present study was to analyse the various risk factors for septic abdominal complications like wound infection, wound dehiscence, anastomotic leak and intra-abdominal abscess in patients who underwent laparotomy for abdominal trauma in emergency.

MATERIALS AND METHODS

A longitudinal cohort study was conducted in a tertiary care and academic center located in India from November 2016 to March 2018. Institutional Ethics Committee approval {TP (MD/MS) (44/2016)/IEC/PGIMER/RMLH/7766/16} was taken prior to the commencement of the study. All procedures in the study were performed in accordance with the ethical standards as per the Declaration of Helsinki 1975, revised in 2013. All patients belonged to a single cohort as per the protocol and were followed-up prospectively for a period of 30 days to monitor the outcomes.

Inclusion criteria: Sixty patients, above the age of 12 years who underwent emergency laparotomy for abdominal trauma in the Surgical Department of our hospital during the study period were included in the study after obtaining the informed consent.

Exclusion criteria: Patients of abdominal trauma who were managed conservatively and patients who were lost to follow-up within 30 days of surgery were excluded from the study.

Sample calculation: The sample size was 60 patients on accrual calculated using the standard formula with a margin of error of 5% and confidence interval of 95% considering the study by Singla B et al., [12].

All patients who presented to the emergency with a history of abdominal trauma were evaluated as per the Advanced Trauma Life Support (ATLS) protocol [13]. All patients were assessed initially by the primary survey. Vital parameters such as pulse rate, blood pressure, respiratory rate and oxygen saturation were monitored. Demographic details, co-morbidities, Body Mass Index (BMI), mechanism of injury, pre-hospital care received, RTS and ISS were noted [10,11]. All patients with a history of abdominal trauma underwent Focused Assessment with Sonography for Trauma (FAST) [14]. The indications for laparotomy in a case of abdominal trauma were:

- Blunt abdominal trauma with haemodynamic instability and FAST positive
- Free intraperitoneal air or retroperitoneal air on imaging
- Contrast Enhanced Computed Tomography (CECT) abdomen suggestive of perforated hollow viscus or severe solid organ injury as per the American Association for the Surgery of Trauma (AAST) grading [15]
- Clinical features suggestive of peritonitis
- Penetrating abdominal trauma with haemodynamic instability
- Evisceration of abdominal organs

In the operating room, all necessary procedures were performed. Perforations of the gastrointestinal tract and genitourinary tract were repaired primarily. Bleeding from the solid organs was controlled by pressure, packing, haemostatic devices and local haemostatic agents. Splenectomy was done in two patients in view of grade 5 splenic injury. Thorough peritoneal lavage was done with warm saline. Rectus sheath was closed continuously with polypropylene suture. Skin was closed with staples. All patients received empirical antibiotics (ceftriaxone 1000 mg BD and metronidazole 500 mg TDS), which were changed according to the culture and sensitivity report in case of any infectious complications. Intraoperative findings, associated injuries, the time interval between trauma and surgery, Intensive Care Unit (ICU) stay requirement and duration of ICU stay were noted. Patients received routine postoperative care. They were followed-up for a period of 30 days for septic abdominal complications like:

- Wound infection
- Wound dehiscence

- Anastomotic leak
- Intra abdominal abscess

STATISTICAL ANALYSIS

The data acquired during the study was coded and recorded in the MS Excel spreadsheet (Microsoft Office, Microsoft, Washington). Data was analysed using SPSS version 21.0 (IBM SPSS Statistics, International Business Machines Corporation, New York). Data was normally distributed. Hence, t-test was used to test the significance of continuous variables. Chi-square test was used to test the significance of categorical variables; p-value of <0.05 was considered significant.

RESULTS

The mean age of patients (n=60) in this study was 35.60 years with a standard deviation of 16.542. The proportion of males (n=32) was slightly higher than females (n=28) [Table/Fig-1]. Among the study subjects, 14 patients had co-morbidities (23.3%). Blunt trauma to the abdomen was the most common mechanism of injury (n=36; 60%) [Table/Fig-1].

Variables	Frequency	Proportion
Gender		
Males	32	53.3%
Females	28	46.7%
Co-morbidities		
Present	14	23.3%
Absent	46	76.7%
Body Mass Index (BMI)		
Underweight	0	0
Normal	40	66.7%
Over weight	18	30%
Class 1 obesity	2	3.3%
Class 2 obesity	0	0
Morbid obesity	0	0
Mechanism of injury		
Blunt trauma	36	60%
Penetrating trauma	24	40%
Pre-hospital care		
Received	22	36.7%
Not received	38	63.3%

[Table/Fig-1]: Table showing the demographic details, mechanism of injury, Body Mass Index (BMI), co-morbidities and pre-hospital care received by patients (N=60).

The overall mean±SD (Standard Deviation) of RTS score was 7.41±0.641 with a range from 5.44 to 7.84. The overall mean±SD of ISS score was 15.10±7.508 with a range from 4 to 35. The mean±SD of time interval between trauma and surgical intervention was 9.2±6.84 hours with a range from 1 to 32 hours.

On laparotomy, gastrointestinal tract was the most common organ to be injured (53.33%). Solid organs were injured in 33.33% of patients [Table/Fig-2]. In the post-operative period, only 14 out of 60 patients required ICU stay [Table/Fig-2]. Most of the patients (76.7%) were managed in the ward. The mean duration of ICU stay was 6.43 days. In the postoperative period, 8 patients had wound infection (13.3%) [Table/Fig-2]. The same patients also had wound dehiscence (13.3%). Anastomotic leak was present in 6 out of 30 patients who underwent anastomosis. The same 6 patients also had an intra-abdominal abscess. Out of these 6 patients, 4 underwent re-exploration and two patients were managed conservatively.

As per t-test analysis, a significant association was present between wound infection and subjects who had greater time interval between trauma and surgical intervention, lesser RTS score and greater ISS score. Wound dehiscence also showed a significant association with the above parameters [Table/Fig-3].

Variables	Frequency	Proportion
No	46	76.7%
Yes	14	23.3%
Intraoperative findings		
Gastrointestinal tract injury	32	53.33%
Solid organ injury	20	33.33%
Others	8	13.33%
ICU stay		
Yes	14	23.3%
No	46	76.7%
Outcomes		
Wound infection	8	13.3%
Wound dehiscence	8	13.3%
Anastomotic leak	6 out of 30	20% of anastomosis done
Intra-abdominal abscess	6	10%

[Table/Fig-2]: Table showing the proportion of associated injuries, intraoperative findings, requirement of ICU stay and outcomes of the patients (N=60)

abdominal complications. However, in some previous studies, older age was associated with increased risk of post-traumatic sepsis [16,17]. This discrepancy may be because of the age of the study subjects in this present study. As in many other previous studies, abdominal trauma was common in younger age groups in the present study [8,18]. Studies specifically on older age group patients may help to arrive at conclusions. Few studies have shown that female gender had a protective effect in traumatic sepsis because of the beneficial effect of estrogens on the immune system [17,19]. In many other studies, there was no association of gender with septic abdominal complications [20,21]. In this present study, there was no significant association of gender with abdominal sepsis.

BMI was not associated with septic abdominal complications in the present study. BMI has been proven as a risk factor for superficial surgical site infections in many studies [22,23]. The non-significant association of BMI with wound infection in this study may be because of the small sample size. The role of BMI as an independent risk factor for morbidity and mortality in trauma is debated. Few studies have proved BMI as a risk factor for multiorgan failure whereas few studies

Variables studied	Wound dehiscence			Wound infection			Anastomotic leak			Intra abdominal abscess		
	Mean		p-value ¹	Mean		p-value ¹	Mean		p-value ¹	Mean		p-value ¹
	Absent	Present		Absent	Present		Absent	Present		Absent	Present	
Age (years)	36.88	27.25	0.286	36.88	27.25	0.286	36.11	31.0	0.620	36.11	31.0	0.620
BMI (kg/m ²)	23.0	25.50	0.16	23.0	25.5	0.161	23.30	23.67	0.857	23.30	23.67	0.857
Time interval (hours)	7.65	19.25	0.001*	7.65	19.25	0.001*	8.93	11.67	0.520	8.93	11.67	0.520
RTS	7.58	6.27	<0.001*	7.58	6.27	<0.001*	7.44	7.10	0.396	7.44	7.10	0.396
ISS	13.27	27.0	<0.001*	13.27	27.0	<0.001*	14.56	20.0	0.240	14.56	20.0	0.240
Length of ICU stay (days)	4.67	7.75	0.19	4.67	7.75	0.190	6.75	6.0	0.770	6.75	6.0	0.770

[Table/Fig-3]: Table comparing the outcomes with continuous variables.

¹Significant at p<0.05, ¹t-test

BMI: Body mass index; RTS: Revised trauma score; ICU: Intensive care unit; ISS: Injury severity score

As per chi-square analysis, a significant association was seen between wound infection, wound dehiscence, anastomotic leak and intra-abdominal abscess with requirement of ICU stay and the presence of associated injuries with a p-value of <0.05 [Table/Fig-4,5].

Variables studied	Sub-categories	Wound infection		Wound dehiscence		Chi-square
		Chi-square	p-value	Chi-square	p-value	
Gender	Female	0.021	0.886	0.021	0.886	0.536
	Male					
Co-morbidities	Absent	1.405	0.236	1.405	0.236	1.014
	Present					
ICU care	No	15.165	<0.001*	15.165	<0.001*	10.952
	Yes					
Associated injuries	No	15.165	<0.001*	15.165	<0.001*	10.952
	Yes					
Pre hospital care	No	2.921	0.087	2.921	0.087	0.016
	Yes					
Intraoperative findings	Hollow viscous perforation	1.01	0.061	1.01	0.061	2.917
	Solid organ injury					
	Others					

[Table/Fig-4]: Table comparing the outcomes with categorical variables (Wound infection and Wound dehiscence).

¹Significant at p<0.05

Variables studied	Sub-categories	Anastomotic leak		Intra abdominal abscess	
		Chi-square	p-value	Chi-square	p-value
Gender	Female	0.536	0.464	0.536	0.64
	Male				
Co-morbidities	Absent	1.014	0.314	1.014	0.314
	Present				
ICU care	No	10.952	0.001*	10.952	0.001*
	Yes				
Associated injuries	No	10.952	0.001*	10.952	0.001*
	Yes				
Pre hospital care	No	0.016	0.9	0.016	0.9
	Yes				
Intraoperative findings	Hollow viscous perforation	2.917	0.233	2.917	0.233
	Solid organ injury				
	Others				

[Table/Fig-5]: Table comparing the outcomes with categorical variables (Anastomotic leak and Intra abdominal abscess).

¹Significant at p<0.05

have shown that BMI was not an independent risk factor for predicting any complication after trauma laparotomy [24,25]. In a study by Wei S et al., on a large population of trauma laparotomy patients, it was found that there was no statistically significant association between BMI and organ/space and superficial surgical site infections [26].

In various studies, there was clear cut association between co-morbidities and postoperative complications in elective surgeries [27,28]. However, in this study the association between co-morbidities

DISCUSSION

The present study was aimed to identify factors for predicting postoperative abdominal septic complications following trauma. In the present study, there was no association of age with septic

and septic abdominal complications did not reach statistical significance. This can be hypothesised because of the predominant role of other associated factors and severity of injury when compared to patients' co-morbidities in dictating the septic complications in trauma surgery. In a previous study by Wang C et al., it was shown that co-morbidities were associated with increased mortality in trauma which was not evaluated in this study [27].

The time interval between trauma and surgery had a significant association with wound infection and dehiscence in the present study. Studies have shown that delay in the surgical intervention had increased risk of mortality and morbidity in surgical patients [29,30]. The time-lapse between trauma and surgery in this study ranged from 1 to 32 hours, indicating that patient transport and referral systems should be improved in our country.

Scoring systems in trauma have shown to be associated with abdominal septic complications following trauma surgery in various studies [20,31-33]. In this study, a low RTS and high ISS score had a significant association with wound infection and wound dehiscence. In a study by Morales CH et al., RTS, ISS and Abdominal Trauma Index (ATI) score were associated with wound infections [20]. In a study by Croce MA et al., ATI and ISS were proved to be significantly associated with abdominal septic complications [26]. In a large German trauma registry analysis of 29,829 patients, it was found that septic patients of trauma had high ISS scores when compared with those without septic complications [8].

ICU stay was significantly associated with all septic abdominal complications in the present study. This was also proved in previous studies where admission to ICU was associated with deep and organ space infection [20,33]. Kusat M et al., have done a retrospective analysis of patients in the National Trauma Data Bank for 2007-2008 and have found a significant association between septic complications and ICU stay [33].

Patients with associated injuries apart from abdominal trauma had increased risk of abdominal septic complications in the present study. This can be explained by the presence of higher trauma scores in these patients and also the increased release of inflammatory mediators. Variables such as pre hospital care received, intraoperative findings and length of ICU stay had no significant association with abdominal septic complications following trauma laparotomy in this study. Prospective study design was the major strength of this study as many previous studies were retrospective and were based on the data available from trauma registries.

Limitation(s)

Small sample size was a major limitation of the present study which has also made sub-group analysis practically impossible. This study may have a centripetal bias as it was a single center study and our institute being a tertiary care referral center.

CONCLUSION(S)

Early recognition of septic abdominal complications following laparotomy for trauma is essential to reduce late onset mortality in trauma patients. In this present study, it was identified that delayed presentation after trauma, low RTS, high ISS, need for ICU stay and presence of associated injuries increased the risk of wound infection and dehiscence. Further, the need for ICU stay and the presence of associated injuries had a significant association with anastomotic leak and intra-abdominal abscess. In trauma, patients factors like low RTS score, high ISS score, need for ICU stay and the presence of associated injuries may help the surgeons to decide in which patients to go for techniques like delayed closure of the wound, stoma instead of bowel anastomosis which may help to reduce postoperative septic complications. Authors recommend a multi-centre study in the future with a bigger sample size to validate the results of the present study.

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