



Splenectomy proportions are still high in low-grade traumatic splenic injury

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ABSTRACT

Objective: The spleen is the most vulnerable organ in blunt abdominal trauma. Spleen-preserving treatments are non-operative management with or without splenic angioembolization, partial splenectomy, and splenorrhaphy. The aim of the present study was to determine the rate of SPTs and to evaluate the usefulness of Injury Severity Score after traumatic splenic injury.

Material and Methods: We searched our institution's database between May 2012 and December 2015. Patients' clinicopathological features, surgeon's title, type of treatment, admission and discharge dates, duration of surgery, intensive care unit requirement, and Glasgow Coma Scale were recorded.

Results: The mean age of patients was 33.36±11.58 years. Of the 33 patients, 26 (78.8%) were males, and 7 (21.2%) were females. Thirty (90.9%) had total splenectomy (TS), and 3 (9.1%) had spleen preserving treatment (2 Nonoperative management and 1 partial splenectomy). No fatal hemorrhage developed after nonoperative management. Exitus rates were 5/30 (15.1%) and 0/3 in the total splenectomy and spleen preserving treatment groups, respectively. Of the 18 hemodynamically stable patients, only 2 (11.1%) had spleen preserving treatment. Of the 19 patients with grade I–III splenic injury, only 3 (15.8%) had spleen preserving treatment. For academic and non-academic surgeons, spleen preserving treatment rates were 3/11 (27.3%) and 0/22 (0%), respectively ($p<0.05$). Injury severity score and mean arterial pressure, number of transfusions, control hematocrit, and GCS had statistically significant relationships.

Conclusions: Spleen preserving treatment proportions were low after traumatic splenic injury. Following trauma, guidelines will not only improve spleen preservation rates but also improve the overall health status of the patients and it will also prevent complications of splenectomy.

Keywords: Splenectomy, surgery, emergency, spleen-preserving treatment, trauma

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INTRODUCTION

The spleen is the most vulnerable organ in blunt abdominal trauma owing to its location and vascularization. Splenectomy is the only treatment for all splenic injuries before 1960 (1). However, spleen-preserving treatments (SPTs) including non-operative management (NOM) with or without splenic angioembolization (SAE), partial splenectomy, and splenorrhaphy have been gradually implemented in time.

The spleen has several critical functions according to its histological parts including the red pulp or white pulp. In the red pulp, it filters and removes senescent erythrocytes in the circulation and recycles iron for the production of new erythrocytes. In the white pulp, it functions as a secondary lymphoid organ and generates both humoral and cellular immune responses. Moreover, 30% of the total thrombocytes are sequestered in the spleen. After splenectomy, cytoplasmic inclusions, including Heinz or Howell–Jolly bodies, occur in the erythrocytes, and the number of granulocytes and thrombocytes start to increase. Complications of splenectomy include atelectasis, pancreatitis, post-operative hemorrhage, thromboembolism, portal vein thrombosis, and fulminant bacteremia (2).

The aim of the present study was to determine the rate of SPTs in our institution, which factors are effective on the treatment choice, and to evaluate the usefulness of Injury Severity Score (ISS) after traumatic splenic injury.

MATERIAL AND METHODS

The study was performed in accordance with the Declaration of Helsinki.

Patient selection

We searched our institution's database between May 2012 and December 2015 to identify patients who had total or partial splenectomy due to trauma. Data were collected from the institution's archive. Patients who had splenectomy due to non-traumatic causes were excluded from the study.

Data collection

We started to search our database from May 2012 because our electronic health record system was set up to the current database system. Patient name, gender, date of surgery, surgeon's title, academic or non-academic, type of treatment (NOM, partial splenectomy, or total splenectomy (TS)), admission and discharge date, duration of surgery, referral status from outside hospitals, intensive care unit (ICU) requirement, Glasgow Coma Scale (GCS), number of transfusions such as erythrocyte suspension (ES) and fresh frozen plasma (FFP), and injuries other than the spleen were recorded in an electronic database system.

Transfusions given between the induction of anesthesia and finalization of surgical operation were called perioperative transfusions, and the number of transfusions given during hospital stay was called total number of transfusions.

Table 1. Clinical and pathological features of the patients according to treatment choice

	Total splenectomy (n=30) Mean±SD or median (min-max)	Spleen-preserving treatment (n=3) (NOM: 2, partial splenectomy: 1) Mean±SD or median (min-max)
Mean age (year)	33.9±11.6	28±10.8
Gender		
Male	24 (80%)	2 (66.7%)
Female	6 (20%)	1 (33.3%)
Surgeon's title		
Non-academic surgeon	22 (73.3%)	0 (0%)
Academic surgeon	8 (26.6%)	3 (100%)
Hemodynamic status		
Stable	16 (53.3%)	2 (66.7%)*
Unstable	14 (46.7%)	1 (33.3%)*
Grades of splenic injury		
I-III	19 (65.5%)	3 (100%)
IV-V	10 (34.5%)	0 (0%)
ICU status		
Required	15 (50%)	1 (33.3%)
Not required	15 (50%)	2 (66.7%)
Median ISS	21 (4-75)	17 (9-22)
Median GCS	15 (3-15)	15 (14-15)
Median duration of surgery (min)	100 (50-165)	40 (40-40)
Mean hospital stay (days)	7 (0-31)	6 (5-7)
Median total ES	3.36 (0-18)	1 (0-2)
Median perioperative ES	1.27 (0-10)	0 (0-0)
Mean total FFP	1.77±1.87	1±1.73
Median perioperative FFP	0.46 (0-4)	0 (0-0)

*Hemodynamically stable patients were treated with NOM, and unstable patients were treated with partial splenectomy
SD: standard deviation; ICU: intensive care unit; ES: erythrocyte suspension; FFP: fresh frozen plasma; ISS: Injury Severity Score; GCS: Glasgow Coma Scale; NOM: non-operative management

We defined an academic surgeon according to the following criteria: a surgeon who works in a teaching hospital and giving lectures to medical students and/or residents and who supposedly follow current treatment guidelines. On the other hand, a non-academic surgeon was defined as a general surgeon who has no teaching responsibility.

Calculation of ISS

We searched all injuries other than the spleen from the patient files and determined the organ injury scales (Abbreviated Injury Scale scores) and ISS calculated for each patient according to Baker et al. (3).

Evaluation of hemodynamic stability

We calculated mean arterial pressures (MAPs) from the initial and control systolic and diastolic blood pressures (SBP and DBP) using the following formula: $MAP = 1/3 \times SBP + 2/3 \times DBP$. The control BP was measured after administering 500 to 1500 cc intravenous crystalloid infusion. We accepted operating room BP if there was no control BP in the emergency setting. Difference between the initial and control hemoglobin (Hb) and hematocrit (Hct) levels was calculated using the following formula: $((\text{initial Hb} - \text{control Hb}) / \text{initial Hb} \times 100)$ and $((\text{initial Hct} - \text{control Hct}) / \text{initial Hct} \times 100)$. Hemodynamic instability criteria were as follows: (1) a MAP level <65 mm Hg in the control BP and (2) an Hb or Hct difference percentage >20.

Grading of splenic injury

Our radiologist re-evaluated all patients' abdominal computed tomography (CT) scans according to the American Association for the Surgery of Trauma (AAST) grading system. Of the 33 patients, 29 had appropriate CT images for AAST grading. We also checked the pathology reports for the remaining patients for grading. One patient had no grading data available.

Our staff

Two professors, three assistant professors, and eight general surgeons were working in the department of general surgery while conducting this research.

Statistical analysis

We performed all statistical analysis after obtaining consultation from the Department of Biostatistics. Since SPTs are gold standards of treatment for grade I-II and recommended for grade III splenic injury and TS is recommended for grade IV-V injury according to the trauma guidelines, we categorized patients into grade I-III and grade IV-V to perform a better statistical analysis for the grades. We compared two categorical data with either Pearson chi-square or Fisher's exact test. To compare a categorical and a scale data, we used independent samples t or Mann-Whitney U tests. For the scale data, we used Pearson correlation test.

RESULTS

Of the 33 patients who had traumatic splenic injury, 26 (78.8%) were males, and 7 (21.2%) were females. The mean age of patients was 33.36 ± 11.58 years (ranging from 7 to 59 years). Of the 33 patients, 30 (90.9%) had TS, and 3 (9.1%) had SPT (2 NOM and 1 partial splenectomy). No fatal hemorrhage developed during the follow-up of the patients treated with NOM. Exitus rates were 5/30 (15.1%) and 0/3 in the TS and SPT, respectively. Eighteen (54.5%) were hemodynamically stable, and 15 (45.5%) were unstable. Of the 18 hemodynamically

Table 2. Clinical features of the patients with splenic injury according to academic vs non-academic surgeons

Clinical features of the patients	Academic surgeon (n=11)	Non-academic surgeon (n=22)	p
Mean age (year)	30.6±12.6	34.7±11.08	0.77
Gender			
Male	8 (72.7%)	18 (81.8%)	0.66
Female	3 (27.3%)	4 (18.2%)	
Grades of splenic injury			
I–III	8 (72.7%)	14 (63.6%)	1
IV–V	3 (27.3%)	7 (31.8%)	
Hemodynamic status			
Stable	5 (54.5%)	13 (59.1%)*	0.48
Unstable	6 (45.5%)	9 (40.9%)*	
Median ISS	22 (4–75)	17 (4–75)	0.3
ICU status			
Required	6 (54.5%)	10 (47.6%)	0.71
Not required	5 (45.5%)	11 (52.4%)	
Median GCS	14 (3–15)	15 (12–15)	0.03
Median duration of surgery (min)	90 (40–120)	100 (50–165)	0.68
Median duration of hospital stay (days)	5 (0–27)	7 (0–31)	0.32
Median no. of consultations	4.5 (1–7)	3 (1–7)	0.23
Median total ES (packs)	3 (0–18)	3 (0–9)	0.89
Median perioperative ES (packs)	2 (0–10)	1 (0–5)	0.62
Mean total FFP (packs)	2±1.55	1.55±1.99	0.51
Median perioperative FFP (packs)	0 (0–4)	0 (0–3)	0.78
Treatment type			
SPT	3 (27.3%)	0 (0%)	0.03
Total splenectomy	8 (72.7%)	22 (100%)	

ISS: Injury Severity Score; ICU: intensive care unit; GCS: Glasgow Coma Scale; ES: erythrocyte suspension; FFP: fresh frozen plasma; SPT: spleen-preserving treatment

stable patients, only 2 (11.1%) had SPT. Thirty-two out of the 33 patients' information were available for grading; 6 (18.8%) had grade I, 2 (6.3%) had grade II, 14 (43.8%) had grade III, 3 (9.4%) had grade IV, and 7 (21.9%) had grade V splenic injury. Of the 22 patients with grade I–III splenic injury, only 3 (15.8%) had SPT. Of the 18 hemodynamically stable patients, only 2 (11.1%) had SPT. The mean ISSs were 15.28±8.28 and 39.33 ± 28.1 (p>0.05) for hemodynamically stable and unstable patients, respectively. Sixteen (48.5%) patients needed ICU post-operatively. Regarding the surgeon's title, there were three academic vs six non-academic surgeons (Tables 1-3).

Patients' clinical features according to academic and non-academic surgeons were the following: mean ages were

Table 3. Clinical features of the patients according to hemodynamic status

	Stable	Unstable	p
Mean age (year)	33.6±10.4	33.06±13.2	0.89
Mean initial MAP	77.25±12.2	72.22±15.1	0.31
Median initial fluid replacement	1000 (500–3000)	1000 (500–3000)	0.63
Mean control MAP	85.38±15.37	71±19.4	0.04
Mean Hct change %	–0.44±26.3	27.4±15.2	0.02
Median total ES (packs)	2 (0–9)	4 (0–18)	0.08
Mean total FFP (packs)	1.16±1.65	2.3±1.9	0.07
Median perioperative ES (packs)	1 (0–5)	1 (0–10)	0.91
Median perioperative FFP (packs)	0 (0–3)	0 (0–4)	0.21
Median duration of surgery (min)	90 (50–165)	120 (40–120)	0.5
Mean ISS	15.28±8.28	39.33±28.1	0.08
Mean hospital stay (days)	9.94±7.9	5.86±5.08	0.96
Median GCS	15 (8–15)	15 (3–15)	0.63

MAP: mean arterial pressure; Hct: hematocrit; ES: erythrocyte suspension; FFP: fresh frozen plasma; ISS: Injury Severity Score; GCS: Glasgow Coma Scale

Table 4. Statistically significant correlations between ISS and other clinical factors

Variables	p	Correlation coefficient (r)
ISS		
Initial SBP	0.007	–0.46
Control SBP	0.02	–0.51
Initial MAP	0.02	–0.4
Control MAP	0.03	–0.37
Control Hct	0.04	–0.37
Perioperative ES	0.04	0.36
Perioperative FFP	0.04	0.36
Total FFP	0.007	0.46
GCS	0.001	–0.57

SBP: systolic blood pressure; MAP: mean arterial pressure; Hct: hematocrit; ES: erythrocyte suspension; FFP: fresh frozen plasma; ISS: Injury Severity Score; GCS: Glasgow Coma Scale

30.6±12.6 years and 34.7±11.08 years (p>0.05), grade I–III/IV–V proportions were 8/3 and 14/7 (p>0.05), hemodynamic stability/instability proportions were 5/6 and 13/9 (p>0.05), ICU requirements were 6 (54.5%) and 10 (47.6%) (p>0.05), median ISSs were 22 (4–75) and 17 (4–75) (p>0.05), median GCSs were 14 (3–15) and 15 (12–15) (p<0.05), and SPTs were 3 (27.3%) and 0 (0%) (p<0.05), respectively (Table 2).

ISS was negatively correlated with initial SBP (p: 0.007, r: –0.46), control SBP (p: 0.02, r: –0.51), initial MAP (p: 0.02, r: –0.4), control MAP (p: 0.03, r: –0.37), control Hct (p: 0.04, r: –0.37), and GCS (p: 0.001, r: –0.57); positively correlated with perioperative ES (p: 0.04, r: 0.36) and perioperative FFP (p: 0.04, r: 0.36) (Table 4).

DISCUSSION

Non-operative treatments with or without SAE, partial splenectomy, and splenorrhaphy are considered as SPTs. The advantages of spleen preservation are maintaining splenic function, avoiding post-splenectomy sepsis, and preventing thrombosis or laparotomy complications (4). Non-operative treatment was first used in pediatric splenic trauma in 1968 and is currently the gold standard of treatment in grade I-II splenic injury (1, 4, 5). The most important complication of NOM is delayed fatal hemorrhage; however, no delayed hemorrhage developed during the follow-up of our NOM patients who had grade III splenic injuries (6).

Jeremitsky et al. (7) investigated NOM success rates in 15.732 patients presenting with blunt splenic injury and reported that the overall splenic salvage rate is 81%, and the NOM success rate is 95% after 5 h of arrival. Dehli et al. (8) evaluated the success rate of SAE with NOM and reported that this combination decreases the rate of splenectomy. Nevertheless, Olthoff et al. (9) corrected the confounding factors using a propensity score while evaluating the success rate of SAE and found no significant difference between the patients who were observed and who had SAE.

The mortality rate of NOM for patients with grade I-II injury was found to be 0%. For grade III injuries, the mortality rate of NOM was found to be closer to operative managements. For grade IV-V patients, the NOM mortality rate was found to be higher than operative management (6, 10, 11). Since there was no contrast extravasation in abdominal CT images in grade III splenic injury and it is recommended by the guidelines, we tried to perform NOM in this group of patients. Thus, we categorized patients into grades I-III and IV-V, as mild and severe splenic injuries, to perform a better statistical analysis. In total, 3 patients with grade III splenic injury were treated with SPTs, with 2 NOM and 1 partial splenectomy, and all of them recovered with no complications in our study.

Several studies in Turkey reported spleen preservation rates ranging from 11% to 66% after a traumatic splenic injury (12-15). Koksall et al. (11) reported that the NOM rate for traumatic splenic injury is 12.2% between the years 1994 and 1997 in their institution and increases to 76.9% between the years 1998 and 2000 with a 100% NOM success rate. Arikan et al. (13) reported that traumatic splenic injuries are treated 89% with TS, 7% with splenorrhaphy, and 4% with partial splenectomy between the years 1992 and 1998 in their institution. Moreover, Yanar et al. (14) investigated the effective factors on NOM success rate and stated that the initial lactate level, solid viscus score, transfusion requirement, fluid replacement, and Hct change are significant factors. Furthermore, Topaloglu et al. (15) reported that the ratio of complications, including wound infection, lung infection, pneumothorax, urinary infection, and re-laparotomy, after a traumatic splenic injury is 18.06%.

Factors that influence the treatment choice after traumatic splenic injury have not been identified in the literature. One study from Olthof et al. (16) reported that SAE and surgery rates vary in five different academic hospitals; however, no effective factor was identified in the treatment choice. We found in our study that academic surgeons performed more

SPT than non-academic surgeons even if the proportions were still low, 27% vs 0%. This relationship may be due to the fact that academic surgeons follow trauma guidelines better, take more surgical risks in their hospital settings, or are younger surgeons than non-academic surgeons. Academic surgeons' responsibility for resident and medical student training may lead them to perform contemporary procedures.

University hospitals, training and research hospitals, community hospitals, private hospitals, newly established affiliated hospitals, and union of university and community hospitals are types of hospitals in Turkey. Some institutions have been leading in modern treatment methods in Turkey such as university and training and research hospitals. However, to our knowledge, there is no study that compared the NOM rates for splenic injuries among these institutions, and there may be different rates of NOM among these institutions. Nevertheless, SPT proportion for patients who had low-grade splenic injury or patients who were hemodynamically stable is still very low and needs to be improved to be consistent with trauma guidelines. Moreover, our study is a unique study that investigated the factors affecting SPTs after traumatic splenic injury and may give rise to further investigations in this topic.

Furthermore, we also investigated the importance of ISS in traumatic splenic injury and found that it was significantly correlated with the initial and control SBPs and MAPs, number perioperative ES and FFP, total FFP, control Hct, and GCS. Therefore, it appears that calculating ISS for patients with trauma in an emergency room may assist physicians to determine the prognosis of the patient, required number of transfusions, or even the need for ICU requirement.

CONCLUSION

We found in our study that SPT proportions were still very low in traumatic splenic injury. This management is inconsistent with trauma guidelines. Surgeons should be more careful about following trauma guidelines to improve the overall health status of the patients and to prevent complications of splenectomy.

Ethics Committee Approval: The authors declared that the research was conducted according to the principles of the World Medical Association Declaration of Helsinki "Ethical Principles for Medical Research Involving Human Subjects."

Informed Consent: Written informed consent was obtained from patient who participated in this study.

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