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Outcomes of Nonoperative Management of Blunt Splenic Injury—Asian Experience

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Management of blunt splenic injury (BSI) has evolved with a focus on nonoperative management (NOM) and spleen preservation. Factors predictive of failure of NOM are yet ill defined. We report our experience of outcomes of NOM of BSI and evaluate factors that predict failure. This is a retrospective study from a prospective trauma registry of a university-affiliated major trauma center over a 4 ½-year period. All the patients admitted with BSI from January 2004 to May 2009 were included in this study. Demographic, clinical, operative, and outcome data were studied. Forty-five patients (51.1%) with a mean age of 38 years (range, 16–77 years) were admitted for NOM. The majority of patients was male (88.9%). Mean Injury Severity Score (ISS) was 25.2 ± 12.7 and the majority of the patients (42.2%) had Grade II BSI. Three patients (6.7%) underwent splenic artery angioembolization. Three patients (6.7%) failed NOM and required splenectomy. The overall splenic salvage rate was 93.3%. The median hospital stay was 7 days (range, 2–66 days) and there was no mortality. Lower hemoglobin on admission (15.9 versus 10.1 g/dL, $P = 0.006$), hematocrit <30.0% on admission ($P = 0.04$), higher ISS (39.3 versus 24.2, $P = 0.04$) and Grade V injury ($P = 0.003$) predicted failure of NOM. NOM for BSI is safe, feasible, and it increases splenic salvage. Splenic artery angioembolization is a useful adjunct. Low hemoglobin, hematocrit <30%, high ISS, and grade V splenic injury predicts failure of NOM. Grade V splenic injury should be considered for routine angioembolization if NOM is contemplated.

Key words: Blunt splenic injury – Nonoperative management

Spleen is the most common organ involved in blunt abdominal trauma. Splenectomy was the standard treatment for blunt splenic injury (BSI) until the 1980s; however, due to improvements in diagnostic imaging, nonoperative management (NOM) strategy has evolved over the last few decades. NOM is an established standard of care in hemodynamically stable patients. NOM avoids

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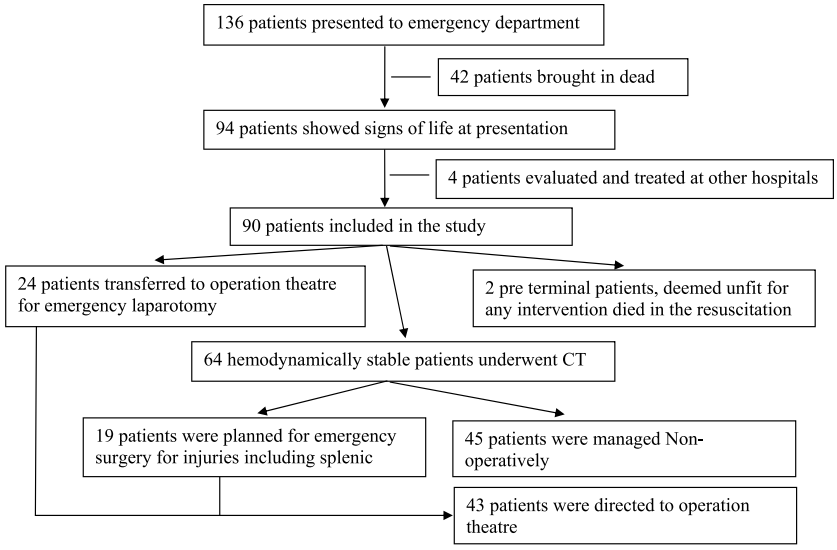

Fig. 1 Flow diagram of presentation and management of splenic injury patients from the emergency department.

the immediate complications of a laparotomy and preserves the splenic function. Success of NOM is reported to be in between 75 and 96%.[1–6] Higher success rates have been reported in children compared to adults, although this may be due to differences in mechanisms of injury.[6,7] It is important to know factors which predict failure of NOM. The aim of the present study was to explore the outcomes of NOM for BSI admitted during a 4 ½-year period from January 2004 to May 2009 and identify factors that predict failure of NOM.

Methods

A review of a prospectively maintained hospital trauma registry database was performed from January 2004 to May 2009. All patients with splenic injuries documented either during hospital stay or at post-mortem reports were reviewed. A total of 136 patients were identified over the study period. Figure 1 shows the flow diagram of management of splenic injury patients at presentation to the emergency department.

Definitions

Tachycardia was defined as a heart rate of >100/min. *Hypotension* was defined as a systolic blood pressure of <90 mmHg. *Injury Severity Score* (*ISS*) was calculated from the abbreviated injury score by dividing the body into 6 compartments and using the formula as suggested by Baker *et al*.[8] The score ranges from 1 to 75, and a higher score indicates worse severity. *Revised Trauma Score* (*RTS*) is a physiologic score calculated from Glasgow Coma Score (GCS), systolic blood pressure, and respiratory rate and calculated as per Champion *et al*.[9] The score range from 0 to 12 and lower score indicates worse severity. *Probability of Survival* (*Ps*) was calculated based on ISS, RTS, and patients age according to Boyd *et al*.[10] Splenic injuries were scored according to guidelines by the American Association for the Surgery of Trauma (AAST).[11] Computerized tomography (CT) scan, intraoperative findings, or post-mortem reports were studied to grade severity of BSI. *Nonoperative management* (*NOM*) was defined as any patient with BSI being managed without a surgical intervention. This also includes patients that required splenic angioembolization. *Failure of nonoperative management* was defined when a surgery was required after an initial period of observation and monitoring. This also includes patients that underwent spleen conserving surgery. Splenic angioembolization is restricted to patients who demonstrate "vascular blush" on a multiphase CT scan and is not based on splenic injury severity grading.

Nonoperative management

Nonoperative management was carried out in a surgical high-dependency ward. All the patients received invasive hemodynamic monitoring with intra-arterial and central venous lines. The intravenous fluids were administered at a rate which achieved renal perfusion to maintain a urine output of at least 0.5 mL/kg/h. All patients received a serial abdominal examination at an interval of 4 to 6 hours in a high-dependency ward. All patients undergo a full

Table 1 Demography and mechanism of injury

	n = 90
Mean age (years)	38.1
Age <18 years	7 (7.8%)
Sex	
Male	75 (83.3%)
Female	15 (16.7%)
Mechanism of injury	
Road traffic accident	60 (66.7%)
Motorcycle (n = 38)	
Car (n = 14)	
Pedestrian (n = 8)	
Fall	24 (26.7%)
Others	6 (6.6%)

blood count, renal function, arterial blood gas, and coagulation screen 4 to 6 hours after admission to a surgical high-dependency ward. If the blood investigations were satisfactory, they would be repeated after 6 to 8 hours or the next morning, whichever was earlier. The maximum interval for blood investigation during an overall stay in high dependency was 12 hours. Threshold for blood transfusion was a hemoglobin level of 8.0 gm/dL in healthy individuals and 9.0 gm/dL in patients with history of ischemic heart disease. A drop in haemoglobin value by 2 or more units was considered for a repeat CT scan regardless of hemodynamic status. After 48 hours of observation, stable patients would be shifted to ward. Trauma surgeons lead the multidisciplinary management in polytrauma patients.

Statistics

All statistical analyses were performed on SPSS version 14.0 (SPSS Institute, Chicago, Illinois). Continuous variables between groups were compared using 2-tailed *t*-tests. For variables with skewed distributions, the Mann-Whitney *U* test was used. For categoric variables, the χ^2-test was used, with linear-by-linear association test if the variables were ordinal. All of the *P*-values reported were 2-sided and *P*-values less than 0.05 were considered statistically significant. All the analysis was performed on an intention-to-treat basis. A multivariate analysis was not planned due to small number of patients with a failure of nonoperative management (NOM).

Results

Ninety patients of BSI presented to the emergency department with signs of life. The mean age was 38 years (16–77 years) and majority (83.3%) of them were male. Road traffic accidents (67%) and fall from height (27%) were the most common injury mechanisms. Table 1 shows the demography and mechanisms of injury. The mean ISS was 32.1 ± 15.8, mean RTS 7.16 ± 1.29 and mean Ps 81.2% ± 29.5. Two patients were preterminal and died within a few minutes while in the resuscitation area in emergency department.

A total of 43 patients were directed to the operating theatre for emergency laparotomy (OM group). Twenty-four of these patients were operated on for hemodynamic instability (55.8%) and 19 hemodynamic stable patients had an opportunity to undergo a CT prior to operative plans. These 19 patients needed surgery for splenic and/or other organ injury. Figure 2 shows the outcome of these 43 patients. On an intention-to-treat analysis, splenic salvage rate was 48.8%.

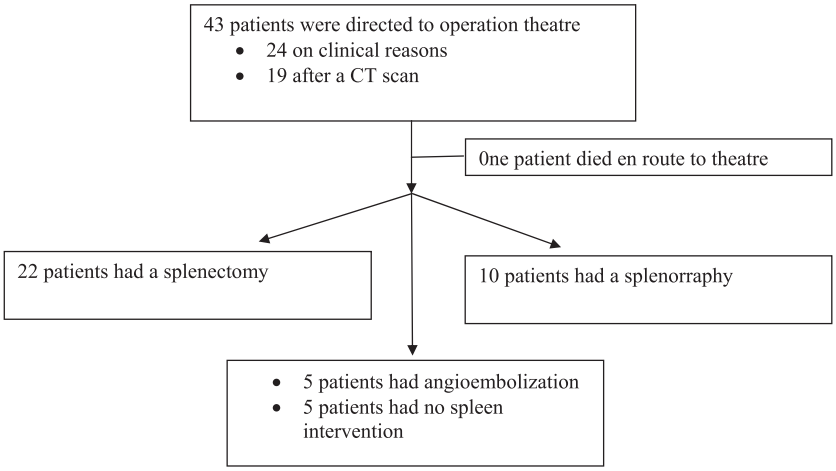

Fig. 2 Outcomes of patients directed to operation theatre.

Table 2 Demography and clinical parameters of operative and nonoperative management patients

	NOM, n = 45	OM, n = 43	P[a]
Age, years	38 ± 16.3	37.9 ± 19.8	0.99
>55 years (n)	7 (15.6%)	10 (23.3%)	0.43
<18 years (n)	2 (4.4%)	4 (9.3%)	0.43
Sex, male	40 (88.9%)	35 (81.4%)	0.38
Tachycardia ≥100/min	16 (35.6%)	23 (53.5%)	0.133
Systolic blood pressure			
<100 mmHg	8 (17.8%)	23 (53.5%)	**0.001**
<90 mmHg	5 (11.1%)	14 (32.6%)	**0.02**
Glasgow coma score <15	12 (26.7%)	20 (46.5%)	0.076
Hemoglobin (mean g/dL)	15.49 ± 12.78	12.57 ± 2.67	0.144
Hematocrit <30	6 (13.3%)	7 (16.3%)	0.77
Injury Severity Score (ISS)	25.2 ± 12.7	38.7 ± 15.7	**<0.001**
Splenic injury grade			0.11
Grade I and II	19 (42.2%)	12 (27.9%)	
Grade III	13 (29%)	13 (30.2%)	
Grade IV	11 (24.4%)	12 (27.9)	
Grade V	2 (4.4%)	6 (14%)	
Splenic salvage	42 (93.3%)	21 (48.8%)	**<0.001**
Length of stay (median, days)	7 (2–115)	16 (4–273)	**0.002**
Mortality	0 (0%)	12 (27.9%)	**<0.001**

[a]Bold values are significant.

Forty-five patients with a mean age of 38 years (range, 16–77 years) underwent nonoperative management (NOM) without splenic angioembolization of the splenic injury. The majority of them were male (88.9%). Mean ISS, RTS, and Ps scores were 25.2 ± 12.7, 7.53 ± 0.67 and 94.1 ± 8.5, respectively. Nineteen (42.2%) patients sustained Grade II lacerations, 13 (28.9%) Grade III, 11 (24.4%) Grade IV and 2 (4.4%) patients had Grade V laceration. Three patients (6.7%) required splenic angioembolization for a vascular blush detected on a CT scan. Three patients (6.7%) failed NOM. Two patients developed hemodynamic instability while being monitored in the high-dependency ward. Both patients failed NOM within 24 hours of admission, 1 patient each had Grade II and Grade V splenic injury. The third patient developed hemodynamic instability on the second day of admission while being operated upon by the orthopaedic team for fixation of limb fractures. This patient had Grade V splenic injury. Splenectomy was performed for all 3 patients. The overall splenic salvage rate was 93.3% (42/45). Median length of hospital stay was 7 days (range, 2–115 days). There were no mortalities in the NOM group.

The 2 groups of patients (NOM versus OM), were similar in terms of demography. Table 2 shows the comparison of demography and clinical parameters of the 2 groups. OM group patients had significantly poorer ISS ($P < 0.001$), RTS ($P = 0.005$), Ps ($P < 0.001$) scores, and were hypotensive with a SBP <90 mmHg on admission ($P = 0.02$). Both, age >55 years and age <18 years and splenic injury severity scores were not predictive of OM. Univariate analysis showed 4 factors were significantly associated with failure of NOM. Lower mean hemoglobin (g/dL) on arrival (10.1 ± 2.96 versus 15.9 ± 2.1, $P = 0.006$), hematocrit level of <30 on arrival (66.7% versus 9.5%, $P = 0.043$), splenic injury severity grade V (0% versus 66.7%, $P = 0.003$) and higher ISS scores (39.3 versus 24.2, $P = 0.045$) predicted failure of NOM. Of the 3 patients, 1 patient had a Grade II splenic injury and the other 2 patients had Grade V splenic injury. Mean duration of follow-up was 6.7 months (range, 1–41 months). No complications such as splenic abscesses, intra-abdominal collections, or splenic artery aneurysms were reported in the NOM group.

Discussion

Spleen has phagocytic and immune functions and helps protect against common infections, especially in childhood.[12] The most feared risk of splenectomy is overwhelming post-splenectomy infection (OPSI). In children <5 years age, splenectomy increases the risk of OPSI by up to 60 to 100 fold and OPSI has high lethality.[13] Hence it is important to preserve spleen. In hemodynamically normal patients with blunt splenic injury (BSI), splenic preservation can be achieved by nonoperative management (NOM). NOM of splenic injury is the standard of care over the last few decades. This is because of improved understanding of natural history of BSI, improved understanding of blood coagulation process, increased access to computerized tomography (CT) scans, advances in critical care medicine, standardization of trauma management protocols, and increasing utility of interventional radiology in the management of trauma patients. In our study involving ninety patients with BSI, the overall splenic salvage rate was 70% (63/90) and splenic salvage rate for NOM was 93.3% (42/45). Low hemoglobin on admission, admission hematocrit <30%, higher injury severity score (ISS), and Grade V splenic injury predicted failure of NOM.

Our hospital is a major trauma hospital and receives approximately 1000 trauma referrals annually. More than 40% of our trauma patients have ISS >15 and majority (>90%) are of blunt trauma.[14] We have previously shown that hypotension, tachycardia, abnormal hematocrit, coagulopathy, higher ISS, lower pH, and multiple injuries are predictors for

emergency surgical intervention.[14] In this study, 27% of patients admitted with BSI are transferred to the operation theatre directly from emergency department. These patients suffer from severe injury with higher ISS and manifest hemodynamic instability or they have evidence of concomitant significant intra-abdominal injury, which requires a laparotomy. This experience is similar to that of other multi-institutional studies.[15] Further, when a laparotomy is warranted for other injuries, we adopt a liberal policy of splenectomy as not only can it be done promptly by experienced trauma surgeons with minimal added morbidity, but also because it facilitates perioperative management, streamlines the resource utilization, and saves the patient from future splenic rebleed.

Old age has been shown to predict failure of NOM of BSI.[16] This is believed to be due to differences in the pattern and mechanisms of injury between the old and the young patients. Also, old patients have less physiologic reserves due to associated comorbidity. Some authors have however advocated that age in itself should not be considered a contraindication to NOM of BSI.[17,18] In our experience of 90 patients with a mean age of 38 years, age >55 years neither predicted the need for operative intervention nor failure of NOM.

High ISS, high splenic injury grade, and need for transfusion have been associated with need for operative intervention and also failure of NOM.[7,19–21] Higher ISS indicates severe trauma. Mean ISS of patients with NOM for BSI was 25.7 in our study, and ISS predicts both need for operation and also failure of NOM. Overall 34.4% (31/90) patients sustained Grade IV or V BSI and NOM was attempted in 42% (13/31). Failure rates for NOM of Grade IV and V BSI ranges from 30 to 100%.[6,15,22] To reduce these failure rates of NOM, routine splenic artery angioembolization has been advocated in Grade IV and V BSI.[23,24] Availability of interventional radiologic expertise and in house trauma surgeon is an essential prerequisite for NOM protocols. Three patients underwent emergency angiography and embolization of splenic and 1 patient underwent pelvic angioembolization. We do not follow routine splenic artery angioembolization practice and only selectively embolize those patients who demonstrate a clear vascular blush on the CT scan. Out of the 3 patients who failed NOM, 2 patients had Grade V splenic injury. Both these patients were hemodynamically stable and hence a NOM was initially attempted. However it is possible that due to resuscitation the tamponade blood clot would have dislodged and rebleeding would have resulted in hemodynamic abnormality, as evidenced by failure within the first 24 hours of admission. It is possible that a routine practice of splenic angioembolization for Grade V injuries could have prevented these failures of NOM. As we did not experience any failures of NOM for Grade IV injuries managed without routine prophylactic embolization, we believe it is acceptable to restrict embolization to patients who demonstrate vascular blush on CT scan.

The overall rate of splenic artery angioembolization in our series is 11% (8 out of 88 patients) and this is consistent with the literature.[25] Blood transfusion requirement is a surrogate of hemoglobin and low hematocrit levels, which indicate ongoing bleeding. We have demonstrated that while low hemoglobin and hematocrit does not predict the need for operative intervention, it does predict the failure of NOM. This is due to the fact that the decision for initial operation is not based on hemoglobin values but on clinical reasons pertaining to hemodynamic instability. With increasing experience in NOM of BSI, the emphasis is now to maintain high splenic salvage rates while reducing transfusion and angioembolization rates. Recently, it has been demonstrated that NOM management with low transfusion and low splenic angioembolization rates (0.6%) can lead to high splenic preservation rates with low mortality in dedicated pediatric trauma units.[25] Such results are yet to be duplicated in an adult population.

This is a single institutional experience from a busy trauma center. The strength of this study lies in a prospectively maintained registry database. Understandably, due to a small number of patients with failure of NOM of BSI, there is a possibility of type II error in statistical calculations. We did not study blood transfusion needs nor did we include other organ injuries. Blood transfusion practises vary across institutions and numbers of transfusion do not serve any guidance on the need for operative intervention. NOM of BSI is a resource-intense strategy and is an acceptable standard of care in trauma units. It is important to know the factors predictive of failure of NOM so that this knowledge could be applied in the clinical practice to not only improve splenic salvage rates, but also patient outcomes. Our study highlights that fact that Grade V injuries should not be managed by observation alone if a NOM strategy is contemplated, and they should be considered for prophylactic embolization.

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