



Surgical Treatment versus Conservative Management of Splenic Rupture: Outcomes and Risk Factors

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ABSTRACT

Objective: This study aimed to evaluate the outcome and risk factors in operative and non-operative management of splenic injury.

Methods: This cross-sectional study was conducted on patients with traumatic splenic injuries who were hospitalized in Kashani Hospital (Isfahan, Iran) from 2017 to 2019. The studied variables were extracted from the medical records of the enrolled participants. The outcomes such as mortality complications and risk factors were compared based on treatment methods.

Results: A total of 240 patients were investigated. The mean age of the patients was 29.8±12.2, with 180 (77.5%) patients being men. 154 (64.2%) patients underwent operative treatment. The mortality rate was 18.9% and 4.6% among operative and non-operative groups ($p<0.001$). Complications were observed in 11.5% and 46.1% of non-operative and operative groups, respectively ($p<0.001$). Operative treatment inversely correlated with mortality ($p<0.001$) and complications ($p<0.05$). Splenic injury severity was correlated positively with mortality ($p<0.001$) and negatively with complications ($p<0.001$). Unstable hemodynamic status was positively correlated with complications ($p<0.001$). Age had a positive correlation with mortality ($p<0.001$) and complications ($p<0.001$). Male sex had a negative correlation with complications ($p<0.001$). GCS score and admission were positively correlated with mortality ($p<0.001$). There was no statistically significant correlation between correlated injuries and outcomes ($p\geq 0.05$).

Conclusion: Patients who received surgery had higher rates of mortality and complications. However, after controlling for confounders, operative treatment was found to be inversely correlated with mortality and complications.

Keywords: Splenic rupture; Conservative treatment; Splenectomy; Injuries.

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Introduction

Trauma kills over 4.5 million people annually, which accounts for 9.8% of Disability-Adjusted Life Years (DALYs) worldwide. Because trauma is partially preventable, it has a considerable impact on the disease burden. The gradual decrease in the proportion of trauma in the global burden of disease from 1990 to 2019 can be attributed to improvements in trauma patient care [1]. Blunt abdominal trauma is a prevalent type of trauma, accounting for roughly 80 % of abdominal injuries in the emergency department. Therefore, blunt abdominal trauma accounts for 13% of intra-abdominal injuries in patients referred to the emergency department [2]. The liver and spleen are the most often affected organs in blunt abdominal trauma [3]. The spleen is a highly vascular organ; therefore, damage to it can result in considerable bleeding from the parenchyma or the arteries and veins that supply it. The spleen plays a crucial role in lymphopoiesis [4]. The symptoms of a splenic injury could vary widely depending on the severity of internal bleeding. Patients might present with signs of tachycardia and hypotension due to hypovolemic shock. Other symptoms might be left upper quadrant soreness, widespread peritonitis, or left shoulder referred pain [5]. These injuries can lead to numerous complications and deaths [6].

Focused Assessment with Sonography for Trauma (FAST) can rapidly assist the early diagnosis by identifying intraperitoneal hemorrhage, particularly in hemodynamically unstable patients. However, intraperitoneal hemorrhage is not always evident in splenic injury. The primary diagnostic imaging for splenic injury is computed tomography, which not only identifies the intra-abdominal free fluid but also depicts the splenic parenchyma and its surrounding area [3, 7]. Computed tomography imaging plays a significant role in determining the best treatment method for splenic injury [8, 9].

Splenic injury can be managed surgically and non-surgically. Patients might require operational treatment due to hemodynamic instability, peritonitis signs, or more severe splenic injuries. Although selecting a proper treatment requires considering all the influential factors, hemodynamic stability and the absence of peritonitis signs are usually considered the primary conditions of conservative treatment. The American Association for the Surgery of Trauma (AAST) classified splenic injuries into five grades based on computed tomography findings. Patients with grade IV and V of splenic injuries usually undergo surgical treatment [10-12]. Although surgery is unavoidable in some cases, recommendations have been altered in recent years to preserve the spleen and favor conservative treatment over surgery [13, 14]. In recent decades, studies that have assessed the outcome of these two treatment methods and the factors influencing them in patients with different conditions indicated conflicting results [9, 15].

Selecting the proper treatment method for patients with splenic injury has been discussed in recent decades, with trends favoring preserving the spleen. Thus, it is necessary to investigate the outcomes of surgical and conservative treatments for splenic injury. Previous studies on the outcome of these treatment methods reported conflicting results. Therefore, the present study aimed to investigate the outcome and influential factors in patients with splenic injury treated with operative and non-operative methods.

Materials and Methods

This retrospective and prognostic cross-sectional study was conducted on patients who were hospitalized in Kashani Hospital (Isfahan, Iran) from 2017 to 2019 and were diagnosed with traumatic splenic Rupture.

The database of Kashani Hospital was used to identify eligible patients, and the required information was extracted from the patient's medical records. This information included demographics, the mechanism of trauma, the AAST splenic injury scores, which were evaluated and determined by a radiologist from the CT scan, taken on admission, the level of consciousness (based on the Glasgow Coma Scale [GCS]), signs of peritonitis in abdominal examination (generalized tenderness and/or guarding), and the vital signs during hospitalization in the emergency department (systolic blood pressure of lower than 90 mmHg, diastolic blood pressure of lower than 60 mmHg, or heart rate over 100 beats per minute were considered as unstable hemodynamics), initial laboratory findings, treatment method, hospitalization duration, number of blood transfusions received, outcome and complications (hemorrhagic shock, intestinal obstruction, infectious complications including pneumonia, sepsis, wound infection, urinary tract infection, deep vein thrombosis, pulmonary thromboembolism, hepatic or renal dysfunction, and intra-abdominal abscesses). The patients with a history of anticoagulant use, acute or chronic liver or kidney disease, cardiovascular or respiratory disease, as well as patients with conservative treatment failure (requiring additional and delayed procedures, such as splenectomy, splenorrhaphy, or angioembolization), and patients who initially underwent conservative treatment were excluded from the study.

The collected data were analyzed using SPSS software (version 28). Qualitative data were expressed as numbers and percentages. Quantitative data were presented as mean±SD. The Kolmogorov-Smirnov test was used to test the normality of the distribution. Inferential analysis was conducted using the independent t-tests, Chi-square test, and partial correlation analysis. A *p*-value of less than 0.05 was considered statistically significant.

Results

The study involved 270 patients. Among them, 19 patients (7.0%) were excluded due to the failure of conservative treatment, and 11 were excluded for other reasons. The failure rate of conservative treatment was 7.0%. A total of 240 patients were investigated. The mean age of the patients was 29.8 ± 12.2 years, and 180 (77.5%) patients were men. 154 (64.2%) patients received operative, and 86 (35.8%) received non-operative treatment. The patients' demographic characteristics, outcomes, and clinical and laboratory findings based on the treatment strategies are shown in Table 1.

According to Table 1, the sex distribution was different between the two groups. The relative frequency of men in the surgical treatment group was higher than those in the conservative treatment group ($p < 0.001$). The results showed that the injury scores of surgical cases were higher than

conservative patients ($p < 0.001$). Patients receiving surgical treatment had significantly higher rates of associated injuries ($p < 0.001$), unstable hemodynamic status ($p < 0.001$), and complications ($p < 0.001$). Furthermore, a higher proportion of patients treated surgically had a moderate and severe loss of consciousness than the conservative group ($p = 0.001$). Mortality was significantly higher among surgical group patients ($p = 0.002$). Patients in the conservative group were more likely to have peritonitis signs ($p < 0.001$). The proportion of trauma mechanisms differed significantly between the two groups ($p < 0.001$). The most common trauma mechanisms among the operative and non-operative groups were motorcycle (50.6%) and pedestrian (38.3%) accidents. By comparing the means of age, duration of hospitalization, and the number of blood transfusions required between the two groups, it was observed that patients who underwent surgical treatment required significantly more amounts of

Table 1. A Comparison of patients managed operatively and non-operatively

Variables		Total (n=240)	Non-operative treatment (n=86)	Operative treatment (n=154)	p-value
Sex	Male	186 (77.5%)	44 (51.1%)	142 (92.2%)	<0.001
	Female	54 (22.5%)	42 (48.8%)	12 (7.8%)	
AAST ^a Injury Score (according to admission CT scan)	1	19 (7.9%)	19 (22.1%)	0 (0)	<0.001
	2	25 (10.4%)	8 (9.3%)	17 (11.0%)	
	3	63 (26.2%)	33 (38.3%)	30 (19.48%)	
	4	89 (37.0%)	26 (30.2%)	63 (40.9%)	
	5	44 (18.3%)	0 (0)	44 (28.5%)	
Mechanism of trauma	Falling	26 (10.8%)	22 (25.5%)	4 (2.6%)	<0.001
	Sports	12 (5.0%)	8 (9.3%)	4 (2.6%)	
	Car Accident	62 (25.8%)	21 (24.4%)	41 (26.6%)	
	Motorcycle accident	78 (32.5%)	0 (0)	78 (50.6%)	
	Penetrating	21 (8.7%)	2 (2.3%)	19 (12.3%)	
	Pedestrian accident	41 (17.1%)	33 (38.3%)	8 (5.2%)	
Correlated injury	No	53 (22.0%)	40 (46.5%)	13 (8.4%)	<0.001
	Yes	187 (78.0%)	46 (53.5%)	141 (91.5%)	
Unstable hemodynamics	No	97 (40.4%)	81 (94.1%)	16 (10.3%)	<0.001
	Yes	143 (59.6%)	5 (5.9%)	138 (89.6%)	
Peritonitis signs	Yes	110 (45.8%)	2 (2.3%)	108 (70.1%)	<0.001
	No	130 (54.1%)	84 (97.6%)	46 (29.8%)	
GCS ^b	Mild (13-15)	160 (66.6%)	70 (81.4%)	90 (58.4%)	0.001
	Moderate (9-12)	53 (22.1%)	12 (14%)	41 (26.6%)	
	Severe (1-8)	27 (11.2%)	4 (4.6%)	23 (14.9%)	
Complications	No	160 (66.7%)	77 (89.5%)	83 (53.9%)	<0.001
	Yes	80 (33.3%)	9 (11.5%)	71 (46.1%)	
Outcome	Recovery	207 (86.2%)	82 (95.3%)	125 (81.1%)	0.002
	Death	33 (13.7%)	4 (4.6%)	29 (18.9%)	
INR ^b	High	192 (80%)	81 (94.2%)	111 (72.0%)	<0.001
	Normal	48 (20%)	5 (5.8%)	43 (27.9%)	
MCHC ^d	Low	240 (100%)	86 (100%)	154 (100%)	-
WBC ^e	Normal	240 (100%)	86 (100%)	154 (100%)	-
Age, Mean±SD		29.8±12.2	32.0±14.5	28.6±10.6	0.056
Hospitalization duration, Days, Mean±SD		4.4±2.2	4.2±2.3	4.6±2.2	0.308
Number of blood transfusions, Mean±SD		2.1±1	1.4±0.9	2.5±0.9	<0.001

^aAAST: American Association for the Surgery of Trauma; ^bGCS: Glasgow Coma Scale; ^cINR: international normalized ratio;

^dMCHC: mean corpuscular hemoglobin concentration; ^eWBC: White blood cell.

Table 2. Correlation of predictive factors and outcomes

Variables	Mortality		Complications	
	Correlation coefficient	p-value	Correlation coefficient	p-value
Operative treatment ^a	-0.244	<0.001	-0.137	0.039
AAST Injury Score (according to admission CT scan)	0.573	<0.001	-0.403	<0.001
Unstable hemodynamics	-0.027	0.690	0.522	<0.001
Age	0.268	<0.001	0.330	<0.001
Sex (Male against female)	0.054	0.420	-0.298	<0.001
GCS	0.459	<0.001	0.033	0.619
Correlated injuries	-0.045	0.500	-0.012	0.863

^aPartial correlation analysis was used.

blood transfusions ($p<0.001$), and no significant difference was found between the two groups in terms of age and duration of hospitalization ($p\geq 0.05$). Baseline laboratory findings showed that patients who underwent conservative treatment had higher INR levels ($p<0.001$).

Logistic regression analysis was initially considered to investigate the association between predictive factors and outcomes. However, due to the non-fulfillment of the conditions of this test, partial correlation analysis was used as an alternative. In analyzing the correlation between each variable and outcome, adjustments were made for the rest of the predictive factors (Table 2).

In comparison with non-operative treatment, operative treatment inversely correlated with mortality ($p<0.001$) and complications ($p=0.039$). Injury scores had a positive correlation with mortality ($p<0.001$) and a negative correlation with complications ($p<0.001$). Unstable hemodynamic status was positively correlated with complications ($p<0.001$). It was also observed that age had a positive correlation with mortality ($p<0.001$) and complications ($p<0.001$). Moreover, the male sex was inversely correlated with complications ($p<0.001$). GCS scores on admission were positively correlated with mortality ($p<0.001$). There was no statistically significant correlation between other predicting factors and outcomes ($p\geq 0.05$).

Discussion

Splenic injuries are among the most prevalent ones caused by abdominal trauma. Considering the immunological function of the spleen, the complications, and the risk of infections and thrombocytosis following splenectomy, current efforts are increasingly focused on preserving the spleen rather than splenectomy in traumatic cases [16, 17]. Despite the rising trend of selecting conservative over surgical management, determining the best treatment for each patient is yet undecided because conservative treatment necessitates intensive monitoring and can be associated with delayed bleeding, missed correlated injuries in the abdominal area in multiple traumas, and in some

cases increased mortality [18].

The primary goal of this study was to investigate the treatment outcomes of patients with traumatic splenic injuries undergoing surgical and conservative management. Studies showed that motorcycle accidents cause the majority of splenic injuries [19]. In our study, motorcycle accidents were the most common mechanism of trauma, and all of these patients underwent surgical treatment. The treatment method for a splenic injury is determined by the patient's hemodynamic stability, intra and extra-abdominal injuries, peritonitis signs, active bleeding, and injury severity [20]. In the present study, the most prevalent splenic injury score was grade 4 on the AAST spleen injury scale, and 70.7% of these patients, as well as all of those with grade five injuries, underwent surgical treatment.

Previous studies indicated higher grades of splenic injury as an independent risk factor for treatment failure. In assessing the correlation coefficients, the findings of the present study indicated that more severe injuries were associated with higher mortality rates, and this association was investigated regardless of the treatment method. Although patients who underwent surgical treatment had a higher risk of mortality and complications, after considering confounding variables, such as age, sex, level of consciousness, trauma grade, hemodynamic stability, and associated injuries, that could affect the outcomes, surgical treatment was found to be associated with lower risk of mortality and complications. In other words, the higher rates of mortality and complications in patients who underwent surgery were probably caused by the effects of age, sex, the severity of splenic injuries, unstable hemodynamics, more associated injuries, and lower consciousness levels on the outcome of these patients, rather than surgical management. This finding differed from most previous studies; the explanation for this discrepancy can be investigated in methodologies, statistical analysis, and the inclusion of numerous confounders [9, 21, 22]. Some studies that have shown poor outcomes in patients treated non-surgically attributed these poor outcomes to the improper management of these patients and delayed treatment of intra-abdominal

injuries [23-25].

Our findings revealed that patients with more severe splenic injuries were less likely to develop complications. In other words, considering the role of confounders, including age, sex, level of consciousness, grade of trauma, hemodynamic stability, and associated injuries, more severe splenic injury was correlated with fewer complications. Several studies demonstrated poor outcomes in patients with more severe splenic injuries [26, 27]. Regarding the inverse correlation of injury severity and complications, our findings were inconsistent with previous studies [28-30]. This difference could be attributed to the correlation between mortality and the severity of the injury. In other words, this disparity could be attributed to the death of some patients with more severe injuries before the incidence of any complication.

In the present study, all patients with unstable hemodynamics underwent operative treatment, and unstable hemodynamics were correlated with complications, which was consistent with previous studies [31, 32].

Our findings suggested that higher admission consciousness levels were positively correlated with mortality risk. According to emergency department treatment protocols, patients with altered levels of consciousness were considered critical, required immediate actions, and were prioritized over other patients [33, 34]. Therefore, it can be hypothesized that patients with loss of consciousness receive critical care in the emergency department, which leads to better outcomes.

The patient's age was positively and independently correlated with mortality and complications. Age has always been considered a significant factor in managing splenic injury. Non-surgical treatment in patients over 55 could be correlated with treatment failure and mortality. Elderly patients had decreasing biological reserves [35]. Age-related structural changes make spontaneous homeostasis unlikely and increase splenic fragility. Furthermore, previous studies marked age as an independent risk factor affecting the outcome of trauma patients [36].

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This study had some limitations. This study had a single-centered design. Furthermore, this study was conducted cross-sectional and did not provide information on the long-term outcomes of patients. For this purpose, conducting cohort studies in this field is required. Similarly, the present study did not investigate the failure of conservative treatment and its related factors, which was a major concern in managing splenic injury. Future studies should take into account the emergency department triage level as a potential confounding factor.

Despite these limitations, this study had some advantages. One of its strengths was adjusting multiple confounding variables in examining the correlation between treatment methods and outcomes, which was only marginally assessed in previous studies. This study assessed patients of one of the major trauma centers in Iran, which can help in the selection of suitable treatment methods for splenic injuries.

Declaration

Ethical approval: The present study was approved by the Isfahan University of Medical Sciences Research Ethics Committee (IR.MUI.MED.REC.1400.526) and was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

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