Original Article

# Outcomes of Nonoperative Management of Splenic Injury: A Retrospective Cohort from a Level 1 Trauma Center in Thailand

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## Abstract

**Background and Objectives:** Nonoperative management (NOM) of splenic injury is the standard treatment for all splenic injury patients who are hemodynamically stable. However, it may be a challenge in developing countries with limited intensive care resources. This study aimed to review the outcomes and identify the factors of unsuccessful NOM of splenic injury in a Level 1 trauma center in Thailand. **Materials and Methods:** This was a retrospective review that collected data from the trauma registry. The enrolled patients had a splenic injury and underwent NOM from 2009 to 2016. Failure of NOM was defined as the need for an operation on the spleen after NOM. The outcomes of NOM were described, and the predictors for failure of NOM were identified. **Results:** Seventy-two splenic injury patients were included in the study. The majority of patients were involved in a motorcycle crash (56%). The average injury severity score was 20. Fifty-nine patients (89%) were successfully treated as NOM. Six patients underwent embolization (8%), and none of the patients required operative management. Univariate analysis showed that hemoperitoneum in ≥4 regions (odds ratio [OR] 3.96, 95% confidence interval [CI] 0.79–25.53; ($P = 0.05$) and received packed red cells >2 units within 24 h (OR 20, 95% CI 2.15–242; $P = 0.003$) were significantly associated with failure of NOM. **Conclusions:** NOM of splenic injury can be performed successfully in a trauma center in a developing country. Splenic angioembolization might be helpful to increase the success rate. The amount of hemoperitoneum was a significant predictor of failed NOM.

**Keywords:** Angioembolization, hemoperitoneum, splenic injury

## Introduction

Traffic injury is a major problem in Thailand. Over 17.4% of world deaths are from traffic injury[1] and 30% to 40% died from bleeding. Abdominal organ injuries are found in 20% to 30% of patients with multi-organ injuries. Splenic injury is the most common intra-abdominal organ injury (46%).[2] Blunt splenic injury has various options for therapeutic treatment depending on the hemodynamic condition and associated organ injuries.

In the past, splenectomy was the standard treatment in traumatic splenic injury, but the current treatment is nonoperative management (NOM) with observation and splenic embolization for patients who are hemodynamically stable. NOM was driven by the desire to avoid the risk of postsplenectomy sepsis,[3] morbidity, and mortality associated with laparotomy.[4]

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Splenic angioembolization (SAE) is the standard treatment for hemodynamically stable patients with splenic injury when a CT shows contrast extravasation. SAE increases the preservation of the spleen after injury. In hemodynamically stable patients, NOM was successful in 60%–90%.[5] With proper case selection, the embolization failure rate and mortality decreased.[6] A meta-analysis favored SAE.[7]

The aim of this study was to demonstrate outcomes of NOM in a Level 1 trauma center in Thailand and identify the predictors of failed NOM and the complications after NOM.

## Materials and Methods

### Study design

This was a retrospective cohort study that included all splenic injury patients from the period January 2009 to December 2016. The patients presented at the emergency department of Songklanagarind Hospital which is a university-based teaching hospital and a Level 1 trauma center in Thailand. The study was approved by the ethics committee of the Faculty of Medicine, Prince of Songkla University (REC No. 59-359-10-4).

### Population

Adult patients defined as >15 years old who underwent NOM were enrolled in the cohort. The excluded patients were those transferred from outside hospitals and those patients whose medical records were either incomplete or irretrievable. Patients who died immediately at the emergency department or patients who were taken to the operation room for other reasons and died were excluded from the study.

### Outcomes

Successful NOM was defined as observation or embolization without operation. Serious complications were defined as life-threatening complications or complications that needed interventions or close observations such as operation, splenic infarction, or splenic pseudoaneurysm that were defined by radiologist reports. The complications were followed from the time of injury until the last computed tomography (CT) abdomen or 1 month after injury in cases that did not have a follow-up scan. Minor complications were defined as nonlife-threatening complications that did not require interventions. Complications were collected until patients were discharged. In case of minor complications such as pleural effusion and fever, deep vein thrombosis, urinary tract infection, and bowel perforation, the collected data were the individual parameters, physiology of the initial presentation, and severity of injury. The Injury Severity Score (ISS) was used to classify the overall severity of the patients. Score above 25 was defined as critical injury. Grading of splenic injury was defined by the American Association for the Surgery of Trauma. The locations of hemoperitoneum were classified into six regions: (1) perisplenic space, (2) perihepatic space, (3) right paracolic gutter, (4) left paracolic gutter, (5) cul-de-sac in pelvis, and (6) inter-bowel loop. All imaging studies were reviewed by a radiologist.

### Statistical analysis

Continuous variables were reported by mean and with standard deviation or median with interquartile range. Categorical variables were presented as percentage. Univariate analysis was performed to identify potential factors of risk of failed NOM. $P < 0.05$ was considered to be statistically significant. The statistical analyses were conducted using the statistical software R-studio version 3.4.1 (R Foundation, Austria). A two-sided p-value of < 0.05 was considered statistically significant.

## Results

A total of 257 patients were evaluated for splenic trauma from January 2009 to December 2016. Seventy-two patients who underwent NOM were enrolled in the study. The details of the patient enrolment are shown in Figure 1. Sixty-two patients (86%) were successfully treated as NOM, and failed NOM occurred in ten patients (14%). Of the six patients who underwent SAE and one patient failed embolization. Nine patients (12.5%) were lost to follow-up after hospital discharge.

Ten patients experienced failed NOM. Six patients (60%) needed a splenectomy. One patient underwent splenorrhaphy with hepatorrhaphy, one patient had electrocautery at the surface of spleen, and two patients had mesenteric injury and no future management of the splenic injuries.

The mean ISS was 19.4 in the success group and 25.4 in the failure group ($P = 0.054$). The most common mechanism of injury was motorcycle crash. Head injury was the most common associated organ injury. The greatest number of patients in the hemoperitoneum region of 5 occurred in the success group, whereas in the failure group, most patients had a hemoperitoneum region of 6. Patients in the failure group had longer intensive care unit stay (2.5 vs. 0, $P = 0.051$). The mortality rate from NOM was 0. The patient characteristics are shown in Table 1, and the severity of injury is demonstrated in Table 2.

The univariate analysis showed that patients who received packed red cells >2 units in 24 h (odds ratio [OR] 20, 95% confidence interval [CI] 2.15–242; $P = 0.003$) and had hemoperitoneum more than 4 regions had a higher risk of NOM

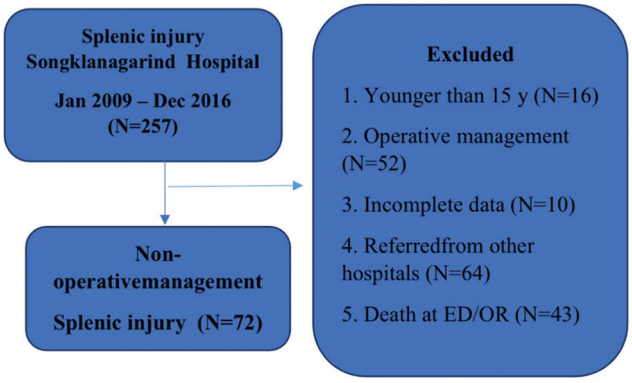


**Figure 1:** Patients enrolment

**Table 1: Demographic and clinical characteristics of patients**

| Variables | NOM | | *P* |
|---|---|---|---|
| | Failure (*n*=10), *n* (%) | Success (*n*=62), *n* (%) | |
| Sex | | | |
| Male | 6 (60) | 48 (77.4) | 0.255* |
| Female | 4 (40) | 14 (22.6) | |
| Mechanism | | | |
| MCC | 6 (60) | 37 (59.7) | 0.885* |
| MCV | 3 (30) | 11 (17.7) | |
| Falling | 1 (10) | 9 (14.5) | |
| Body assault | 0 | 5 (8.1) | |
| Other organ injuries | | | |
| Chest | 2 (20) | 13 (21) | 1.0* |
| Liver | 5 (50) | 24 (38.7) | 0.51* |
| KUB | 0 | 19 (30.6) | 0.054* |
| Head | 5 (50) | 36 (58.1) | 0.736* |
| Extremities | 2 (20) | 23 (37.1) | 0.477* |
| Vascular | 0 | 1 (1.6) | 1* |
| Systolic blood pressure | 120.5 (15.2) | 117 (27.8) | 0.955‡ |
| Heart rate | 97.7 (23.7) | 93 (17.7) | 0.47‡ |
| Units of blood transfusion (24 h) | 2 (1.2, 3.8) | 0 | <0.001‡ |
| Units of blood transfusion (48 h) | 2.5 (2, 3.8) | 0 (0, 0.5) | <0.001‡ |
| Initial hematocrit | 35.6 (5.1) | 39.7 (5.3) | 0.025† |
| ICU length of stay (days) | 2.5 (0, 3) | 0 (0, 1) | 0.051‡ |
| Total length of stay (days) | 11 (9.2, 34.2) | 11 (6, 17.8) | 0.257‡ |

*Chi-squared test, †*t*-test (mean±SD), ‡Wilcoxon rank-sum test. MCC: Motorcycle crash, MCV: Motor vehicle accident, SD: Standard deviation, NOM: Nonoperative management, ICU: Intensive care units, KUB: kidney, ureter, and bladder

**Table 2: Severity of injury of study patients**

| Severity of injury | NOM | | *P* |
|---|---|---|---|
| | Failure (*n*=10), *n* (%) | Success (*n*=62), *n* (%) | |
| Grade spleen injury (AAST score) (%) | | | |
| I | 1 (10) | 12 (19.4) | 0.133* |
| II | 3 (30) | 27 (43.5) | |
| III | 3 (30) | 19 (30.6) | |
| IV | 2 (20) | 4 (6.5) | |
| V | 1 (10) | 0 | |
| Hemoperitoneum region (%) | | | |
| 0 | 0 | 3 (4.8) | 0.209* |
| 1 | 0 | 9 (14.5) | |
| 2 | 0 | 4 (6.5) | |
| 3 | 0 | 11 (17.7) | |
| 4 | 3 (30) | 12 (19.4) | |
| 5 | 3 (30) | 16 (25.8) | |
| 6 | 4 (40) | 7 (11.3) | |
| Injury Severity Score (SD) | 19.4 (9) | 25.4 (9.4) | 0.054† |

*Fisher's exact test, †*t*-test (mean±SD). SD: Standard deviation, AAST: American Association for the Surgery of Trauma, NOM: Nonoperative management

failure (OR 3.96, 95% CI 0.79–25.53; $P = 0.05$). More details of the univariate analyses are shown in Table 3.

Six patients underwent SEA and most complications after embolization were splenic infarction and pleural effusion. All NOM patients underwent CT abdomen 7 days after the injury.

One patient (case 6) had successful embolization but underwent splenectomy because of hemodynamic instability. A hemoperitoneum of 500 mL was found intraoperatively with splenic injury grade II. The details of the patients who underwent splenic embolization are shown in Table 4.

## Discussion

Splenic trauma has a high incidence, and NOM is the new standard treatment in hemodynamically stable patients.[8]

**Table 3. Frequency of risk factors in study patient**

| Variables | NOM | | OR | | *P* |
|---|---|---|---|---|---|
| | Failure (*n*=10), *n* (%) | Success (*n*=62), *n* (%) | Parameter | 95% CI | |
| Age (≤60) | 9 (90) | 60 (96.8) | 3.33 | 0.5-68.86 | 0.32 |
| SBP≤90 (mmHg) | 1 (10) | 3 (4.8) | 0.46 | 0.03-26.66 | 0.508 |
| Heart rate (>110) | 10 (16.1) | 3 (30) | 2.23 | 0.31-11.93 | 0.29 |
| Hemoperitoneum region ≥4 | 7 (70) | 23 (37) | 3.96 | 0.79-25.53 | 0.05 |
| Grade spleen >II | 6 (60) | 23 (37) | 2.54 | 0.53-14.43 | 0.171 |
| Receiving PRC >2 units within 24 h | 4 (40) | 2 (3.2) | 20 | 2.15-242 | 0.003 |
| Hct ≤30 | 1 (10) | 1 (1.61) | 0.15 | 0-12.8 | 0.134 |

NOM: Nonoperative management, OR: Odd ratio, Hct: Hematocrit, SBP: Systolic blood pressure, CI: Confidence interval, PRC: Packed red cells

**Table 4: Cases of splenic embolization and complications**

| Case | Age | Grade splenic injury | CT finding splenic injury | Hemoperitoneum grade | Complications | Treatment |
|---|---|---|---|---|---|---|
| 1 | 24 | III | Contrast extravasation | 2 | Splenicinfarction (D7) Pleural effusion (D6) | PCD* |
| 2 | 44 | I | Contrast extravasation | 2 | Splenicinfarction (D5) Pleural effusion (D5) | Observation |
| 3 | 30 | III | Contrast extravasation | 3 | - | - |
| 4 | 17 | II | pseudoaneurysm | 2 | Splenic infarction | Observation |
| 5 | 20 | IV | Splenic laceration | 2 | - | - |
| 6 | 30 | III | Pseudoaneurysm | 3 | Failed embolization | Splenectomy |

PCD: Percutaneous catheter drainage, CT: Computed tomography

Therefore, the frequency of NOM has increased in patients with splenic injuries. Over an 8-year period, NOM of splenic injury has been successful in our hospital. The proportion of open surgery to splenectomy has decreased. The overall complication rate was low and no mortalities resulted from NOM in this study population.

NOM in our hospital was highly successful (86%), and the overall complication rate was low compared with other reports. In a report from the ReCONECT study,[9] the success rate of NOM was 62%, and a study from Smith *et al*. reported a success rate of 78%.[10] The success rate in the embolization group in this current study was 83% which was similar to another report that preserved the spleens in 71%.[5] Haan *et al*.[11] reported a 92% success rate of NOM with splenic embolization in 40 of 126 patients with angiographic evidence of vascular injury. Hemoperitoneum was a significant factor to predict failure of NOM which correlated with previous data.

The major complication after NOM was splenic infarction. Most major complications in previous reports were bleeding and splenic infarction.[12,13] The number of patients who had complications after NOM was very few. However, in this study, the nine patients lost to follow-up after discharge may have had undetected complications. Pleural effusion was the most common minor complication that occurred after NOM, which correlated with a study from Ekeh *et al*. that reported pleural effusion, fever, and coil migration were common complications.[1] However, only one patient in this current study required percutaneous catheter drainage for pleural effusion.

A limitation of this study is that our hospital admits few patients with splenic injury even though our hospital is a trauma center. Most patients were transferred to our hospital for further management and these patients were excluded from our study.

## Conclusions

NOM of splenic injury can be done successfully in a high-level trauma center in a developing country. Embolization might be helpful to increase the success rate. The amount of hemoperitoneum and the number of blood products that patients received in the first 24 h were significant predictors for failed NOM.

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### Conflicts of interest

There are no conflicts of interest.

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