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Nonoperative management of blunt splenic injury: a rural hospital experience

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ABSTRACT

Aims: Nonoperative management (NOM) of blunt splenic injuries in adults has become a standard approach in hemodynamically stable patients. We aimed to investigate the reliability of NOM and the risk factors for failure of NOM.

Methods: Included in the present study were 97 patients who underwent NOM for blunt splenic trauma between 2014 and 2022, whose computed tomography (CT) images, treatment, number of transfused erythrocyte suspensions, complications, duration of hospital stay and mortality data were evaluated retrospectively. The cases that underwent laparotomy due to NOM failure (group OP, n: 20), and those in whom NOM was successful (group NOM, n: 77) were statistically compared.

Results: Among the patients, nine were female and 88 were male, with a mean age of 23.7 years. The CT grade was higher in the OP group than in the NOM group (p: <0.001); the number of patients with multiple organ injuries was significantly higher in the OP group (p: 0.026); the number of ES transfused patients was significantly higher in the OP group (p<0.001); and the duration of hospital stay was longer in the OP group (p<0.001). The CT grade and number of ES transfusions (cut off >0.5 units) were determined as risk factors for NOM failure based on a receiver operating characteristic analysis (p<0.001). There were no differences between the groups in terms of complications, ICU admissions and mortality

Conclusion: Non-operative management is a safe and effective protocol in cases of blunt splenic trauma. High grade injury and the quantity of transfused erythrocyte suspensions (>0.5 units) were found to be predictive for NOM failure.

Keywords: Blunt trauma, computerized tomography, non-operative management, splenic injury

INTRODUCTION

The spleen is one of the most commonly injured organs following blunt abdominal trauma. The treatment of blunt splenic trauma has been subject to much discussion in recent decades, and protocols have changed substantially. Nonoperative management (NOM) is accepted as the standard care approach in some centers.[1,2] The accepted criteria for the application of NOM are hemodynamic stability, absence of signs of peritonitis and absence of no other injury requiring laparotomy. The single absolute contraindication for NOM is the presence of hemodynamic instability, although polytrauma, high grade splenic injury and the presence of a large hemoperitoneum have also been reported to be risk factors for NOM failure.[3,4]

Besides these criteria, factors such as the experience of the surgeon, the type of hospital and access to the required blood products are effective in decisions to follow a NOM approach, while the feasibility, indications and risks in selecting NOM in such instances are less clear. The present study evaluates the results of NOM in blunt splenic trauma, and analyzes the risk factors for NOM failure.

METHODS

The study was carried out with the permission of the Dicle University Faculty of Medicine Non-interventional Clinical Researches Ethics Committee (Date: 12.12.2022, Decision No: 27). We obtained an informed consent form from all patients for procedure. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. Retrospective analysis was performed on patients who were hospitalized between January 2014 and September 2022 at the Şırnak State Hospital. A total of 97 patients, all of whom were over the age of 18 years, with blunt splenic trauma and who were applied NOM at admission were included in the study. Excluded from the study were patients with penetrating traumas, those below the age of 18 years, those operated on with an urgent laparotomy at admission, those who died before the total diagnostic work-up was completed, those with non-survivable brain injuries and those with missing data in their medical records (n: 14).

The patient demographics, computed tomography (CT) images, treatment approaches, number of transfused blood products, duration of hospital stay and mortality data were recorded. The

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NOM group and the group of patients who were operated on due to failure of NOM (group OP) were statistically compared to determine the risk factors for surgery. In addition, the grade of splenic injury on CT and the intraoperative injury grade in the patients who underwent surgery were compared and correlations were analyzed.

The CT images of all patients were evaluated retrospectively by the same radiologist, who had 8 years of experience. The splenic injury grade was determined based on the American Association for the Surgery of Trauma (AAST) splenic injury scale.[5] An increase of at least 50% in hemoperitoneum in a follow-up CT was considered a sign of progression. NOM failure was defined as the need for laparotomy in patients initially admitted to the ICU or ward for nonoperative treatment. Mortality was accepted as death within 30 days of the trauma. The number of transfused erythrocyte suspensions (ES) was calculated taking into account only the preoperative ES replacements, while intraoperative and postoperative ES replacements were excluded.

Statistical Analysis

The statistical analyses were performed using IBM SPSS Statistics (Version 25.0. Armonk, NY: IBM Corp.). A histogram analysis and Kolmogorov-Smirnov test were used to evaluate whether the variables were normally distributed. Descriptive statistics were expressed as mean, standard deviation, median, and min-max. Categorical variables were compared with a Pearson's Chi-square test. A Mann-Whitney U test was used for a between-group comparison of variables with a non-normal distribution (nonparametric). A Spearman's Correlation test was used to analyze numerical data. The values with the potential to predict the OP group were evaluated with a ROC analysis. The correlations between the intraoperative and CT grades of splenic trauma were assessed with a Kappa correlation analysis. The level of statistical significance was set at $p<0.05$.

RESULTS

Among the patients, nine were females and 88 were male, with a mean age of 23.77±9.54 years. Of the total, 33 had signs of multiple traumas. A total of 83 patients underwent a second CT evaluation, with a mean interval between the first and follow-up CT of 12.75±4.17 hours. NOM failure was recorded for 20 patients who underwent surgery (group OP) while 77 patients were recorded as successful NOM. Among the patients, 46 were admitted to the ICU. The mean duration of hospital stay in the total series was 4.64±2.05 days with a mortality rate of 4.1% (n: 4) (Table 1).

No significant differences were noted in age or gender between the NOM and OP groups. The CT grade of splenic injury was significantly lower in the NOM group ($p<0.001$). The patients in the NOM group had mostly grade 2 injuries, while grade 3 injuries were most common in the OP group. The number of patients with a "sign of progression on follow-up CT" was significantly higher in the OP group ($p<0.001$), and another significant parameter in the OP group was presence of multiple traumas (p:0.026). The most common injury other than splenic injury was, in descending order, the thorax (n: 14) followed by the liver (n: 11). The mean number of ES transfused preoperatively was 1.25±0.85 and 0.31±0.57 in the OP and NOM groups, respectively ($p<0.001$). The most commonly observed complications were pulmonary complications and infective complications (n: 4, each) (Table 2). No significant difference was noted in the rate of complications between the two groups. No overwhelming post-splenectomy infection (OPSI) or sepsis developed in any of the cases in the OP group. The duration of hospital stay was shorter in the NOM group ($p<0.001$), while there was no significant difference in the mortality rates of the two groups (Table 3). All four patients who died had multiple traumas, and the cause of death was secondary to other organ injuries.

Table 1. Main demographic. clinical and radiological data (n: 97)

		n (%)/mean±SD
Age		23.77±9.54
Gender	Male	88 (90.7)
	Female	9 (9.3)
CT grade	1	20 (20.6)
	2	52 (53.6)
	3	20 (20.6)
	4	5 (5.1)
Control CT		83 (85.6)
Control CT interval (hour)		12.75±4.17
Progression in control CT		21 (25.3)
Multiple trauma		33 (34.0)
Complications		10 (10.3)
Number of ES		0.51±.74
Intraoperative grade	1	0 (0)
	2	1 (5)
	3	15 (75)
	4	4 (20)
ICU admission		46 (47.4)
Length of hospital stay (day)		4.64±2.05
Mortality		4 (4.1)

SD: Standard deviation, CT: Computed tomography. ES: Erythrocyte suspension. ICU: Intensive care unit

Table 2. Type of complications

Type of complication	OP group, n (%)	NOM group, n (%)
Pulmonary	1 (5)	3 (3.9)
Infective	2 (10)	2 (2.6)
Hemorrhagic shock	1 (5)	-
Ileus	1 (5)	-

OP: Postoperative, NOM: Nonoperative management

The CT grade and the number of ES transfused were identified as significant predictive factors for NOM failure ($p<0.001$) (Table 4). The CT grade cut-off value was determined to be >2.5, with 85% sensitivity and 89.61% specificity. The cut-off value for the number of ES transfused was determined to be >0.5, with 80% sensitivity and 74.03% specificity.

The CT grade and intraoperative grade in the OP group was evaluated, and a positive correlation was noted between them (r: 0.764), and a significant correlation was found between the two grades (Ḱ: 0.657) (Table 5).

Table 3. Comparison of demographic, radiological and clinical features between NOM and OP groups

		OP group n/mean±SD	NOM group n/mean±SD	p
Age		25.65±9.57	23.29±9.53	0.1291
Gender (Male/Female)		18/ 2	70/7	0.9012
CT grade	1		20	<0.001
	2	3	49	
	3	14	6	
	4	3	2	
Control CT		18	65	0.5272
Progression in control CT		14	7	<0.0012
Multiple trauma		11	22	0.0262
Complication		4	6	0.1102
Number of ES		1.25±0.85	0.31±0.57	<0.0011
ICU admission		13	33	0.0772
Length of hospital stay (day)		7.95±1.90	3.78±0.88	<0.0011
Mortality		2	2	0.1382

[1]Mann-Whitney U test, [2]Chi-square test, OP: Postoperative, NOM: Nonoperative management, SD: Standard deviation, CT: Computed tomography, ES: Erythrocyte suspension, ICU: Intensive care unit

Table 4. ROC analysis of predictive parameters for failure of NOM

				95% CI						
	Area	SD error	p	Lower	Upper	Cut-off	SEN	SPE	PPV	NPV
CT grade	0.889	0.041	<0.001	0.810	0.969	>2.5	(85.00)	(89.61)	(68.00)	(95.83)
Number of ES	0.803	0.060	<0.001	0.685	0.920	>0.5	(80.00)	(74.03)	(44.44)	(93.44)

ROC: Receiver operating characteristic, NOM: Nonoperative management, SD: Standard deviation, SEN: Sensitivity, SPE: Specifitiy, PPV: Positive predictive value; NPV: Negative predictive value

Table 5. The relationship and compliance between CT grade and intraoperative grade in the OP group

		Intraoperative grade		
		2	3	4
CT grade	2	1	2	-
	3		13	1
	4			3

Grade 2	Grade 3	Grade 4	Total	r[1]	Ḱ[2]	p
100%	86.67%	75%	85%	0.764	0.657	<0.001

[1]Spearman correlation test, [2]Kappa compliance analysis, CT: Computed tomography, OP: Postoperative

DISCUSSION

The spleen is the most commonly damaged organ in blunt abdominal traumas, and is affected in around 33% of patients with traumatic abdominal injuries.[6,7] The standard treatment of splenic injury has been splenectomy for the last 100 years, while NOM has gained popularity since the late 1980s. Currently, more than 80% of adult patients with blunt splenic traumas are managed nonoperatively.[3]

The spleen is a highly efficient immunological organ, and contributes substantially to the development of primary and secondary immune responses through antibody production against antigens, mediated by the T and B lymphocytes that are present intensely in its white pulp. Furthermore, macrophages in the spleen perform phagocytosis, and remove foreign antigens and immune complexes though phagocytosis. The spleen is an organ with regulatory functions affecting plasma volume and albumin synthesis, and has a rich reticular structure and a large reservoir function. The most feared complication of splenectomy is therefore OPSI, which develops in 3-5% of splenectomy cases.[8] Most infectious complications are caused by encapsulated bacteria (*Meningococcus*, *Pneumococcus and Hemophilus)*, and there is a further tendency for thrombosis to develop due to the increase in platelet, fibrinogen and tissue plasminogen activator inhibitor-type 1 levels following splenectomy.[9] Thrombotic complications frequently include pulmonary embolism, porto-mesenteric system thrombosis and caval system thrombosis.

Surgeons tend to opt for spleen-preserving methods due to the vital functions of the spleen and the complications secondary to splenectomy. Partial splenectomy, splenorrhaphy and splenic artery embolization as para-surgical treatment methods may be applied, while NOM is accepted as the standard treatment for blunt splenic trauma in some centers. Consensus on the contraindications for NOM have been reached, being hemodynamic instability and peritonitis.[10,11] Franseva et al.[1] reported NOM to be inappropriate for patients with an Abbreviated Injury Scale >3, while Godley et al.[12] reported NOM to be contraindicated in patients aged >55 years.[13] The failure rate for NOM was reported to be 2.5 times greater in patients aged >55 years than in those aged <55 years in a multicenter study of 1,488 patients, while Cocanour et al.[14] concluded in their retrospective study reported similar rates of NOM failure in those aged >55 years and younger patients. Age was found not to be a risk factor for NOM failure in the present study.

Smith et al.[4] reported high-grade splenic injury and large hemoperitoneum to be risk factors of NOM failure. In a study of 94 cases with grade 4 splenic trauma, NOM was suggested to be safe for the treatment of such cases, provided a rigid protocol was followed.[15] The CT grade in the OP group was higher in the present study and the CT grade was determined to be a risk factor for NOM failure. Also revealed in the present study was that CT grading in cases of splenic trauma was compatible with actual intraoperative grading. The reliability of CT in this area and the experience of the radiologist with the CT signs of splenic trauma are important in planning the optimal treatment.

Generally, the NOM failure rate is accepted to be increased in multiple solid organ injuries in literature.[10] Malhotra et al.[16] reported higher rates of NOM failure, a greater transfusion requirement and more frequent mortality in patients with multiple organ injuries. In contrast, Sartorelli et al.[17] reported the outcome of NOM in patients with multiple parenchymal trauma to be no different to that of NOM in unique splenic injury. In the present study, multi-organ injury was found not to be a risk factor for NOM failure, although the ratio of patients with multiple organ trauma was higher in the OP group.

A transfusion of 2 units of blood to keep the hemoglobin level above 8 g/dl in the first 48 hours may be sufficient for successful NOM, although a ≤4 unit blood transfusion has been reported as the standard criteria for NOM in some studies.[14,18,19] The amount of blood transfused was found to be significantly higher in the OP group, with a blood transfusion of >0.5 units (above the cut-off number) being a significant risk factor for NOM failure in the present study.

Treatment with angioembolization in blunt spleen traumas is a widely applied method in the last 2-3 decads. To avoid surgery

and preserve splenic parenchyma, selective splenic artery embolization is increasingly being used in haemodynamically stable patients with evidence of ongoing haemorrhage on contrast-enhanced computed tomography. It has been reported in the literature that it can be applied in grade 3-4-5 splenic injuries.[20] Sclafani believes that this procedure is compatible with the maintenance of splenic immune function and even if surgery is necessary, splenorrhaphy is facilitated.[21] Since there is no interventional radiology department in our hospital, splenic angioembolization could not be performed.

A review of the current literature reveals that there are numerous predictive scoring systems for identifying NOM failure.[22] One such system, which incorporates variables such as Glasgow coma scale, systolic blood pressures, abdominal injury score and injury severity score (ISS) at the time of patient presentation, has demonstrated that a score of 5 or higher is predictive of NOM failure.[23] Since these parameters were not included in our study, the predictive value of these scoring systems could not be evaluated in our research.

Limitations

The study has some significant limitations, the first of which is its retrospective, single center study design the low number of patients. Second, several patients (n: 14) were excluded from the study due to missing data in their medical records, and ISS, Glascow coma scale score parameter, which has been evaluated in most studies on the subject in literature, was not included in the analysis for the same reason. Another limitation is the absence of an evaluation of the long-term outcome of the patients.

CONCLUSION

Nonoperative management can be considered a safe and effective protocol in cases of blunt splenic trauma. AAST CT grade, frequency of multiple organ injury and blood transfusion amounts were found to be higher and the duration of hospital stay to be longer in patients with NOM failure, which was also predicted by high-grade injury and transfused erythrocyte suspension amounts exceeding 0.5 units.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Dicle University Faculty of Medicine Non-interventional Clinical Researches Ethics Committee (Date: 12.12.2022, Decision No: 27).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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