Ten-year experience of splenic trauma in New Zealand: the rise of non-operative management

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ABSTRACT

AIM: The aim of this study was to describe the demographics, mechanisms of injury, management and outcomes in patients who suffered splenic trauma in Christchurch, New Zealand.

METHODS: A retrospective study included all splenic injury patients admitted to Christchurch Public Hospital between January 2005 and August 2015.

RESULTS: A total of 238 patients were included, with a median age of 26 years (4–88.7). Of these, 235 patients had blunt injuries. Eighty-nine had high-grade injuries. Yearly admissions of splenic trauma patients have gradually increased. A total of 173 (72.7%) patients were managed with observation; 28 patients (11.8%) had radiological intervention and 37 patients (15.5%) had splenectomy. Patients who died were significantly more likely to be older (median, 46.5 vs 25.2 years, p=0.04) and to have been admitted to ICU (100% vs 32%, p=<0.001).

CONCLUSION: Splenic injuries have shown a steady increase in the last decade. Splenectomy rates have decreased in favour of non-operative techniques. Radiological intervention with splenic artery embolisation was successful in all selected patients with high-grade injuries.

Maintaining splenic function is important because of the spleen's role in immune competence. The spleen reduces infection from encapsulated organisms and alters the risk of developing malignancy as well as mediates its outcome.1–3 The spleen, however, is injured in up to 45% of blunt abdominal trauma.4–5 The mortality associated with splenic injuries has been reported to be as high as 7%.6–8 Much of the early mortality is to be thought to be preventable,9 if expedient treatment and accurate diagnosis can be achieved. While the incidence of splenic injuries differs according to geographic location and patient ethnicity,10 the outcome of adult patients with splenic trauma does not vary with the treating hospital's experience.11

There is limited published New Zealand data on splenic injuries with only a small retrospective study published in 1999, where a third of the patients received immediate splenectomy and 10% died pre-operatively.12 Since that time, the experience of non-operative management (NOM) of splenic trauma has increased.

Non-operative management of splenic injuries includes radiological intervention with splenic artery embolisation (SAE)13 and conservative management. While the uptake of SAE has generally been increasing,14 many uncertainties surround its optimal use.15 Some centres utilise SAE routinely as a management option for haemodynamically stable patients with high-grade splenic injuries. Other centres, on the other hand, are much more reserved in their use of SAE, offering it only rarely.16

The aim of this study was to describe the characteristics of splenic trauma patients over a 10-year period. Changes in management and outcomes, in particular for high-grade injuries, were assessed including the role of SAE.
Methods

Study setting
This retrospective study included all patients with a splenic injury admitted to Christchurch Public Hospital (CPH) between January 2005 and August 2015.

Patient selection
Case identification was carried out in two steps:
1. All records of all patients undergoing open splenectomy were reviewed.
2. A search of the CPH’s picture archiving and communication system (PACS) for computed tomography (CT) was undertaken using a combination of the keywords ‘spleen or splenic’ and ‘trauma, injury, laceration or rupture’.

All patients who had splenic injury were included regardless of age. Patients were classified as ‘paediatric’ if under 16 years of age on the date of admission; these patients were managed by the paediatric services. Patients 16 years and above, on the other hand, were classified as adult and managed by the adult services.

Patients were defined as having a splenic injury if they had evidence at operation or on CT scanning of splenic parenchymal disruption, evidence of recent bleeding or haematoma formation. A high-grade splenic injury was defined as AAST-grade IV or V injuries, or any splenic injury that required emergency open splenectomy due to haemodynamic instability on presentation.

Confirmed cases from the post-operative notes and CT reports were subsequently reviewed more closely. Only patients admitted and managed within the CPH were included. Non-traumatic and iatrogenic insults to the spleen were excluded.

Data collection
Admission and discharge data were collected from the CPH's electronic patient record system. If not stored electronically, physical notes were sought. The group was analysed as a whole then the high-grade injuries were examined separately to inform current management trends and outcomes in this important group.

Statistical analysis
Descriptive statistics were used to analyse the majority of the data while independent-samples Student t-test, Mann-Whitney U test, regression analysis and Kaplan-Meier analysis were utilised for the remainder. Statistical significance was determined if type I error rate was <5%. All analyses were performed using SPSS Statistics® software package (version 22.0.0.0).

Results
An initial sample of 597 possible suitable patients was identified, from which a study population of 238 patients was included, as shown in Figure 1. Of these, 89 patients had high-grade injuries. Results are given for the entire cohort of 238 patients before focusing on the outcomes of the 89 patients with high-grade injuries.

Figure 1: Iatrogenic splenic injury n=7.
Baseline characteristics of the splenic injury cohort

The median age on admission was 26 years (range, 4–88.7). There were more males (n=169) than females (n=69). The number of patients stratified by age and sex is shown in Figure 2.

Figure 3 demonstrates the mechanisms of injury. All but three injuries were the result of blunt trauma. The three penetrating injuries consisted of two patients who were assaulted with knives and a third patient in a hunting arrow accident. Three patients’ injuries were directly related to the 2011 Christchurch earthquake. Yearly admissions of splenic trauma patients have gradually increased over the decade, peaking in 2014 (see Figure 4).

Figure 2: Distribution of splenic injury patients by age and sex.

Figure 3: Mechanisms of trauma causing splenic injuries.

Other refers to a heterogeneous group of patients whose injuries were caused by workplace accidents (n=7), rugby tackles (n=3), hunting arrow (n=1) and skydiving (n=1). MVC = motor-vehicle crash; EQ = earthquake.
Management and outcomes—all grades

Patients were initially managed and stabilised in accordance to Early Management of Severe Trauma (EMST) guidelines. For patients who had an admission CT (n=215), most (63.4%) had low-grade splenic injuries (grade I=63, grade II=42 and grade III=45). Sixty-five patients had grade IV or V splenic injuries; 23 patients were taken for splenectomy without CT imaging.

Generally, there was a trend, albeit non-significant, to increased NOM over the study period (see Figure 5). The majority of patients in our cohort (173 patients; 72.7%) were managed conservatively, whereas 37 patients (15.5% of all patients) underwent splenectomy. Twenty-eight patients (11.8% of all patients) had SAE, 11 of whom sustained low-grade splenic injuries (all grade III): 10 patients demonstrated active bleeding on CT, while the last patient had...
no documented reason for SAE. One patient failed SAE and was successfully re-embo-
lised four days later (see Table 1).

In patients for whom blood transfusion data were available (n=223), 91 (40.8%) received one or more units of packed red blood cells (pRBC) and/or other blood products. In observation patients, the median number of pRBC units transfused was 0 units (range, 0–14), compared with two units (range, 0–42) in patients treated with SAE or splenectomy (p<0.001). The proportion of patients receiving a blood transfusion per year remained unchanged throughout the study period (mean, 40.6%).

The median length of hospital stay was 6.8 days (range, 0–190 days). Eighty-three patients (34.9%) were admitted to ICU during their hospital stay. The median duration of ICU stay was three days (range, 1–32).

### Management and outcomes—high grade

A total of 89 patients had high-grade injuries. Since these patients were more likely to have severe physiological compromise than low-grade patients, they were analysed separately for management and outcomes (see Table 2). Of these, 40 patients (44.9%) were managed conservatively. This sub-group was significantly younger than splenectomy patients (p=0.002), but not SAE patients (p=0.20).

Patients treated conservatively were significantly less likely to be transfused compared with patients managed with splenectomy (p=0.001) but not SAE (p=0.30). Similarly, their admission haemoglobin was significantly higher than patients treated with splenectomy (p=0.026) but not SAE (p=0.64).

### Table 1: Clinical parameters in the three management groups.

<table>
<thead>
<tr>
<th></th>
<th>NOM (n)</th>
<th>RI (n)</th>
<th>Splenectomy (n)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total (n)</td>
<td>173</td>
<td>28</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>Adult patients (n)</td>
<td>144</td>
<td>28</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Paediatric population (n)</td>
<td>29</td>
<td>0</td>
<td>1</td>
<td>0.006</td>
</tr>
<tr>
<td>Adult age (mean, years ± SD)</td>
<td>31.5 (±18.7)</td>
<td>35.5 (±20.2)</td>
<td>41.4 (±18.4)</td>
<td>0.013</td>
</tr>
<tr>
<td>Male (%)</td>
<td>72.3</td>
<td>71.4</td>
<td>65.8</td>
<td>0.73</td>
</tr>
<tr>
<td>Blood transfusion (%)</td>
<td>44.5</td>
<td>85.7</td>
<td>68.4</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Length of stay (median, days)</td>
<td>6.4</td>
<td>9.4</td>
<td>8.0</td>
<td>0.56</td>
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</tbody>
</table>

NOM = Non-operative management; RI = radiological intervention; SD = standard deviation.

### Table 2: Description of study population demographics.

<table>
<thead>
<tr>
<th></th>
<th>Male (n)</th>
<th>Female (n)</th>
<th>p-value</th>
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<tbody>
<tr>
<td>Total number (n)</td>
<td>169</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>Overall age (median, range)</td>
<td>25 (4–88.7)</td>
<td>27 (5.6–85)</td>
<td>0.41</td>
</tr>
<tr>
<td>Paediatric* age (median, range)</td>
<td>13 (4–16)</td>
<td>13 (5.6–15.9)</td>
<td>0.87</td>
</tr>
<tr>
<td>Adults age (median, range)</td>
<td>29 (16.3–88.7)</td>
<td>33 (16.2–85)</td>
<td>0.36</td>
</tr>
</tbody>
</table>

*Paediatric population was defined as being less than 16 years of age.
Thirty-two patients were treated with splenectomy. This included 23 (71.9%) patients who were emergently taken to the operating theatre without CT imaging due to haemodynamic instability (all had positive Focused Assessment with Sonography for Trauma scans of the abdomen). Patients managed with splenectomy were significantly more likely to have higher-grade splenic injuries (ie, higher proportion of grade V injuries) compared with patients treated conservatively (p=0.001) or with SAE (p=0.035). They were also significantly more likely to be admitted to ICU compared with conservative (p=0.014) or SAE (p=0.033) patients. Their stay in ICU, however, was not different to conservatively managed (p=0.89) or SAE (p=0.76) patients who were admitted to ICU.

A total of 17 patients underwent SAE. The median delay from admission to SAE was 389 minutes (range, 9 minutes–10 days). Eight patients had proximal SAE, seven had distal SAE, one patient had both and a site was not recorded for one patient. Most SAE were accomplished using coils (58.8%), followed by particle or glue plugs (17.6%) and combination (23.5%).

Splenic artery pseudoaneurysms were present in 29.4% of patients undergoing SAE. During angiography, 52.9% of patients were found to have active bleeding. All SAE were successful. The only complication was splenic infarction in one patient. No patient required subsequent splenectomy. SAE patients had a similar length of hospital stay compared with patients managed conservatively (p=0.64) and with splenectomy (p=0.48).

Discussion
This large study has shed light on patient demographics, characteristics of trauma and management outcomes of splenic injuries in a large tertiary centre in New Zealand; most patients sustained low-grade splenic injuries as a result of a blunt injury (most commonly an MVC) and were managed conservatively. There has been a steady increase in the number of patients diagnosed with splenic injury—especially low grade—perhaps attributable to better radiological imaging techniques and/or a change in risks to which post-earthquake Christchurch residents are exposed. In addition, there has been an increase in the use of radiological interventions in the management of these patients.

Patient characteristics in this study are similar to those described by Sanders et al’s report on adult patients where they reported that MVC was the most common cause of splenic injury. MVC patients in our study were more likely to have sustained less severe injuries and be haemodynamically stable (65.8%), compared with previous older studies. Safety measures in newer motor vehicles and stricter road policies could have contributed to differences in injury severity and/or mechanisms of injury.

There is an ongoing paradigm shift in the management of splenic injuries with a tendency towards NOM. This is clear in the patterns detected in our study, and is a major differentiator between our study (NOM=72%) and Sanders et al’s study (NOM=56.2%). While NOM has become the standard of care for haemodynamically stable patients with blunt splenic injury, those with peritonitis or haemodynamic instability still require exploratory laparotomy. The indications for SAE remain more controversial but include: high-grade injuries (grades IV and V), the presence of a contrast blush on CT, a moderate haemoperitoneum or clinical evidence of ongoing splenic bleeding. In the present study, SAE was used successfully in patients with both low- and high-grade injuries with one instance each of splenic infarction and re-embolisation, and no patients requiring splenectomy.

In general, our findings are similar to those from other international series on splenic injuries over a similar time-period. Table 3 summarises findings of our study, compared with Scottish and Taiwanese patients with splenic injuries.

This study is subject to certain limitations and biases. It is retrospective in design. During the decade over which this study spanned, Christchurch experienced several earthquakes and subsequent rebuild; these could have affected the catchment numbers and the risk profile to which residents are exposed. There are also potential issues with the recruitment of the study population. In the absence of a local trauma registry, it is possible that a few patients may have been missed, including those who had
an urgent laparotomy without a CT scan and despite having a splenic injury did not have their spleens excised. However, data from multiple sources were sought in order to corroborate the findings reported, and it is unlikely that a significant number of patients was missed. Multiple injuries often contribute to outcomes in splenic trauma patients. Injury severity scores were not reported in this study, which must be considered when comparing outcomes to other studies. Despite this, our study remains the largest study to be reported on splenic injuries in New Zealand.

### Table 3: Comparing three international studies on splenic injury patients.

<table>
<thead>
<tr>
<th></th>
<th>This study</th>
<th>Soo et al 10</th>
<th>Brady et al 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Origin</td>
<td>New Zealand</td>
<td>Taiwan</td>
<td>Scotland</td>
</tr>
<tr>
<td>Sample</td>
<td>238</td>
<td>578</td>
<td>672</td>
</tr>
<tr>
<td>Age (mean, years)</td>
<td>33.4</td>
<td>36.7</td>
<td>35.7</td>
</tr>
<tr>
<td>Male (%)</td>
<td>70.1</td>
<td>73.2</td>
<td>76.3</td>
</tr>
<tr>
<td>MVC (%)</td>
<td>50</td>
<td>32.5</td>
<td>71</td>
</tr>
<tr>
<td>LOS (mean, days)</td>
<td>11.4</td>
<td>11.2</td>
<td>8</td>
</tr>
<tr>
<td>Splenectomy (%)</td>
<td>16.7</td>
<td>44.6</td>
<td>N/A</td>
</tr>
<tr>
<td>Mortality* (%)</td>
<td>8</td>
<td>5</td>
<td>33.5</td>
</tr>
</tbody>
</table>

LOS = length of stay; MVC = motor vehicle crash; N/A = information not available.
*Refers to overall mortality rate to date of data acquisition.

### Conclusion

Admissions with splenic injury have shown a steady increase in the last decade with young males remaining the group most frequently affected. Splenectomy rates have decreased in favour of non-operative techniques including SAE. While haemodynamic instability and peritonitis mandate splenectomy, SAE may be considered in stable patients with high-grade injuries, contrast extravasation or clinical evidence of ongoing bleeding. In all other blunt splenic injuries, conservative management remains the gold standard.

### Competing interests:
Nil.

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