Blunt Splenic Trauma: Predictors for Successful Non-Operative Management

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Abstract

Background: Non-operative management of blunt splenic trauma is the preferred option in hemodynamically stable patients.

Objectives: To identify predictors for the successful non-operative management of patients with blunt splenic trauma.

Methods: The study group comprised consecutive patients admitted with the diagnosis of blunt splenic trauma to the Department of Surgery, Hadassah-Hebrew University Medical Center in Jerusalem over a 3 year period. Prospectively recorded were hemodynamic status, computed tomography grade of splenic tear, presence and extent of extra-abdominal injury, number of red blood cell units transfused, and outcome. Hemodynamic instability and the severity of associated injuries were used to determine the need for splenectomy. Hemodynamically stable patients without an indication for laparotomy were admitted to the Intensive Care Unit and monitored.

Results: There were 64 adults (45 males, mean age 30.2 years) who met the inclusion criteria. On univariate analysis the 13 patients (20.3%) who underwent immediate splenectomy were more likely to have lower admission systolic blood pressure (P = 0.001), Glasgow Coma Scale < 8 (P = 0.02), and injury to at least three extra-abdominal regions (P = 0.06). Nine of the 52 patients (17.3%) who were successfully treated non-operatively suffered from grade ≥ 4 splenic tear. Multivariate analysis identified admission systolic BP (odds ratio 1.04) and associated injury to less than three extra-abdominal regions (OD 8.03) as predictors for the success of non-operative management, while the need for blood transfusion was a strong predictor (OR 66.67) for splenectomy.

Conclusions: Admission systolic blood pressure and limited extra-abdominal injury can be used to identify patients with blunt splenic trauma who do not require splenectomy and can be safely monitored outside an ICU environment.

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Over the past few decades, refinement of the indications for non-operative treatment of splenic trauma, the inclusion of more severe splenic injuries for non-operative treatment, and the progress of minimally invasive techniques for the care of the injured patient have been explored. Currently, non-operative management has been the most common method of splenic salvage [1]. Conservative, non-operative management remains the cornerstone of treating hemodynamically stable blunt splenic injury. The benefits of splenic conservation are well recognized, including elimination of the risk of overwhelming post-splenectomy sepsis, as well as avoiding potentially unnecessary surgery and the complications of laparotomy [2,3].

Recently published reports suggest that conservative management should be applied to patients younger than 55 years with low grade splenic injuries, who are hemodynamically stable and have no neurological impairment [2,3]. Other authors question the significance of associated injuries and computed tomography grading as predictors of outcome [4]. The present study was undertaken to assess the safety of a protocol for non-operative management of blunt splenic trauma. The secondary goal was to identify predictors for the successful management of these patients.

Patients and Methods

From February 2002 to February 2005 all consecutive patients with blunt splenic trauma who were admitted to the Department of General Surgery and Trauma Unit at the Hadassah-Hebrew University Medical Center were included in the study. Data including patient demographics, mechanism of injury, hemodynamic parameters upon admission, laboratory data, imaging studies, interventions, blood transfusions, associated injuries, Intensive Care Unit and overall stay, morbidity and mortality were prospectively collected. Inclusion criteria were blunt splenic trauma and age above 15. Patients with hypothermia (core temperature < 34°C) on admission or during resuscitation, and those requiring emergency room thoracotomy were excluded.

Focused abdominal sonogram for trauma was performed in all patients by a radiologist. The diagnosis and grading of splenic injury was established on CT or at laparotomy. CT scans were read by a senior radiologist during working hours and by a junior radiologist after hours. CT scan interpretation was performed according to criteria of the Association for the Surgery of Trauma for the Organ Injury Scaling Committee [5]. Repeat CT scan of the abdomen to evaluate the degree of splenic healing was performed a week and a month after injury.

The decision to perform splenectomy was taken by the attending trauma surgeon based on factors such as hemodynamic

BP = blood pressure
OD = odds ratio
ICU = Intensive Care Unit

stability, degree of splenic injury on CT, and presence and severity of associated injuries. Currently, head injury is not considered an indication for splenectomy. However, the cognitive impairment associated with head injury is believed to obscure the diagnosis of intra-abdominal injury, mainly bowel injury. Thus, the presence and severity of head injury was used by several of the trauma surgeons to determine the need for splenectomy. Hemodynamic instability was defined as systolic blood pressure < 90 mmHg despite adequate fluid replacement. Patients who were managed non-operatively were monitored in the Intensive Care Unit. Bed rest for 5 days was initiated for patients with injuries graded 3 or higher. Standard of care consisted of infusion of crystalloid fluids or packed red blood cells as required to keep systolic blood pressure > 90 mmHg and hemoglobin concentration > 8 g/L. For patients suffering from ischemic heart disease hemoglobin was kept > 10 g/L. Deep venous thromboembolism prophylaxis was achieved with an intermittent pneumatic compression device or an inferior vena cava filter.

Associated injuries were divided into five anatomic regions (head and face, thorax, pelvic fracture, extremity fractures, and spine fractures). The median number of regions injured for all patients was one, and the interquartile range was 1–3. We therefore defined injury to three or more regions as "injury to multiple regions." Definitive treatment of associated injuries such as fractures and soft-tissue injury was performed after consultation with the attending trauma surgeon.

Primary outcome was the success of initial non-operative management. Secondary outcome was morbidity and evaluation of independent factors that predict immediate splenectomy in blunt trauma patients. Data are presented as median and interquartile range. Fisher's exact test was used to compare proportions and the Mann-Whitney *U* test was used to compare continuous variables. Predictors for the success of non-operative treatment were analyzed using multivariate backwards logistic regression analysis. Statistical significance was accepted for $P < 0.05$. Statistical analysis was performed using the SPSS version 11.5 (Chicago, IL, USA).

Results

During the study period 70 patients above the age of 15 were admitted to the Hadassah-Hebrew University Medical Center with blunt splenic trauma. Six patients were excluded from the study for the following reasons: immediate laparotomy performed due to bowel and/or mesenteric tear (three patients), laparotomy due to liver bleeding with packing (two patients), and a non-therapeutic laparotomy performed for suspected bowel injury (one patient). These six patients suffered from minor splenic tears that stopped bleeding and did not require splenectomy. Of the 64 patients in the study 45 were males (70.3%), with a mean age of 30.2 years (range 15–85 years). Mechanism of injury was motor vehicle accident in 64.1% of patients (41/64). The patients were grouped into those who underwent splenectomy within 12 hours of admission defined as the splenectomy group, and patients selected for non-operative management. There were 13 patients (20.3%) in the splenectomy group; the remaining 51 patients (79.7%) were admitted with planned non-operative management of splenic injury. No failure was observed in this group.

Indications for splenectomy were hemodynamic instability (n=7) or splenic injuries associated with severe head injuries (n=5). Six of the 13 patients (46.2%) were unstable upon arrival and taken immediately for splenectomy. One patient who was unstable initially was taken for splenectomy after failure of angiographic embolization of the splenic artery. Five patients (38.5%) with splenic injury and severe head trauma underwent splenectomy. One patient (7.7%) with a diaphragmatic tear required splenectomy due to continuous bleeding from a splenic tear. For 12 of the 13 patients (92.3%) splenectomy was performed within 4 hours of admission. One patient initially underwent angiographic embolization of the splenic artery which failed and surgery was performed 8 hours after admission.

Splenectomy group vs. non-operative group

Demographic data were similar for patients in both groups [Table 1]. Significantly more patients in the splenectomy group had a systolic blood pressure < 90 mmHg, high grade splenic tears (CT grade ≥ 3), and Glasgow Coma Scale < 8. Injury severity score was also significantly higher for patients in the splenectomy group. The majority of patients in both groups had extra-abdominal injuries (100% in the splenectomy group and 80.4% in the non-operative group). Three or more injured regions were recognized in 46% of patients in the splenectomy group vs. 17.6% in the non-operative group ($P = 0.06$) [Figure 1]. CT grading of splenic injury is shown in Figure 2. In the non-operative group there were 7 (13.7%) with grade 4 injuries and 2 patients (3.9%) with grade 5 injuries. Of the 13 patients in the splenectomy group, 7 (53.8%) underwent CT [Figure 2]. High grade splenic injuries (≥ 4) were significantly more common in the splenectomy group compared to the non-operative group – 5/7 patients (71.4%) vs. 9/51 patients (17.6%), respectively, $P < 0.001$). Twelve patients (92.3%) in the splenectomy group received transfusion of red blood cells in the first 24 hours compared with 8 patients (15.7 %) in the non-operative group ($P < 0.001$). The number of red blood cell units transfused was also significantly higher in

Table 1. Demographic and clinical characteristics of patients with blunt splenic trauma

	Non-operative group (n=51)	Splenectomy group (n=13)	*P*
Males (%)	36 (71)	9 (69.2)	NS**
Age (yrs)	25 (19–40.5)	27 (20–30)	NS*
Systolic BP (mmHg)	130 (116.5–145)	112 (106–117)	0.001*
Heart rate/min	93 (81.5–109)	112 (81–128)	0.10*
Lowest hemoglobulin in first 24 hrs (g/L)	11.4 (9.8–12.8)	9.3 ± 1.37	0.002*
Injury Severity Score	21(5–50)	36(17–57)	0.0001*
≥ 3 regions injured	9 (17.6%)	6 (46.1%)	0.06**
Glasgow Coma Scale < 8	5 (9.8%)	5 (38.5%)	0.023**

Data shown as median and (interquartile range).

* Mann-Whitney *U* test

** Fisher's exact test.

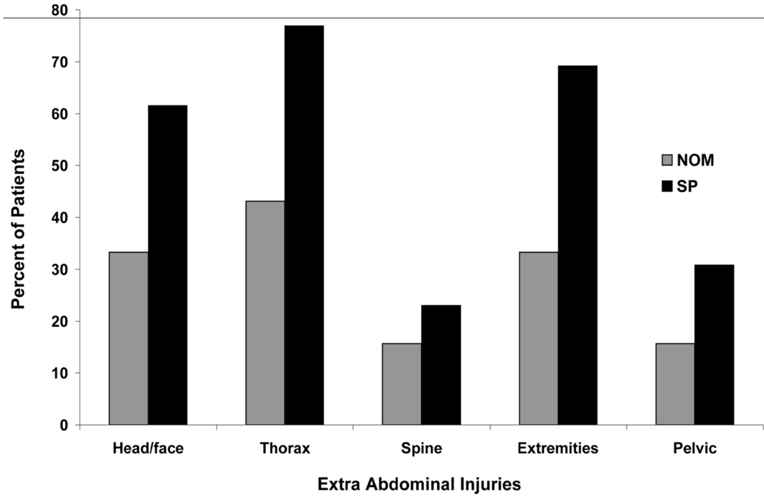

Figure 1. Associated extra-abdominal injuries in non-operative management (NOM) and splenectomy (SP) groups.

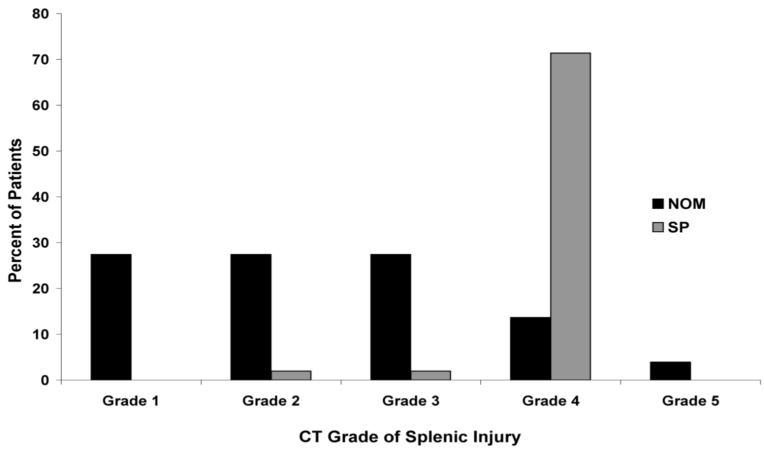

Figure 2. Grading of splenic injury in non-operative management (NOM) and splenectomy (SP) groups.

Table 2. Comparison of length of stay and complications

	Non-operative group (n=51)	Splenectomy group (n=13)	*P*
Length of stay (days, median)			
ICU	2 (0–27)	10 (1–34)	0.05*
Hospital	10 (2–60)	22 (1–75)	0.06*
Morbidity, No. (%)	8 (15.6%)	6 (46.1%)	0.03**
Mortality, No (%)	0	2 (15.4%)	0.02**

Data shown as median and (interquartile range).
* Mann-Whitney *U* test
** Fisher's exact test.

the splenectomy group – median 6 units (range 2–27 units) vs. median 2 units (range 1–3 units) in the non-operative group ($P < 0.001$).

Complications

Two patients in the splenectomy group died on the day of admission: one died from severe head trauma (ISS 43), and the second from uncontrollable intra-abdominal bleeding due to liver and inferior vena cava tear (ISS 57). The rate of pneumonia with or without symptomatic pleural effusion (mainly left-sided), and prolonged ileus of more than 5 days duration treated with a nasogastric tube were compared between the groups [Table 2]. Two of the 13 patients (15.3%) in the splenectomy group developed pneumonia compared with 4 of the 51 patients (7.8%) in the non-operative group ($P = 0.59$). Three of the 51 patients (5.8%) in the non-operative group suffered from prolonged ileus compared with all 13 patients in the splenectomy group ($P = 0.0001$). Two patients (15.3%) in the splenectomy group developed wound infections. There were two patients with delayed abdominal wall closure with skin graft in the splenectomy group.

Predictors for the success of non-operative treatment

Multivariate regression analysis was performed to identify predictors for the success of non-operative treatment of splenic trauma. Age, gender, admission systolic blood pressure and heart rate, injury to multiple regions, Glasgow Coma Scale and the need for blood transfusion were entered into a backward stepwise logistic regression model [Table 1]. Because CT was performed for only 7 of the 13 patients (53.8%) in the splenectomy group, it was not entered into the model. The requirement for blood transfusion (odds ratio 66.67, 95% confidence interval 5.55–100, $P = 0.001$) was a predictor for the need for splenectomy. Limited extra-abdominal injury (< 3 regions) (OR 8.03, 95% CI 1.82–35.48, $P = 0.006$), and admission systolic blood pressure (OR 1.04, 95% CI 1.00–1.08, $P = 0.032$) were found to be positive predictors for the success of non-operative management.

Follow-up of non-operative management

Scheduled follow-up CT was performed a week after the trauma for 31 of the 51 patients (60.8%) in the non-operative group. Free abdominal fluid was resolved in six of seven patients (85.7%) with grade 2 tears but was still present for the remaining patients. One pseudoaneurysm was found in an asymptomatic patient with a grade 3 tear of the spleen. No treatment was undertaken. Follow-up CT performed one month following the injury in 18 asymptomatic patients (35.3%) showed signs of healing of the splenic tear with less abdominal fluid, and downgrading of the injury in two patients from grade 4 to grade 3 compared with the initial study.

Splenic artery embolization

Three patients with grade 4 (two patients) and grade 5 (one patient) splenic injury who were stable either at admission or after resuscitation underwent splenic artery embolization due to contrast "blush" on initial CT (n=2) and a traumatic arteriovenous

ISS = Injury Severity Score

CI = confidence interval

fistula (n=1). Selective embolization of branches of the splenic artery at the hilum (two patients) and main splenic artery (one patient with grade 5 tear) was performed. In one patient with grade 4 tear the procedure failed and splenectomy was performed 8 hours after injury and 4 hours after splenic artery embolization. This patient has injury to four extra-abdominal regions, and an ISS of 34. One patient with a successful procedure was treated for left-sided pneumonia and pleural effusion with antibiotics and tube thoracostomy.

Discussion

Normal admission systolic blood pressure is clearly a sign of hemodynamic stability and intuitively a predictor of the success of non-operative management. Likewise, the requirement for blood among patients with blunt splenic trauma is intuitively a strong predictor for the need for splenectomy. ISS and other trauma assessment scores are frequently used to analyze the outcome and prognosis of trauma patients, but have little impact on initial patient evaluation and management. The extent of extra-abdominal injury has not been studied previously in the assessment of successful non-operative management of blunt splenic trauma.

The key findings of the present study are the identification of injury to less than three body regions and systolic blood pressure upon admission as positive predictors for the success of non-operative treatment of splenic trauma, while the need for blood transfusion is a very strong predictor for splenectomy. Our results demonstrate that patients with limited extra-abdominal injury (less than three regions) who do not require blood transfusion are significantly more likely to be treated successfully non-operatively (OR 8.03 and 0.015, respectively). Injury to fewer than three body regions is an obvious yet unrecognized simple factor that can serve to predict the success of non-operative management and guide management of patients with blunt splenic trauma.

Non-operative treatment of splenic injury was initially practiced in children with excellent results. Its success in adults varies widely and, according to different reports, ranges from 60% to 98% [6,7]. Previous criteria used for the selection of patients for non-operative splenic management are probably too rigid [2,8]. The multi-institutional trials committee of the Eastern Association for the Surgery of Trauma examined the results of treatment in 1488 adults at 27 trauma centers [9]. Grade of splenic injury, degree of hemoperitoneum, and ISS were important determinants for the successful outcome of non-operative management. A failure rate of 11% occurred in those managed non-operatively. Age above 55 years was also found to be a predictor of failure [10]. More recent studies report success rates of 78–100% for non-operative management in patients older than 55 [11, 12]. Our results support this approach for patients with blunt splenic trauma regardless of age.

Recent reports attribute little significance to the presence of head injury in determining the need for splenectomy [13,14]. However, our data show that the presence and severity of head injury was factored by the attending trauma surgeons to determine the feasibility of non-operative management for an individual patient. This probably stems from the conviction that head trauma with impaired consciousness may delay diagnosis of unrecognized bowel injury. Our data do not support a role for the Glasgow Coma Scale as a predictor of failure for conservative treatment. This would seem to strengthen the argument that impaired consciousness should not be a factor in the decision-making process of blunt splenic trauma.

Increased hospital length of stay and increased mortality in selected subsets of patients are the greatest concerns associated with failure of non-operative management for splenic injury [2,15]. None of the 51 patients in the non-operative group required splenectomy and there was no mortality among these patients. Since all the patients in the splenectomy group had laparotomy and were more severely injured, their complication rate was expectedly higher compared with the non-operative group. This higher morbidity for the splenectomy group was clearly associated with longer ICU and hospital lengths of stay. Our results show that pneumonia with or without symptomatic pleural effusion, and prolonged ileus due to intra-abdominal hemorrhage are two important complications of non-operative management (7.8% and 5.8%, respectively).

The mortality rate of isolated splenic injuries has effectively remained at 0% for nearly 40 years [1,5]. It is difficult to assess the additive effect of splenic hemorrhage to other injuries. Total mortality rates remain at 6–7% or higher in many series because of the presence of associated injuries [1]. There was no mortality in the non-operative group. Two of our patients in the splenectomy group died from other causes (severe head trauma and bleeding from the inferior vena cava). CT is utilized to grade the degree of splenic trauma in stable patients and to guide management.

In adults, an increasing grade of injury to the spleen seems to correlate with the need for immediate operation and the incidence of failure of non-operative treatment [16,17]. Nine of the 14 patients (64.3%) with grade ≥ 4 splenic injury in this study were successfully treated non-operatively. Univariate analysis performed on this prospectively collected database demonstrates that failure of non-operative management is significantly associated with a higher CT grade (≥ 4) of injury ($P = 0.001$). Since the grade of CT injury was not entered into the regression model, it is impossible to assess its ability to predict the success of non-operative treatment.

The rationale for performing follow-up CT in patients treated non-operatively is based on the higher failure rate with higher grade splenic injury, and the report by Davis et al. [18] that 74% of pseudoaneurysms were detected only on follow-up CT performed 48–72 hours after admission. However, Thaemert and colleagues [19] found that the management of only 2% of patients (1 of 49) was affected by the findings on follow-up CT. With our current understanding of the natural history of late bleeding from blunt injury to the spleen, we cannot predict which patients are more likely to develop pseudoaneurysms. Lynch et al. [20] reported on the rate of splenic healing and found that grade 1 injuries healed after a mean of 3.1 weeks, grade 2 after 8.2 weeks, grade 3 after 12.1 weeks, and grade 4 after 20.7 weeks. They concluded that the time to radiographic healing is proportional to the grade of injury. Our data and the available literature show that for patients in the non-operative group, follow-up CT does not change management and is probably not indicated [2,21].

Angiographic embolization of the splenic artery has been described as an effective tool to increase the success rate among patients managed with the non-surgical approach [22]. Angiography is not routinely used because most patients with blunt splenic injury can be managed successfully by bed rest and close observation alone, and no further procedures are necessary. Indications for embolization are based on CT findings and include significant hemoperitoneum, contrast extravasation, splenic artery pseudoaneurysm, and arteriovenous fistula, with associated failure rates of 10%, 17%, 12%, and 40%, respectively [23,24]. There is considerable risk in transporting multiple trauma patients, who may develop life-threatening hemorrhage, to the angiography suite for a time-consuming intervention. Cooney and associates [24] used selective criteria and only 5% of patients with splenic trauma were treated with splenic artery embolization based primarily on CT findings (vascular blush and large hemoperitoneum) and bleeding (manifested primarily as gradually decreasing hematocrit). Splenic salvage in this study was successful with selective splenic artery embolization in 67% of cases. We performed angiographic embolization for three patients with one failure leading to prolonged hospitalization and the need for delayed abdominal wall closure with skin graft. Thus, based on the limited number of patients in this study, we cannot recommend routine splenic artery embolization for patients with high degrees of blunt splenic injury.

In summary, non-operative management of blunt splenic trauma is feasible and safe for hemodynamically stable patients. Limited extra-abdominal injury is an important and significant predictor for the success of non-operative management. Age should probably not be a factor in the clinical decision-making process. Patients with low grade splenic injuries and limited extra-abdominal trauma can be safely observed in a regular ward with no follow-up imaging studies. Patients with high grade splenic injury that are not amenable to angiographic therapy and who have three or more injured extra-abdominal areas have a higher probability of operative treatment and should be managed in an ICU environment. The requirement for blood transfusion is a strong indicator for severe splenic injury that may mandate splenectomy.

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