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# Independent risk factors for failure of non-operative management in patients with splenic injury

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## Abstract

**Objective:** It is crucial to assess non-operative management (NOM) of risk failures before it is preferred as a management option for treatment of splenic trauma or rupture. The purpose of this study is to investigate the outcome of non-operative management of splenic trauma, and to determine the independent predictive factors effecting NOM failure.

**Material and Methods:** Seventy-seven patients among all of consecutive patients admitted with splenic trauma between January 2005 and June 2015 were included in the study. The patients were divided into two groups. Group 1: Successfully treated with non-operative management, and Group 2: The failure of non-operative management. Data recorded included patient demographics, vital signs, injury mechanism, Injury Severity Score (ISS), splenic trauma grade, hematologic parameters, Glasgow Coma Scale (GCS), transfusion requirements, and length of hospital stay.

**Results:** There were 66 (85.7 %) patients in group 1, while only 11 patients (14.3%) in group 2. Mechanism of injury was blunt in seventy-one patients and, penetrating in 6 patients. ISS [Odds Ratio=1.293; 95% CI=1.045-1.601; p=0.018] and blood transfusion [Odds Ratio=2,739; 95% CI= 1.140-6,581; p=0.024] were detected to be an independent predictive factors for the failure of non-operative management. Group 1 has significantly higher hospitalization period (7.73±2.867 vs 6.67±2.289).

**Conclusions:** Non-operative management failure risk is crucial and higher in patients with high ISS and in patients who require much blood transfusion in first 24 hours. Special attention should be paid to these patients if non-operative management becomes the preferred management option.

**Key words:** Non-Operative Management, NOM, Splenic Rupture, Risk Factors

## Introduction

The spleen is one of the most commonly injured organs in abdominal trauma. Historically, the best treatment option for patients with traumatic splenic injury was splenectomy (1). Procedures for preservation of the spleen have attracted more attention since the description sepsis of post-splenectomy by Singer (2).

Developments in the intensive care units and in the field of radiology have provided an opportunity for application of spleen preservation procedures and non-operative management (NOM). Nowadays, the standard treatment choice of hemodynamically stable patients with blunt splenic trauma is NOM, although it is associated with a potential risk of failure.

The greatest advantage of NOM is the preservation of splenic function.

In many studies, 78-98% success rates for NOM have been described (1, 2, 3, 4, 5). However, many risk factors have been described in the literature that may lead to failure of NOM. Hemodynamic instability, age above 55 years, multiple organ injuries, higher splenic trauma grade, Injury Severity Score (ISS) and transfusion requirement, lower blood pressure and GCS at admission, degree of hemoperitoneum, and contrast extravasation are patient-related factors frequently reported to be associated with failure of NOM (1, 6). However, there is no consensus on the predicting factors that may lead to NOM failure.

In this study, the outcomes of splenic trauma of NOM were retrospectively investigated and determined the independent predictive factors effecting NOM failure.

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## Material and Methods

The study was conducted at the Dicle University after approval of study by the ethical committee. A total of 256 patients with splenic trauma had been admitted to our clinic during January 2005 to June 2015. Patients who received NOM treatment and met the following criteria were included in the study; hemodynamically stable, no demonstrable peritoneal irritation finding on physical examination, and no injuries on computed tomography (CT) scans requiring operative intervention. All but unstable patients were evaluated with imaging modalities like ultrasonography (US) and CT. Exclusion criteria are factors like high bleeding risk such as coagulopathy, use of anticoagulants. A total of 77 patients with splenic trauma meeting the above criteria were included in the study.

Records of these patients were retrospectively evaluated. Patient demographics, vital signs, injury mechanism, Injury Severity Score (ISS), splenic trauma grade, hematologic parameters, Glasgow Coma Scale (GCS) score, transfusion requirements, and length of hospital stay were recorded. This data was then compared between two groups which were defined as Group 1; patients were successfully treated with NOM and Group 2; patients requiring operation due to the failure of NOM. Patients were monitored closely in an intensive care unit or monitored setting. Oral intake was restricted, parenteral fluids were given, and bed rest was ordered. Immediate operation were performed when patients exhibited any abnormality requiring operative management like instable hemodynamic condition, continuing bleeding, or positive peritoneal irritation signs. American Association for the Surgery of Trauma (AAST) classification was used for grading splenic trauma (7).

### Statistical analysis

SPSS package program (SPSS for Windows 16.0, SPSS Inc. Chicago, IL) was used for statistical analysis. Chi square or Fischer's exact test was used for comparisons of percentages, while independent t-test was used for the mean values. Multivariate regression analysis was used to detect the independent factors effecting failure of NOM of splenic trauma. A $p < 0.05$ was accepted as being statistically significant.

## Results

NOM procedures were followed for a total of 77 patients. However, NOM had failed in 11 patients (14.3%), and splenectomy was performed. The clinical finding and patients' demographics are demonstrated in Table 1. Mechanism of injury was blunt in seventy-one patients, and penetration in six in injuries. Mean length of hospital stay was 6.67±2.289 for group I, 7.73±2.867 for Group II. There were no mortalities.

While patient demographics, vital signs, GCS, number of additional organ injury were not different at a statistically significant level between the groups in a univariate analysis, Splenic trauma grade, ISS, Hg levels, and transfusion requirements were different. So they entered into a multivariate logistic regression analysis. ISS [Odds Ratio (OR) =1,293; 95% Confidence Interval (CI) = 1,045-1,601; p=0.018] and blood transfusion [Odds Ratio (OR) = 2,739; 95% Confidence Interval (CI) = 1,140-6,581; p=0,024] were determined to be independent predictive factors for the failure of NOM (Table 2). Length of hospital stay was significantly higher in Group 1 than in Group 2 (6.67±2.289 vs 7.73±2.867).

**Table 1**: Comparison of demographic and clinical characteristics of the patients

| | Group 1(NOM) (n = 66) | Group 2 (NOM failure) (n = 11) | P value |
|---|---|---|---|
| Age (years) | 30.86±11.124 | 30.91±14.543 | 0.484 |
| SBP(mmHg) | 112.27±13.103 | 100.91±11.362 | 0.271 |
| ISS | 5.64±3.728 | 15.36±6.652 | 0.018 |
| GCS | 13.88±1.504 | 13.55±1.508 | 0.167 |
| Grade of splenic injury n (%) | | | |
| I | 20 (30.3%) | 0 | |
| II | 35 (53%) | 1(%9) | <0.0001 |
| III | 7 (10.6%) | 5 (45.5%) | |
| IV | 4 (6.1%) | 5 (45.5%) | |
| Hgb (g/dL) | 12.58±1.683 | 10.21±1.600 | 0.699 |
| Blood transfusion (IU)* | 0.62±1.212 | 2.82±0.751 | 0.024 |
| EAI | 23 (34.8%) | 6 (54.5%) | 0.314 |
| IAI | 27 (40.9%) | 6 (54.5%) | 0.515 |
| LS(days) | 6.67±2.289 | 7.73±2.867 | 0.001 |

*SBP: Systolic blood pressure, ISS: Injury Severity Score, GCS: Glasgow Coma Scale, EAI: Extraabdominal organ injury, IAI: Intraabdominal organ injury, LS: Length of Stay in Hospital *Within first 24 hours*

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**Table 2**: "Binary Logistic Regression" to detect predictors for the failure of non-operative treatment

| Variables | Odds Ratio | 95% Confidence Interval (Lower-Upper) | p Value |
|---|---|---|---|
| ISS | 1.293 | (1.045-1.601) | 0.018* |
| Grade of splenic injury | 1.042 | (0.064-17.005) | 0.977 |
| SBP(mmHg) | 0.952 | (0.851-1.065) | 0.388 |
| Hgb levels | 0.853 | (0.381-1.909) | 0.699 |
| Blood transfusion | 2.739 | (1.140-6.581) | 0.024* |

*ISS: Injury Severity Score SBP: Systolic blood pressure.*
**ISS and blood transfusion was significant independent predictive factor for non-operative management.*

## Discussion

The NOM of splenic trauma has gained increasing acceptance in adults recently [8]. The benefits of NOM of splenic trauma include the followings: preservation of splenic function, avoidance of overwhelming post-splenectomy sepsis, avoidance of potential postsplenectomy thrombocytosis and avoidance of the risks associated with nontherapeutic laparotomy [9]. It is critically important to predict in which patients NOM will fail. However, the absence of a consensus regarding which patients NOM should be administered requires further study. A positive correlation was founded between the splenic trauma grade and NOM failure in many studies (1, 10, 11, 12, 13).

217 patients were identified splenic trauma grade of 3 or higher on CT as an independent predictive factor for failure of NOM by Velmahos et al (14). However, it was reported that trauma grade was not identified as a predictive factor for failure of NOM 815). We found the correlation between splenic trauma grade and NOM failure to be statistically significant but the splenic trauma grade was detected not to be predictive factor for NOM failure our study. We attribute this to the bias we have as we were inclined to administer NOM on lower grades of splenic trauma.

There is no consensus in the literature regarding the relationship between NOM failure rates and the number of blood transfusion requirements. In a study, more than 1 IU of RBC transfused was identified as predictive factor for failure of NOM [14]. Velmahos et al [14] also identified the higher failure rate in patients who were transfused more than 1 IU of RBC. Also, Sartorelli et al. (16) proposed that the failure rate is higher in patients who received more than 4 IU of RBC. Boyuk et al (10) proposed that the failure rate is higher in patients who received more than 2 IU of RBC. Hsieh et al (17) reported that patients with a low hemoglobin level at admission and a high number of transfusion requirement in the intensive care unit were predictive for NOM failure.

In the review of Olthof et al. (1), no evidence was found between hemoglobin/hematocrit levels and predictive factors for NOM failure in patients with blunt splenic trauma. In our study, the rate of NOM failure was higher in patients who required more than 2 IU of RBC in first 24 hours.

NOM is not proper management option in elderly patients, especially 55 years and over (18,19, 20). Rodrigeus et al (21), proposed that contraction and retraction of intra-parenchymal vessels are limited due to less elastic splenic capsule with increasing age. Failure of NOM may occur due to restricted splenic distention in the spleens of the elderly (10). In the report of Renzulli et al. (22), where they investigated the factors leading to NOM failure in patients with blunt splenic trauma, age over 40 years was the only independent predictive factor for failure of NOM. Whereas, age was not found to be limiting factors for NOM administration in many other studies (11, 12, 13, 14). Similarly, we also found age to not be a factor leading to NOM failure.

In the past, patients with altered mental status were not treated conservatively because of overlooked intra-abdominal injuries that might require laparotomy. According to Pal [24] the CT scans represent a very effective diagnostic method for hemodynamically stable patients with altered mental status. In our study GCS was not different between the two groups. In eight studies, where Systolic Blood Pressure (SBP) was analyzed (11, 14, 17, 19. 24, 25, 26, 27), only one study determined a correlation between failed NOM and statistically significantly lower SBP in admission (12).

Rosati et al (9) reported patients managed by immediate splenectomy had a significantly lower SBP as compared with those managed by NOM. The proportion of patients who presented with an SBP of <90 was also significantly higher in the group managed by immediately splenectomy. There was no difference between SBP of two groups compared in this study.

In review of Olthof et al. (1), ISS was found to be a strong prognostic factor for failure of NOM in patients with traumatic blunt splenic trauma. ISS was suggested as an independent predictor of failure by Bee et al. (27) and Malhotra et al. (29).

Velmahos et al. (14) observed a higher mean ISS in patients with NOM failure. ISS of greater than 25 was statistically significant in a univariate analysis. However it was not an independent predictive factor in multivariate analysis. It was demonstrated that patients who failed NOM were more likely to have 25 or higher ISS values (1). In the study of Rosati et al (9), patients undergoing immediate splenectomy had a higher ISS as well as higher morbidity and mortality rates compared to patients successfully managed non-operatively. In our study, ISS was found to be an independent predictive factor for failure of NOM.

Gender is not considered as an important factor for NOM failure in the literature. However, one study determined a higher NOM failure in men (11). Gender was not found to be a predictive factor in our study.

Although NOM approaches have been considered as standard of care in hemodynamically stable patients with blunt splenic trauma for a long time, it is also being increasingly utilized in patients with penetrating abdominal trauma, including the settings of solid organ injury. Despite this evolution of clinical practice in penetrating splenic trauma, safety and efficacy of NOM is not known exactly (26). In addition to blunt trauma, NOM also can be applied for penetrating traumas. Dematriades et al (30) applied it liver in 28.4% of selected patients, kidney in 14.9%, and spleen in 3.5%. In our study, seventy-one patients who suffered from blunt and, six from low-grade penetrating injuries were treated non-operatively.

Hospitalization in NOM of splenic trauma varies between 3 to 7 days, if no other injuries are present to elicit a prolonged stay (31). NOM failure increased length of hospital stay and increased mortality in selected subsets of patients (9, 32). Accordingly, NOM has shorter length of hospital stay than operative management in patients with isolated solid organ injuries (30). In contrast, the length of hospital stay of NOM group was shorter in this study.

There are no comprehensive guidelines for management and follow-up of patients who were planned for NOM in evidence-based setting (33). In the report of Renzulli et al. (22), patients with splenic trauma were admitted to an intermediate care unit the first 24–48 hours. Hemoglobin was measured per four-six hours in the first day and daily after that, and 1–7 days bed rest was recommended. Restrictions on the activities of patients after discharge varied between 4 and 12 weeks based on the grade of splenic trauma and the demand of the activity. Strict bed rest for 48–72 hours and then limited bed rest for one week were recommended by the Renzulli et al (22), and patient's injuries and status depended limitations were prescribed.

## Conclusion

Currently, NOM is the standard treatment for treating hemodynamically stable patients with splenic trauma without additional traumas which require laparotomy. We found the chance of NOM failure to be higher in patients with a higher ISS, and in patients requiring blood transfusion in first 24 hours. Special attention should be paid to these patients when they are treated with NOM approaches. Predicting NOM failure reduces the frequency of non-operative treatment failure, especially in severe splenic trauma; however, it is still necessary to perform prospective, randomized clinical investigations.

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