



Article

Outcomes and Predictors of Failure of Non-Operative Management in Blunt Splenic Trauma: A South African Level I Trauma Centre Experience

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Abstract

Background: Non-operative management (NOM) is the standard of care for haemodynamically stable patients with blunt splenic injury; however, failure of NOM remains clinically significant, particularly in settings where adjunctive interventions such as splenic artery embolisation are not routinely utilised. This study aimed to evaluate NOM outcomes and identify predictors of failure at a South African Level I trauma centre. **Methods:** A retrospective cohort study of adult patients with blunt splenic injury over a 5-year period (2020–2025) was conducted. Patients were stratified according to their initial management strategy into operative and non-operative groups. Categorical variables were compared using Fisher's exact test, and continuous variables using the Mann–Whitney U test. Multivariable logistic regression analysis was performed to identify independent predictors of NOM failure. **Results:** A total of 136 patients were included. Twelve patients (8.8%) underwent immediate operative management, while 124 (91.2%) were initially managed non-operatively. NOM was successful in 112 patients (90.3%), with 12 patients (9.7%) requiring delayed operative intervention. Overall mortality was 4.4% (6/136), with all deaths attributable to associated injuries rather than isolated splenic trauma. Increased admission heart rate was independently associated with NOM failure (OR 1.04 per beat increase; 95% CI 1.01–1.08; $p = 0.009$). Higher Injury Severity Scores and severe traumatic brain injury were more frequent in patients with NOM failure but were not independently predictive. Splenic artery embolisation was not utilised in this cohort. **Conclusions:** Non-operative management is safe and effective for blunt splenic injury, with high rates of splenic preservation. Admission tachycardia predicts NOM failure and may guide early clinical decision-making. These findings support the use of NOM in low- and middle-income settings where interventional radiology is not routinely available.

Keywords: non-operative management; blunt splenic injury; splenic trauma; splenectomy; low- and middle-income countries



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1. Introduction

Blunt abdominal trauma remains a significant cause of morbidity and mortality worldwide, particularly among young adults, with the spleen representing the most frequently injured intra-abdominal organ following blunt trauma [1–3]. Splenic injuries commonly result from high-energy mechanisms such as motor vehicle collisions (MVC), pedestrian–vehicle collisions (PVC) and falls from height [1–3]. Historically, operative management

with splenectomy was considered the standard treatment for splenic trauma because of concerns regarding uncontrolled haemorrhage and haemodynamic instability [2–4]. However, increasing recognition of the immunological importance of the spleen and the potential complications associated with splenectomy has driven a paradigm shift toward splenic preservation whenever feasible [2–4].

Over the past several decades, non-operative management (NOM) has become the preferred treatment strategy for haemodynamically stable patients with blunt splenic trauma [2,3,5]. Advances in trauma imaging, particularly computed tomography (CT), together with improvements in trauma resuscitation, critical care monitoring, and the introduction of adjunctive therapies such as splenic artery embolisation, have significantly improved the success of splenic preservation strategies [3,5,6]. Contemporary studies report NOM success rates exceeding 85–90% in appropriately selected patients [2,3,5,7].

Despite these favourable outcomes, failure of NOM remains an important clinical concern. Delayed haemorrhage or clinical deterioration may necessitate operative intervention, and identifying patients who are at increased risk of NOM failure is therefore a key component of trauma care [2,8,9]. Several factors have been associated with failure of NOM, including higher grades of splenic injury, haemodynamic instability, increased injury severity score (ISS), transfusion requirements, and the presence of associated injuries [9,10]. Early recognition of these predictors may assist clinicians in identifying patients who require closer monitoring or early operative intervention.

Much of the available literature describing outcomes of NOM for blunt splenic trauma originates from high-income countries (HICs), where trauma systems are well developed and access to advanced imaging, critical care resources, and interventional radiology is widely available [3,11]. These studies consistently demonstrate high success rates for NOM in carefully selected patients [2,3]. However, it remains uncertain whether similar outcomes can be consistently achieved in low- and middle-income countries (LMICs), where trauma burden is often higher and healthcare systems frequently operate under resource constraints [11,12]. Variability in the utilisation of adjunctive interventions such as splenic artery embolisation may influence both patient selection and the success of NOM strategies [13,14].

The aim of this study was to evaluate the outcomes of non-operative management in patients with blunt splenic trauma treated at a Level I trauma centre in a low- and middle-income country and to identify predictors of NOM failure, thereby contributing to the limited evidence on splenic trauma management in similar settings.

2. Methods

This retrospective observational study included adult trauma patients aged ≥ 18 years who sustained blunt splenic injury and were managed at a Level I trauma centre in Johannesburg, South Africa. The study period was five years (1 June 2020 to 31 May 2025). Patients with blunt splenic injuries were identified using the Medibank trauma registry. Patients who died in the emergency department before a management decision could be made were excluded.

According to institutional trauma protocols based on Advanced Trauma Life Support® (ATLS®) principles, haemodynamically unstable patients with suspected intra-abdominal bleeding underwent emergent operative intervention. Haemodynamically stable patients with blunt splenic injury were considered for NOM, which consisted of close clinical observation, serial physical examinations in an Intensive Care Unit (ICU) or High Care Unit (HCU), and repeat imaging when clinically indicated. Although interventional radiology services were available at our institution, the use of splenic artery embolisation (SAE) was not incorporated into a standardised institutional protocol during the study period.

Decisions regarding angioembolisation were made at the discretion of the treating surgeon. During the study period, none of the adult patients admitted with blunt splenic injuries underwent SAE. This study was approved by the University of the Witwatersrand Human Research Ethics Committee (Medical) (approval number: M251053).

Patients were categorised according to their initial management strategy as immediate operative management (OM) or NOM. Failure of NOM was defined as the requirement for delayed operative intervention following an initial attempt at NOM.

The following variables were collected from the trauma registry and electronic medical records: age, sex, mechanism of injury, admission physiological parameters (systolic blood pressure, heart rate, and Glasgow Coma Scale [GCS]), Injury Severity Score (ISS), and splenic injury grade. Splenic injuries were graded using the American Association for the Surgery of Trauma (AAST) splenic injury scale, based on computed tomography findings. Associated injuries, including head, chest, pelvic, extremity, and other intra-abdominal injuries, were recorded. Patients were also categorised according to the presence of three or more injured body regions.

The primary outcome was failure of non-operative management. Categorical variables were analysed using Fisher's exact test, and continuous variables using the Mann–Whitney U test. Multivariable logistic regression analysis was performed to identify predictors of NOM failure. A p -value < 0.05 was considered statistically significant. All statistical analyses were conducted using Stata version 19 (StataCorp LLC, College Station, TX, USA).

3. Results

3.1. Patient Cohort

During the study period, 136 patients with blunt splenic trauma were included. Of these, 12 patients underwent immediate OM due to clinical indications for surgery, while 124 patients were initially managed with NOM.

Among the NOM cohort, 112 patients (90.3%) were successfully managed non-operatively, whereas 12 patients (9.7%) experienced failure of NOM and subsequently required operative intervention (Figure 1).

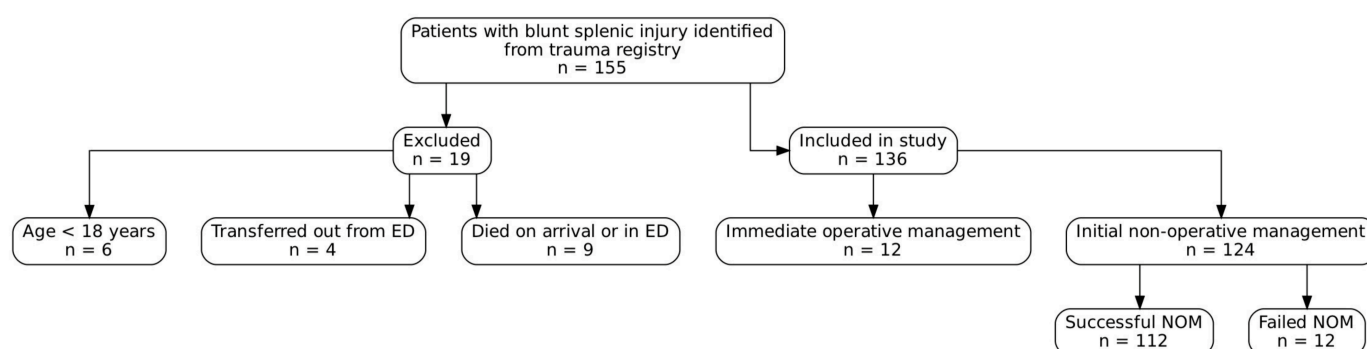


Figure 1. Flow diagram illustrating study inclusion and management pathways of patients with blunt splenic trauma. Of 155 patients identified during the study period, 19 were excluded (6 aged < 18 years, 4 transferred to another institution from the emergency department, and 9 died on arrival or in the emergency department). The final study cohort comprised 136 adult patients, of whom 12 underwent immediate total splenectomy and 124 were initially managed non-operatively. Among those managed non-operatively, 112 (90.3%) were successfully treated and 12 (9.7%) required delayed splenectomy following failure of non-operative management. All failures of non-operative management occurred within 48 h of admission. Failure was diagnosed clinically on the basis of haemodynamic deterioration and ongoing blood transfusion requirements, prompting immediate operative intervention. Intra-operatively, ongoing haemorrhage from the injured spleen was identified in all cases. Overall in-hospital mortality was 6/136 (4.4%) and was attributable to associated injuries.

3.2. Demographic and Clinical Characteristics

Baseline demographic and clinical characteristics of patients undergoing non-operative management are summarised in Table 1.

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

Variable	Non-Operative Group (<i>n</i> = 112)	Operative/Failure Group (<i>n</i> = 12)	<i>p</i>
Males (%)	84 (75.0)	9 (75.0)	1.000
Age (years)	40 (31.5–52)	28 (25–40)	0.030
Systolic BP (mmHg)	123.5 (109–139.5)	114.5 (91.5–141)	0.335
Heart rate/min	94 (84.5–112)	141.5 (120–147)	<0.001
Injury Severity Score	29 (22–36)	39.5 (29.5–50.5)	0.010
>3 regions injured (%)	58 (51.8)	5 (41.7)	0.556
Isolated splenic injury (%)	1 (0.9)	0 (0.0)	1.000
Glasgow Coma Scale < 8 (%)	35 (31.3)	8 (66.7)	0.023
Type of blunt MOI			0.346
MVC	60	4	
PVC	8	0	
MBC	23	4	
Crush	8	2	
Fall	10	2	
Assault	3	0	

The majority of patients were male, comprising 84 (75.0%) of those successfully managed with NOM and 9 (75.0%) patients who experienced NOM failure. Patients who failed NOM were significantly younger, with a median age of 28 years (IQR 25–40) compared with 40 years (IQR 31.5–52) in the successful NOM group ($p = 0.030$).

Physiological parameters on admission also differed between groups. Patients who experienced NOM failure had higher admission heart rates, with a median of 141.5 bpm (IQR 120–147) compared with 94 bpm (IQR 84.5–112) in those successfully managed non-operatively ($p < 0.001$). Admission systolic blood pressure did not differ significantly between groups.

Patients who failed NOM demonstrated greater injury severity, with a higher median Injury Severity Score (ISS) of 39.5 (IQR 29.5–50.5) compared with 29 (IQR 22–36) in the successful NOM group ($p = 0.010$). Severe traumatic brain injury (GCS < 8) was also more common among patients with NOM failure (66.7% vs. 31.3%, $p = 0.023$).

Patients were stratified according to successful NOM or NOM failure requiring splenectomy. Continuous variables are presented as median (interquartile range), and categorical variables as number (percentage). Statistical comparisons between groups were performed using the Mann–Whitney U test for continuous variables and Fisher’s exact test for categorical variables.

Only two patients (1.5%) had isolated splenic injuries; one underwent immediate splenectomy for an isolated Grade V injury, while the other had an isolated Grade I injury and was successfully managed non-operatively. The proportion of patients with injuries involving three or more body regions was similar between groups.

3.3. Mechanism of Injury

The most common mechanism of injury was motor vehicle collision, followed by motorbike collisions, pedestrian–vehicle collisions, falls, and crush injuries. The distribution of injury mechanisms did not differ significantly between patients with successful NOM and those who experienced NOM failure.

3.4. Splenic Injury Grade Distribution

The distribution of splenic injury grades according to NOM outcome is shown in Figure 2. Lower-grade injuries (AAST grades I–III) were more commonly associated with successful NOM, whereas high-grade injuries (grades IV–V) accounted for a greater proportion of NOM failures.

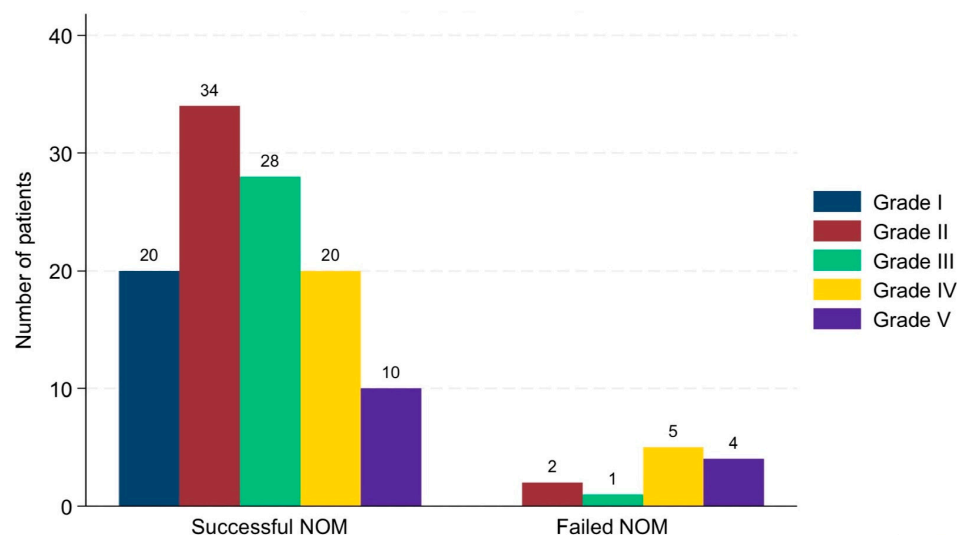


Figure 2. Distribution of splenic injury grades according to the outcome of non-operative management (NOM). The bar chart demonstrates the number of patients with American Association for the Surgery of Trauma (AAST) splenic injury grades I–V stratified by successful NOM and failed NOM. Lower-grade injuries (Grades I–III) were more commonly managed successfully with NOM, whereas higher-grade injuries (Grades IV–V) accounted for a greater proportion of NOM failures.

3.5. Clinical Outcomes

Clinical outcomes of patients managed with NOM are summarised in Table 2. ICU admission occurred in 48 patients (42.9%) in the successful NOM group and 5 patients (41.7%) in the NOM failure group, with no significant difference between groups.

Table 2. Clinical outcomes of patients with blunt splenic injury managed with NOM, comparing those with successful NOM and those who experienced NOM failure. Outcomes assessed included ICU admission, ICU LOS, and total hospital LOS. Continuous variables are presented as median (IQR), and categorical variables as number (percentage).

Variable	Successful NOM (<i>n</i> = 112)	Failed NOM (<i>n</i> = 12)	<i>p</i> Value
ICU admission, <i>n</i> (%)	48 (42.9)	5 (41.7)	1.00
ICU length of stay, days (median IQR)	13.5 (6–21.5)	24 (15–56)	0.10
Hospital length of stay, days (median IQR)	21 (11.5–32.5)	23.5 (16–39.5)	0.65

Median ICU length of stay (LOS) was 13.5 days (IQR 6–21.5) in patients with successful NOM and 24 days (IQR 15–56) in those who experienced NOM failure. Median hospital length of stay was 21 days (IQR 11.5–32.5) in the successful NOM group and 23.5 days (IQR 16–39.5) in the NOM failure group. These differences were not statistically significant, as shown in Table 2.

ICU length of stay was calculated among patients admitted to an ICU. Statistical comparisons between groups were performed using Fisher’s exact test for categorical variables and the Mann–Whitney U test for continuous variables.

Variables associated with NOM failure on univariate analysis were entered into a multivariable logistic regression model to identify independent predictors of failure. The overall model was statistically significant ($LR \chi^2 = 30.5, p < 0.001$).

Increased admission heart rate was independently associated with failure of non-operative management (OR 1.04 per beat increase; 95% CI 1.01–1.08; $p = 0.009$).

High-grade splenic injury demonstrated a strong association with NOM failure (OR 4.94; 95% CI 0.97–25.09), although this did not reach conventional statistical significance ($p = 0.054$).

Age, Injury Severity Score, and severe traumatic brain injury (GCS < 8) were not independently associated with NOM failure after adjustment. The results are shown in Table 3.

Table 3. Multivariable logistic regression analysis identifying predictors of failure of NOM in patients with blunt splenic injury. The model included age, ISS, admission heart rate, GCS < 8, and high-grade splenic injury. Results are presented as odds ratios (OR) with 95% confidence intervals (CI). Increasing admission heart rate was independently associated with a higher likelihood of NOM failure, while high-grade splenic injury showed a trend toward significance.

Variable	Odds Ratio	95% CI	<i>p</i> Value
Age	0.95	0.90–1.01	0.11
Injury Severity Score (ISS)	1.05	0.97–1.14	0.21
Heart rate	1.04	1.01–1.08	0.009
Glasgow Coma Scale < 8	1.46	0.29–7.38	0.65
High-grade splenic injury	4.94	0.97–25.09	0.054

3.6. Model Performance

Model calibration assessed using the Hosmer–Lemeshow goodness-of-fit test demonstrated adequate fit ($\chi^2 = 78.0, p = 0.998$). The model demonstrated excellent discrimination, with an area under the receiver operating characteristic (ROC) curve of 0.9085, as shown in Figure 3.

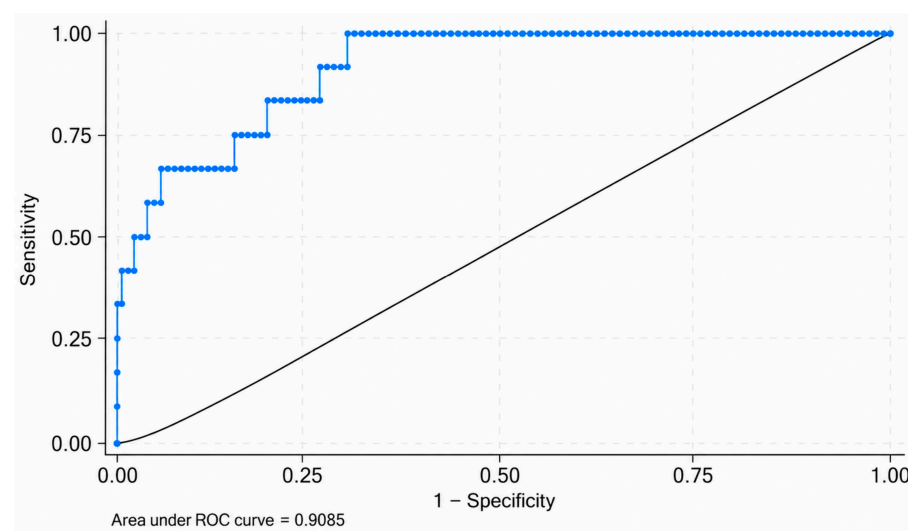


Figure 3. Receiver operating characteristic (ROC) curve demonstrating the predictive performance of the multivariable logistic regression model for failure of non-operative management (NOM) in patients with blunt splenic injury. The ROC curve plots sensitivity against 1 – specificity across varying probability thresholds. The model demonstrated excellent discrimination, with an area under the ROC curve (AUC) of 0.9085, indicating a high ability to distinguish between successful and failed NOM. The diagonal reference line represents the performance of a non-informative classifier (AUC = 0.5).

4. Discussion

This study evaluated the outcomes of NOM in adult patients presenting with blunt splenic trauma at a Level I trauma centre. In this cohort, NOM was successful in 90.3% of patients, while 9.7% required operative intervention following initial non-operative treatment. Increased admission heart rate was independently associated with failure of NOM, and high-grade splenic injury showed a trend toward increased risk of failure. Overall mortality was low (4.4%) and was attributable to associated injuries, rather than splenic injury itself.

NOM has become the standard of care for haemodynamically stable patients with blunt splenic injuries. Current trauma guidelines recommend NOM as the primary management strategy in stable patients regardless of injury grade when appropriate monitoring and resources are available. Reported success rates in the literature typically range between 85% and 95%, particularly in centres with established trauma systems and advanced imaging capabilities. The NOM success rate observed in our cohort (90.3%) is therefore consistent with previous large observational studies and systematic reviews that have demonstrated high rates of splenic preservation with selective operative intervention when necessary [2,3,5,7].

The mechanism of injury observed in this cohort reflects the epidemiology of blunt trauma commonly reported in trauma registries worldwide. MVC were the most common mechanism of injury, followed by MBC and PVC. Similar patterns have been reported in trauma registry studies where road traffic collisions account for the majority of blunt splenic injuries, particularly in urban trauma populations [2,15,16]. In our study, the distribution of injury mechanisms did not differ significantly between patients with successful NOM and those who experienced treatment failure, suggesting that the mechanism of injury alone may not be a reliable predictor of NOM outcomes.

Injury grade remains an important consideration when determining the likelihood of successful non-operative management. In this study, lower-grade splenic injuries (AAST grades I–III) were more frequently associated with successful NOM, whereas higher-grade injuries (grades IV–V) accounted for a greater proportion of NOM failures. Although high-grade injury demonstrated a strong association with failure of NOM, it did not reach conventional statistical significance after adjustment. Previous studies have similarly shown that increasing injury grade is associated with higher rates of NOM failure; however, successful non-operative management can still be achieved in selected patients with high-grade injuries when careful monitoring and timely intervention are available [3,6–8].

Physiological parameters at presentation are important indicators of ongoing haemorrhage and clinical deterioration. In the present study, an increased admission heart rate was independently associated with failure of NOM. Heart rate was defined using the first recorded admission value and should be interpreted in conjunction with the overall clinical assessment and serial observations. Potential confounders such as pain, anxiety, and prior medication use were not consistently documented and could not be accounted for in this retrospective analysis. Tachycardia may represent an early physiological response to hypovolaemia and has been identified in several trauma studies as a marker of injury severity and potential haemodynamic compromise. Early recognition of such physiological abnormalities may therefore assist clinicians in identifying patients who are at increased risk of NOM failure who may require closer monitoring or earlier operative intervention [2,8,15,17].

Interestingly, systolic blood pressure at presentation was not independently associated with failure of NOM in this cohort, and several patients who ultimately required operative intervention initially presented with normal blood pressure. Similar observations have been reported in previous studies of blunt splenic trauma, where hypotension was not

consistently identified as an independent predictor of NOM failure. This observation likely reflects the phenomenon of compensated haemorrhagic shock, in which early physiological responses such as tachycardia and peripheral vasoconstriction maintain the systolic blood pressure despite ongoing blood loss. Consequently, hypotension may represent a relatively late manifestation of haemorrhage, whereas earlier physiological responses such as tachycardia may provide more sensitive indicators of ongoing bleeding in patients undergoing non-operative management of splenic injury [2,7,15,18].

Patients who experienced NOM failure also demonstrated higher Injury Severity Scores and a greater proportion of severe traumatic brain injury compared with those who were successfully managed non-operatively. These findings likely reflect the increased physiological stress and complexity associated with polytrauma. However, these factors were not independently associated with NOM failure after adjustment in the multivariable model. Similar observations have been reported in previous trauma studies evaluating predictors of NOM failure, where overall injury severity contributes to the clinical complexity but does not necessarily independently predict failure of splenic preservation strategies [6,8,16].

Overall mortality in this cohort was relatively low, at 4.4%. Importantly, all deaths occurred in patients with significant associated injuries, rather than isolated splenic trauma. This finding is consistent with prior trauma studies demonstrating that mortality following blunt splenic injury is often related to concomitant injuries, particularly traumatic brain injury or multisystem trauma, rather than splenic injury itself [2,3,17]. These findings reinforce the importance of considering the overall injury burden when evaluating outcomes in patients with blunt abdominal trauma.

An important contextual consideration in this study is that SAE was not routinely utilised during the study period. Although interventional radiology services were available at our institution, the use of SAE was not incorporated into a standardised institutional protocol, and the decision to pursue embolisation was made at the discretion of the treating surgeon. During the study period, none of the adult patients admitted with blunt splenic injuries underwent SAE. In addition, access to interventional radiology was limited during weekends and after-hours, which coincide with peak trauma presentation times in our setting. Patients who failed non-operative management were taken directly to the operating room for laparotomy, where 11 underwent total splenectomy and 1 underwent subtotal splenectomy. In many trauma centres, splenic artery embolisation has become an important adjunct to increase the success of non-operative management, particularly in patients with high-grade injuries or radiological evidence of vascular injury. Despite the absence of routine embolisation in this cohort, our centre achieved a high rate of successful NOM. This suggests that careful patient selection, vigilant clinical observation, and timely surgical intervention when required remain key components of effective splenic injury management. This suggests that careful patient selection, vigilant clinical observation in a monitored setting, and timely surgical intervention when required remain key components of effective splenic injury management [3,8,13].

5. Limitations

This study has several limitations. Its retrospective, single-centre design is subject to incomplete documentation and may limit the generalisability of the findings. In addition, the relatively small sample size, particularly the limited number of patients who failed non-operative management, may have reduced the ability to detect other independent predictors of failure. Although our institution uses thromboelastography (TEG)-guided haemostatic resuscitation protocols, specific coagulation parameters and complete transfusion data,

including quantities of packed red blood cells and other blood products, were inconsistently captured in the retrospective dataset and could therefore not be analysed.

6. Conclusions

Non-operative management remains a safe and effective strategy for the management of haemodynamically stable patients with blunt splenic trauma. In this cohort, a high rate of splenic preservation was achieved, with admission tachycardia emerging as an independent predictor of treatment failure. Mortality was low and was largely attributable to associated injuries, rather than splenic trauma itself. These findings support the role of careful patient selection and vigilant clinical monitoring in optimising outcomes in patients undergoing non-operative management of blunt splenic injury, even in LMIC settings.

Author Contributions: V.B. and S.M. collected and analysed the patient data, and equally contributed to writing the manuscript. M.S.M. designed this study and interpreted the patient data. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Human Research Ethics Committee (Medical) of University of the Witwatersrand (approval number: M251053) on 6 November 2025.

Informed Consent Statement: Informed consent was waived due to the retrospective nature of the study involving review of existing medical records. The study posed minimal risk to participants, as no direct contact or intervention was undertaken, and no identifiable patient information was collected for analysis.

Data Availability Statement: The datasets are available upon reasonable request.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

NOM	Non-Operative Management
CT	Computed Tomography
ISS	Injury Severity Score
HICs	High-Income Countries
LMICs	Low- and Middle-Income Countries
ATLS	Advanced Trauma Life Support
ED	Emergency Department
ICU	Intensive Care Unit
HCU	High Care Unit
OM	Operative Management
GCS	Glasgow Coma Scale
AAST	American Association for the Surgery of Trauma
IQR	Interquartile Range
BPM	Beats Per Minute
MOI	Mechanism Of Injury
MVC	Motor Vehicle Collisions
PVC	Pedestrian–Vehicle Collisions
MBC	Motor Bike Collisions
LOS	Length Of Stay
SAE	Splenic Artery Embolisation
TEG	Thromboelastography

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