European Journal of Trauma and Emergency Surgery (2019) 45:933–938
https://doi.org/10.1007/s00068-018-0975-y

ORIGINAL PAPER

Successful non-operative management of haemodynamically unstable traumatic splenic injuries: 4-year case series in a UK major trauma centre

Richard A. Armstrong[1] · Andrew Macallister[1] · Benjamin Walton[1] · Julian Thompson[1]

Received: 11 April 2018 / Accepted: 12 June 2018 / Published online: 16 June 2018

Abstract

Purpose Management of traumatic splenic injury may be operative or non-operative (including embolization and conservative management). Traditionally, haemodynamic instability has been an indication for operative intervention. We aimed to report our experience of managing traumatic splenic injury at a regional major trauma centre in the UK over a 4-year period, with a particular focus on the non-operative management (NOM) of haemodynamically unstable patients.

Methods All patients with splenic injuries admitted to North Bristol NHS Trust from April 2012 to March 2016 were included. Patients were classified for analyses by injury severity (low or high grade), haemodynamic instability (defined as a reverse shock index < 1) and management category (operative or non-operative).

Results 106 patients were included. Overall 85.8% of patients received NOM: 79.2% conservative and 6.6% interventional radiology. Two patients (2.4%) managed conservatively required further intervention. Haemodynamically stable and unstable patients were equally likely to receive NOM (89.7 and 81.3% respectively, $p = 1$). All unstable patients with low-grade injuries were managed conservatively and only one (2.7%) required further intervention. Two unstable patients with high-grade injuries (28.6%) underwent NOM successfully.

Conclusions These data support the safe application of non-operative management to haemodynamically unstable patients with traumatic splenic injury, particularly in those with low-grade injuries. Additional prospective work is required to define the subgroup of patients for whom this is appropriate and to determine the long-term outcomes of NOM.

Keywords Major trauma · Splenic injury

Introduction

Splenic injury occurs in 1.3% of all trauma patients and the spleen is the most commonly injured abdominal organ in blunt trauma affecting up to 45% of patients [1, 2]. Splenic injuries are most commonly the result of road traffic collisions (RTCs), which injure over 180,000 people in Great Britain each year [2, 3]. Splenic haemorrhage is potentially life threatening and requires prompt management. Traditionally this has involved operative splenectomy, but there has been an increasing appreciation of the immunological importance of the spleen and thus attempts at splenic preservation are becoming more prevalent. This can be achieved by operative salvage or non-operative management (NOM). The latter has increased over recent decades since its introduction in paediatric trauma in the 1960s [4, 5], now accounting for up to 60% of cases [6], and may include conservative management or an embolization procedure by interventional radiology. A recent review suggests that the gold standard for minor splenic injuries is non-operative treatment, and that non-operative treatment also yields a lower mortality when managing severe splenic injuries [7].

The traditional approach to decision-making in these patients has utilized haemodynamic stability as the primary determinant [4] with a central tenet being that haemodynamically unstable patients require operative intervention. Guidance on selective non-operative management of blunt splenic injuries published by The Eastern Association for the Surgery of Trauma (EAST) states that non-operative management should only be considered

✉ Richard A. Armstrong
richard.armstrong@nbt.nhs.uk

[1] Intensive Care Unit, Southmead Hospital, Southmead Road, Bristol BS10 5NB, UK

for patients who are haemodynamically stable; indeed, the sole level 1 recommendation in the guidance is that haemodynamically unstable patients should undergo urgent laparotomy [8].

We report our experience of managing traumatic splenic injury at a regional major trauma centre in the UK over a 4-year period, with a particular focus on the non-operative management of haemodynamically unstable patients. We hope to inform the decision-making in this potentially challenging group by demonstrating that such an approach is feasible and can be safely applied to appropriate patients.

Methods

Data collection

The Trauma Audit and Research Network (TARN) database was used to identify all splenic injuries admitted to North Bristol NHS Trust from April 2012 to March 2016. The TARN registry is a prospective observational registry of hospitalized patients who have undergone major trauma in England and Wales. TARN has given ethical approval (Section 251) for research on the anonymized data submitted by member hospitals. Local approval was granted by The Quality Assurance and Clinical Audit Department (reference CE6572). The TARN submission and electronic trauma notes were used to collect data on gender, age, arrival date and time, haemodynamic variables, mechanism of injury, injuries sustained, injury severity score (ISS), splenic management and rationale, other operations, and mortality. Where these data were missing or incomplete, full case notes were reviewed.

Patient classification

Splenic injuries were graded according to the American Association for the Surgery of Trauma (AAST) splenic injury scale [9] on abdominal computed tomography (CT) by one radiologist and grouped as low grade (grades I–III) or high grade (grades IV–V) for further analyses. Clinical observations from the pre-hospital and emergency department documentation were used to calculate a reverse shock index (rSI) for each patient: the lowest systolic blood pressure (mmHg) divided by the heart rate (bpm). Haemodynamic instability was defined as a rSI of less than 1 [10]. Patients were grouped by splenic management for further analysis: non-operative management (NOM), comprising conservative and interventional radiology, and operative management (OM).

Statistical methods

Statistical analyses were performed using RStudio (RStudio, Inc.; Version 1.0.143, 2016). Continuous variables were assessed for normality using the Shapiro–Wilk test and compared using independent *t* tests or Mann–Whitney *U* test, depending on distribution. Categorical variables were compared using Chi-squared, Fisher's exact test or Cochran–Mantel–Haenszel test as appropriate. The interactions between variables were compared using logistic regression before and after adjusting for relevant confounding factors (age, gender, ISS). p values < 0.05 were considered statistically significant; where multiple comparisons were performed the Bonferroni correction was applied.

Results

Patients

116 records were identified, of which 10 were excluded (Fig. 1). The average age of patients was 37.8 years (IQR 22.9–55.1, range 12.7–91.6) with 74.5% male. The most common mechanism of injury for all patients was RTC (70.8%).

Grading of splenic injury and injury severity score

The injuries of four patients could not be graded as they were deemed too haemodynamically unstable to undergo imaging prior to splenic management. For the remaining 102 patients, median grade of injury was 3 (IQR 2–3). 86 (84.3%) were low-grade injuries (grades I-III) with 16 (15.7%) high grade (grades IV–V). Median ISS for all patients was 27 (IQR 17–38, range 4–66) and did not differ by grade of splenic injury ($p = 0.32$). Average ISS differed by management strategy at 34 (25–45.5) in those managed operatively versus 25 (16.5–35) in the NOM group ($p = 0.04$).

Management of splenic injury

Of 106 patients overall, 84 (79.2%) were managed conservatively, 7 (6.6%) by interventional radiology (IR) and 14 (13.2%) operatively. Four patients (3.8%) were too haemodynamically unstable in the emergency department for diagnostic imaging and proceeded immediately to the operating theatre. The four ungraded patients were all male, with an average age of 44.8 (32.4–53.6) years, and all had been injured in RTCs. The average ISS was higher than the rest of the cohort [47.5 (42.25–50) vs 25 (17–37.5), $p = 0.03$].

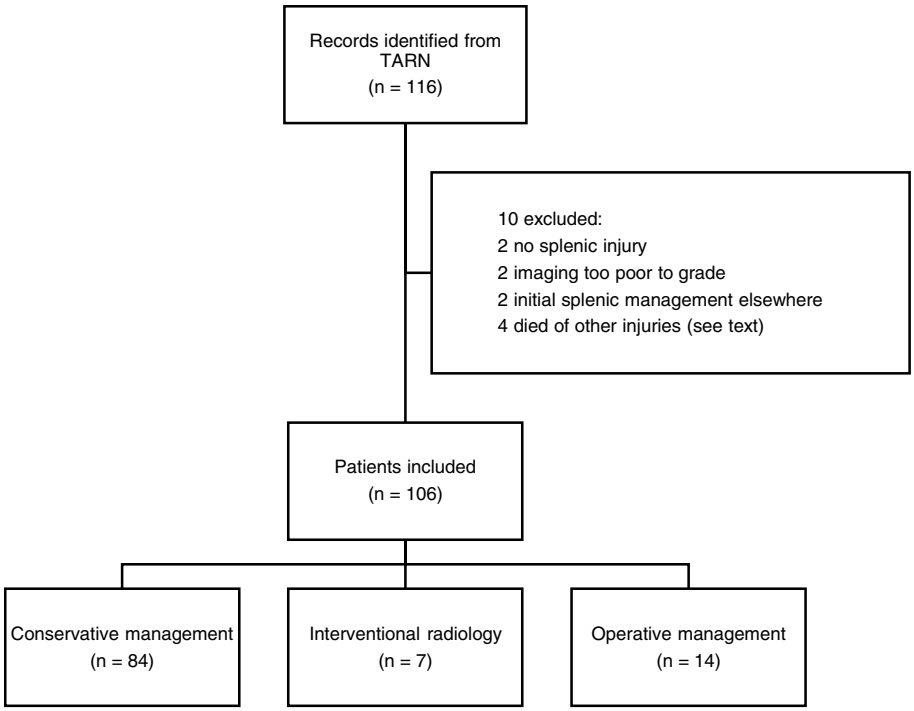

Fig. 1 Flow diagram

Two patients who initially underwent conservative management (2.4%) required further intervention (1 underwent IR after 5 days; 1 underwent IR after 48 h, with operative management after a further 24 h) and were classed as failed conservative management (Fig. 2). After excluding those whose injuries were ungraded, the remaining 102 patients were grouped as non-operative management

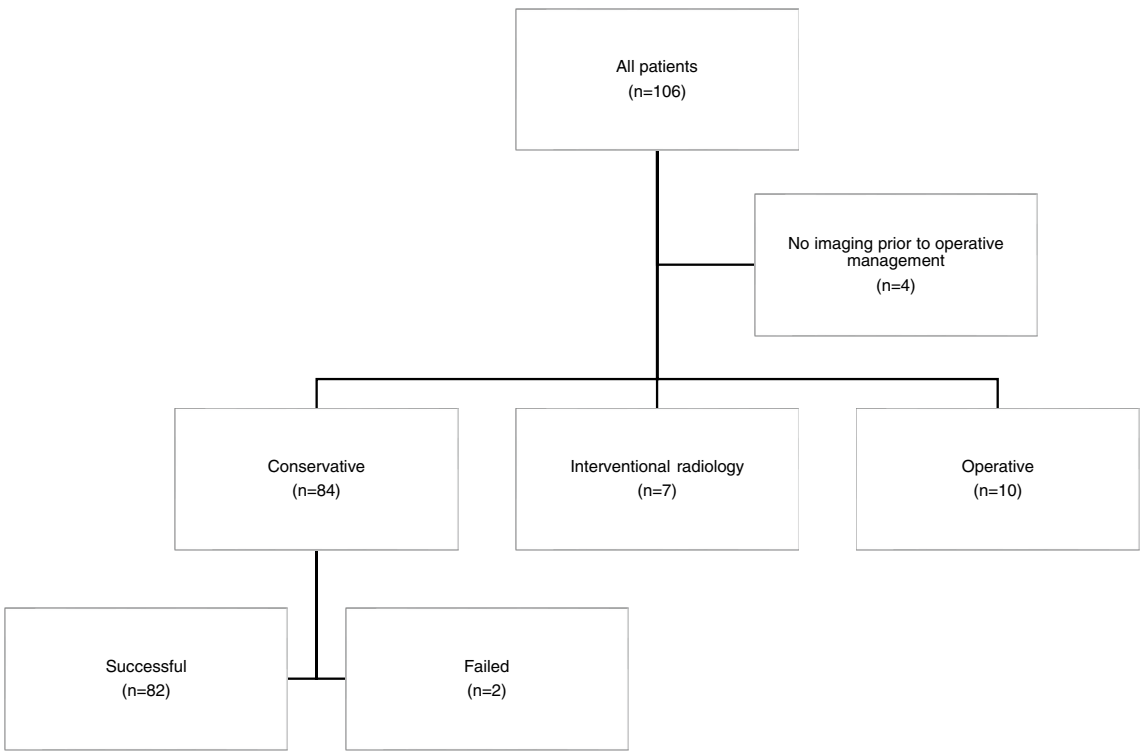

Fig. 2 Flowchart of patient management

(NOM; 91, 89.2%) or operative management (OM; 10, 9.8%) for further analyses.

- Management by haemodynamic stability (Fig. 3)

56.9% of patients were haemodynamically stable. Management did not differ based on haemodynamic stability alone: 89.7% of stable patients and 81.3% of unstable patients received NOM ($p=1$).

- Management by haemodynamic stability, grouped according to grade of injury

Management did not differ significantly with haemodynamic stability in either group of patients. In those with low-grade injuries ($n=86$), 91.8% of stable patients and 100% of unstable patients received NOM ($p=0.13$). Of those with high-grade injuries ($n=16$), 77.8% of stable patients and 40% of unstable patients received NOM ($p=0.13$).

- Management by grade of injury

There were significant differences in management by injury severity with 95.3% of low-grade injuries receiving NOM versus 56.3% of high-grade injuries ($p=0.0001$). Grade of injury was significantly lower in the NOM group with an average of 2 (IQR 2–3) versus 5 (IQR 3–5) for OM ($p=0.0001$). After adjusting for age, gender, ISS and haemodynamic stability, the relationship between grade of injury and management was significant: high-grade injury was associated with an increased likelihood of OM, and low-grade injury with a reduced likelihood [adjusted OR 14.5 (3.4–71.7) for high-grade injury; OR 0.07 (0.01–0.28) for low-grade injury; $p=0.0004$].

- Management by grade of injury, grouped according to haemodynamic stability

In the haemodynamically stable patients, management did not differ by grade of injury with 91.8% of low-grade and 77.8% of high-grade injuries undergoing NOM ($p=0.23$). By contrast, in the unstable patients, management differed significantly by grade of injury with 100% of low-grade and 28.6% of high-grade injuries receiving NOM ($p<0.0001$) (Table 1).

Mortality

Of the 116 cases reviewed, 7 patients died (6.0%), all due to other injuries. Four of these were excluded from further analyses as they died prior to commencement of any potential treatment for their splenic injuries: three arrived in traumatic cardiac arrest and died before any management of injuries was undertaken; one had a devastating neurological injury and received no active management. Of the other three patients, one suffered cardiac arrest in the emergency department and ultimately died in the operating theatre; the

Table 1 Management by haemodynamic stability and grade of injury

Haemodynamic stability	Grade of injury	Non-operative management *n* (%)	Operative management *n* (%)	*p* value*
Stable	Low	45 (91.8)	4 (8.2)	0.23
	High	7 (77.8)	2 (22.2)	
Unstable	Low	37 (100)	0 (0)	0.00001
	High	2 (28.6)	5 (71.4)	

*Fisher's exact test

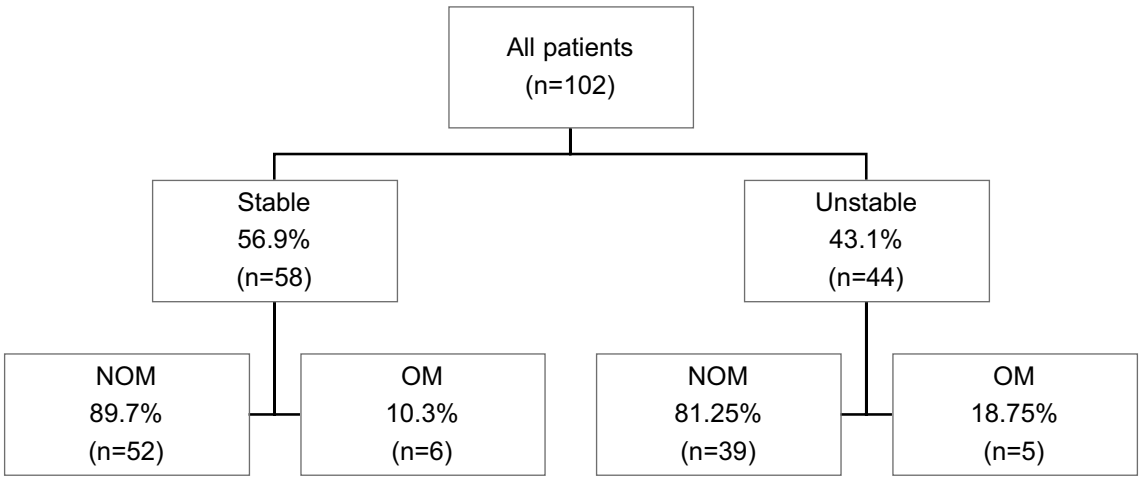

Fig. 3 Management by haemodynamic stability (*NOM* non-operative management, *OM* operative management)

remaining two cases had their splenic injuries managed conservatively but died due to other injuries.

Discussion

In this cohort of patients admitted to a major trauma centre with splenic injuries, 85.8% of patients underwent non-operative management (NOM): 79.2% conservative and 6.6% interventional radiology. This high proportion of NOM is in keeping with the 'modern management' of splenic trauma described in the literature [5]. Of those managed conservatively, only 2.4% required further intervention, one after 48 h and one after 5 days. No patients died as a direct result of their splenic injury.

The established literature on this topic has suggested that haemodynamic instability, regardless of injury severity, should prompt operative management [11]. By contrast, we found haemodynamically stable and unstable patients equally likely to receive non-operative management (89.7 and 81.3% respectively, of whom 90.4 and 94.5% were managed conservatively). All haemodynamically unstable patients with low-grade injuries were managed conservatively by observation, with only one such patient requiring subsequent intervention by IR and then operative management. As such, 97.3% of patients with low-grade injuries and haemodynamic instability managed conservatively required no further intervention demonstrating that NOM can be safely applied to such patients. For those patients with haemodynamic instability and high-grade injuries, the operative approach would be expected. Our cohort contained only seven unstable patients with high-grade injuries, the majority of whom did undergo operative intervention. Two such patients were successfully managed non-operatively, but our small sample size precluded further analysis.

The reported benefits of NOM include lower rates of both systemic infection and mortality [11, 12], but the approach has also been associated with longer hospital stay [6, 12] and increased specific morbidity [13], though not consistently [14]. We did not collect follow-up data to assess these outcomes. The low complication and re-intervention rates we report echo attempts to apply NOM to haemodynamically unstable patients in Holland. They found a similar time to intervention when compared to operative management, and a trend towards lower transfusion requirements. However, only nine NOM and seven surgical cases were included in the study [15]. Of note, the application of this strategy relies upon the necessary interventional radiology provision and as such may be limited in other UK centres without major trauma centre designation [16].

The notable exceptions were four patients (3.7%) who had such critical haemodynamic instability that they were unable to undergo trauma protocol CT imaging and proceeded immediately to emergency laparotomy. Two suffered cardiac arrest in the emergency department; the remaining two patients had positive FAST scans. All patients had suffered multiple high-energy injuries in road traffic collisions and as a group they had a significantly higher average injury severity score than the cohort as a whole. These patients likely represent a distinct cohort of patients in whom operative intervention is the only feasible management strategy and as such were analysed separately.

The overall mortality rate of 6% is similar to other reported cohorts [7]. It is lower than the 22.2–24.5% reported by the European group above, but this is likely explained by the presence of a higher proportion of high-grade injuries [11]. The observed mortality in our patients was not due to splenic injury, but rather the other injuries patients sustained.

Limitations

The work describes the practice in a single centre and as such may not be generalizable to all clinical settings. The retrospective study design meant we were limited in the variables and outcomes we could assess. Whilst we have attempted to adjust for confounding factors, it is possible there are unmeasured confounders which are not included in our analyses. We defined haemodynamic instability based on documented observations, but this may not represent the full clinical picture. The small number of patients with haemodynamic instability and high-grade injuries limited the conclusions that can be drawn from this this group.

Conclusion

Our experience of managing traumatic splenic injuries in a UK major trauma centre over a 4-year period demonstrates that non-operative management can be safely applied to haemodynamically unstable patients. This is in contrast to traditional teaching and further prospective work should be undertaken to further define the important subgroup of patients in whom this is appropriate, and the long-term outcomes associated with non-operative management.

Acknowledgements We gratefully acknowledge the contribution of Emily Batt to this work.

Compliance with ethical standards

Conflict of interest R Armstrong, A Macallister, B Walton and J Thompson declare that they have no conflict of interest.

Ethical approval For this type of study formal consent is not required.

Informed consent The Trauma Audit and Research Network has given ethical approval (Section 251) for research on the anonymized data submitted by member hospitals. Local approval was granted by The Quality Assurance and Clinical Audit Department (reference CE6572).

References

1. Davis JJ, Cohn I, Nance FC. Diagnosis and management of blunt abdominal trauma. Ann Surg. 1976;183:672–8.
2. Brady RR, Bandari M, Kerssens JJ, Paterson-Brown S. Parks RW Splenic trauma in Scotland: demographics and outcomes. World J Surg. 2007;31:2111–6.
3. Department for Transport. Reported road casualties in Great Britain, annual report: 2016. https://www.gov.uk/government/statistics/reported-road-casualties-great-britain-annual-report-2016. Accessed 17 Jan 2018.
4. Hildebrand DR, Ben-Sassi A, Ross NP, Macvicar R, Frizelle FA, Watson AJ. Modern management of splenic trauma. BMJ. 2014;348:g1864.
5. Cirocchi R, Boselli C, Corsi A, et al. Is non-operative management safe and effective for all splenic blunt trauma? A systematic review. Crit Care. 2013;17:R185.
6. Sinha S, Raja SV, Lewis MH. Recent changes in the management of blunt splenic injury: effect on splenic trauma patients and hospital implications. Ann R Coll Surg Engl. 2008;90:109–12.
7. Schnüriger B, Inaba K, Konstantinidis A, Lustenberger T, Chan LS, Demetriades D. Outcomes of proximal versus distal splenic artery embolization after trauma: a systematic review and meta-analysis. J Trauma. 2011;70:252–60.
8. Stassen NA, Bhullar I, Cheng JD, et al. Selective nonoperative management of blunt splenic injury: an Eastern Association for the Surgery of Trauma practice management guideline. J Trauma Acute Care Surg. 2012;73:S294–300.
9. Moore EE, Cogbill TH, Jurkovich GJ, Shackford SR, Malangoni MA. Champion HR Organ injury scaling: spleen and liver (1994 revision). J Trauma. 1995;38:323–4.
10. Lai WH, Rau CS, Hsu SY, et al. Using the reverse shock index at the injury scene and in the emergency department to identify high-risk patients: a cross-sectional retrospective study. Int J Environ Res Public Health. 2016;13:357.
11. Heuer M, Taeger G, Kaiser GM, et al. No further incidence of sepsis after splenectomy for severe trauma: a multi-institutional experience of the trauma registry of the DGU with 1,630 patients. Eur J Med Res. 2010;15:258–65.
12. Scarborough JE, Ingraham AM, Liepert AE, Jung HS, O'Rourke AP, Agarwal SK. Nonoperative management is as effective as immediate splenectomy for adult patients with high-grade blunt splenic injury. J Am Coll Surg. 2016;223:249–58.
13. Chastang L, Bège T, Prudhomme M, et al. Is non-operative management of severe blunt splenic injury safer than embolization or surgery? Results from a French prospective multicenter study. J Visc Surg. 2015;152:85–91.
14. Olthof DC, van der Vlies CH, Goslings JC. Evidence-based management and controversies in blunt splenic trauma. Curr Trauma Rep. 2017;3:32–7.
15. Olthof DC, Sierink JC, van Delden OM, et al. Time to intervention in patients with splenic injury in a Dutch level 1 trauma centre. Injury. 2014;45:95–100.
16. Hughes J, Scrimshire A, Steinberg L, et al. Interventional radiology service provision and practice for the management of traumatic splenic injury across the Regional Trauma Networks of England. Injury. 2017;48:1031–4.