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Factors Determining Splenectomy in Cases of Splenic Injuries

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Abstract

Introduction: In light of the severe morbidity associated with Overwhelming Post-Splenectomy Infection (OPSI), the standard of care for splenic injury has evolved to prioritize organ conservation over surgical extirpation. The primary aim of this investigation was to evaluate the prognostic factors influencing the surgical management of isolated splenic trauma, thereby identifying opportunities to maximize immunocompetent splenic preservation.

Patients and Methods: This study interrogated the clinical records of 55 subjects presenting with solitary splenic trauma attributable to acute abdominal mechanisms between the years 2017 and 2022. Data were evaluated via a retrospective analytical modeling framework. Clinical outcomes were classified according to a therapeutic triad: non-surgical intervention, operative salvage techniques, and radical splenectomy.

Results: The majority of patients suffered splenic injury due to traffic accidents or falls. Splenectomy was performed on 33 patients (60%), 12 patients (22%) underwent non-surgical treatment, and 10 patients (18%) were surgically salvaged. The important factors determining splenectomy were the degree of splenic injury, the surgeon's rank, and the assistant's rank.

Discussion: Motor vehicle collisions and falls constitute the predominant mechanisms of blunt abdominal trauma observed in this cohort. The ultimate grade of splenic injury is seemingly a function of the ratio between kinetic force transmission and local anatomical shielding. Regarding therapeutic intervention, the feasibility of splenic preservation is largely dictated by the surgical team's expertise, their inclination toward organ-sparing techniques, and the accessibility of requisite intraoperative technologies.

Conclusion: The implementation of rigorous vehicular safety legislation and enhanced parental supervision may effectively mitigate the severity of splenic trauma resulting from blunt abdominal mechanisms. Furthermore, in clinical scenarios necessitating operative intervention, splenic preservation strategies should be prioritized for intermediate-grade isolated injuries to curtail the long-term risk of Overwhelming Post-Splenectomy Infection (OPSI).

Keywords: Splenic Injury, Therapeutic Intervention; OPSI.

Introduction

The spleen constitutes the most frequently injured solid viscus following instances of blunt abdominal trauma. Historically, the therapeutic standard for such injuries was predicated on radical splenectomy, with the primary objective being immediate hemostatic control. However, the elucidation of the spleen's critical immunological competence specifically its role in the phagocytic clearance of encapsulated pathogens from the systemic circulation has necessitated the implementation of mandatory postoperative prophylactic regimens. These protocols, comprising vaccination and antimicrobial therapy, are essential in asplenic patients to mitigate the risk of Overwhelming Post Splenectomy Infection (OPSI). Consequently, to preserve native immunity and obviate the risks associated with asplenia, the clinical management paradigm underwent a significant transition in the 2022s, shifting from routine surgical extirpation toward splenic preservation strategies [1-4].

Contemporary strategies for splenic preservation encompass a multimodal approach, including conservative Non-Operative Management (NOM), angiographic embolization, and operative salvage techniques. However, within our specific clinical setting, the management of blunt splenic trauma remains predominantly surgical, characterized by a suboptimal rate of organ conservation. This clinical challenge is further compounded by high rates of patient non-compliance with outpatient follow-up. Such attrition precludes accurate epidemiological assessment of OPSI incidence and significantly impedes the effective administration of mandatory post-splenectomy prophylactic regimens, including vaccination and antimicrobial therapy.

Discussion. Contemporary trauma algorithms increasingly prioritize Non-Operative Management (NOM) utilizing adjunctive therapies such as angiographic embolization and blood product resuscitation, even for high-grade splenic injuries. Paradoxically, however, among patients necessitating exploratory laparotomy, there has been a marked shift toward radical splenectomy even for low-grade injuries representing a significant deviation from historical preservation prac-

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tices. This trend is quantified by Ko et al., whose comparative analysis of historical (2012–2024) and contemporary (2014–2022) cohorts revealed a precipitous decline in splenorrhaphy utilization (from 43.4% to 1.4%), despite the procedure retaining consistently high efficacy (98.7% vs. 100%). These findings are corroborated by recent National Trauma Data Bank data, which indicated a similarly negligible rate of splenic repair (1.7% in 2015). Despite these established trends, there remains a paucity of data regarding the specific impact of these divergent surgical strategies on patient outcomes [5-8].

The primary objective of this investigation was to delineate the prognostic disparities between distinct operative modalities specifically splenorrhaphy versus radical splenectomy within the population of trauma patients requiring exploratory laparotomy [9-11]. We postulated that splenic preservation is associated with superior clinical outcomes relative to surgical extirpation. This hypothesis is grounded in two fundamental physiological tenets: first, that surgical asplenia compromises host immunocompetence, thereby exacerbating the risk of infectious sequelae and general postoperative morbidity; and second, that splenectomy heightens the susceptibility to venous thromboembolism (VTE), a phenomenon attributable to the cessation of the spleen's critical role in hemorheology and the sequestration of senescent erythrocytes [11-17].

Main objective of this investigation was to elucidate the specific determinants necessitating splenectomy in patients presenting with isolated splenic trauma secondary to blunt abdominal mechanisms. By analyzing these factors within a defined regional cohort, this study sought to identify clinical opportunities to optimize protocols and enhance the overall rates of splenic preservation.

Patient and methods

Design of the Study

Methods. A retrospective, hospital-based descriptive study was conducted to evaluate isolated splenic injuries resulting from blunt abdominal trauma. The study population comprised patients diagnosed and stratified via abdominopelvic ultrasonography between 2017 and 2022 at the surgical unit of Wesley Guild Hospital, Ilesa a satellite facility of the Obafemi Awolowo University Teaching Hospitals Complex (OAUTHC), Ile-Ife, Nigeria [18-20]. This institution functions as a regional referral center serving the demographic catchment area of Ilesa, Ekiti State, and adjacent municipalities.

Data were systematically aggregated using a structured data extraction instrument. Demographic and clinical variables included age, gender, mechanism of injury, injury-to-presentation interval, and hemodynamic indices at admission (pulse rate and blood pressure) [21]. Hematological and operative metrics encompassed admission packed cell volume (PCV), transfusion requirements (pre and intra operative), volume of hemoperitoneum, and injury severity (classified via the Splenic Organ Injury Scaling System). Furthermore, procedural details such as the timing of surgical intervention, the seniority of the primary and assisting surgeons, and the specific therapeutic modality utilized were rigorously recorded [22-23].

Setting of the study

The study was carried out over a period of approximately ten weeks, specifically from 29 November 2024, to 3 February 2025. During this time, all patients who were clinically suspected of having acute appendicitis and who met the inclusion criteria were enrolled in the study.

The study instruments and sampling

Therapeutic interventions were stratified into three distinct modalities: Non-Operative Management (NOM), operative salvage, and splenectomy. The protocol for NOM was strictly reserved for patients demonstrating sustained hemodynamic stability following initial resuscitation, corroborated by stable or resolving pathology on serial abdominal ultrasonography. Conversely, patients failing to meet these physiologic criteria necessitated operative intervention. Cases presenting with incomplete clinical datasets were excluded from the final analysis. Statistical Analysis. Data processing was executed utilizing SPSS Version 15.0 for Windows [23]. The analytical framework incorporated descriptive statistics and linear regression models, with statistical significance established at a threshold of $p < 0.05$. All data were cross-verified with patient records for accuracy and consistency [24-25].

Inclusion criteria

Patients age below 18 and above 60, patients with no medical disease (past medical history negative).

Statistical analysis

The collected data were entered into Microsoft Excel and analyzed statistically to determine the diagnostic value of ultrasou 4. False Negatives (FN) [26]: Cases where ultrasound was negative but histopathology confirmed appendicitis. Based on these values, the following were computed:

Sensitivity = TP / (TP + FN)
Specificity = TN / (TN + FP)
Positive Predictive Value (PPV) = TP / (TP + FP)
Negative Predictive Value (NPV) = TN / (TN + FN)
Accuracy = (TP + TN) / Total number of cases

Furthermore, a matching analysis was performed to compare the consistency between ultrasound and histopathological findings. Cases were classified as: 1) Positive matching: both US and HPE results were positive, and 2) Negative matching: both results were negative. The diagnostic performance was then summarized in contingency tables and visualized using bar charts and pie charts to enhance clarity.
Ethical Considerations

The study was conducted in compliance with ethical standards. Permission to access patient data and perform diagnostic evaluations was obtained from the respective hospitals. All patient data were anonymized to maintain confidentiality. If required by the institutional review boards, verbal or written consent was obtained prior to inclusion.

Results

A total of 55 subjects satisfied the inclusion criteria, exhibiting a male-to-female ratio of 1.9:1 (n=36 males, n=19 females). The median age of the cohort was 14 years (range: 3–60 years). Table I delineates the distribution of injury mechanisms stratified by age decile. The analysis reveals an inverse relationship between age and the prevalence of isolated splenic trauma, accompanied by marked age-dependent variations in etiology. Motor vehicle accidents (MVAs) and falls constituted the predominant mechanisms, collectively accounting for 91% (n=50) of the study population. Within the first two decades of life, falls (49%) and MVAs (40%) represented the primary causes of injury; notably, all recorded instances of falls from height were exclusively confined to this demographic. Conversely, among patients in the third to sixth decades, the injury mechanism was overwhelmingly dominated by MVAs (95%), with the residual incidence attributable to minor falls and a solitary case of assault.

The preponderant burden of morbidity comprised moderate to severe splenic trauma, with 73% (n=40) of the cohort sustaining

injuries classified as Grade III through V. As delineated in Table II, the incidence of high-grade injury was strongly correlated with high-energy mechanisms, specifically motor vehicle accidents (MVAs) and falls from height.

Regarding therapeutic management, successful Non-Operative Management (NOM) was achieved in 22% (n=12) of the total population (out of an initial subset of 20 candidates). Failure of conservative therapy was recorded in six patients, necessitated by recalcitrant hemodynamic instability and declining hematocrit levels. Consequently, exploratory laparotomy was performed in 78% (n=43) of the cohort. Intraoperative outcomes, detailed in Table III, indicate a splenic salvage rate of 18% (n=10), while radical splenectomy was required in 60% (n=33) of cases. Postoperative mortality was limited to a single fatality within the splenectomy group, attributed to Acute Respiratory Distress Syndrome (ARDS) secondary to anesthetic complications. Stratification of surgical efficacy revealed that splenic salvage was achievable in 93% of Grade II and 44% of Grade III injuries. Utilized splenorrhaphy techniques included electrocautery and vertical mattress suturing, augmented where indicated by omentoplasty (omental overlay/wrapping). Notably, angiographic embolization was not utilized in this series due to institutional resource constraints.

Analysis of management strategies stratified by age reveals an inverse relationship between advancing age and the success of splenic preservation. As detailed in Table IV, 49% (n=17) of patients within the first two decades of life were successfully managed via Non-Operative Management (NOM) or splenorrhaphy, in contrast to only 25% (n=5) of patients in older age cohorts. Furthermore, temporal and mechanistic variables significantly influenced surgical outcomes. The incidence of splenectomy was notably elevated among patients treated during nocturnal operating hours (Figure 1 and 2) and in those sustaining high-energy trauma secondary to motor vehicle accidents or falls from height (Table 2). Multivariate Analysis. Linear regression analysis (Table 1) identified the severity of splenic injury (grade) and the seniority of the surgical team as the primary independent predictors of splenectomy. Specifically, a positive correlation was observed between the cumulative experience of the operating surgeon and assistant and the likelihood of successful intraoperative splenic preservation.

Table 1: *The mechanism of injury versus age in decades.*

Age in decades	MVA	Fall from height	Assault	Abuse	Sports	Total
1st decade	8	7	0	1	2	18
2nd decade	6	10	1	0	0	17
3rd decade	9	0	0	0	0	9
4th decade	6	0	1	0	0	7
5th decade	3	0	0	0	0	3
6th decade	1	0	0	0	0	1
Total	**33**	**17**	**2**	**1**	**2**	**55**

Table 2: *Degree of splenic injury V. Mechanism of injury.*

Mechanism of injury	Grade I	Grade II	Grade III	Grade IV	Grade V	Total
MVA	0	9	10	12	2	33
Fall from height	0	4	6	7	0	17
Assault	0	0	1	0	1	2
Abuse	0	0	1	0	0	1
Sports	1	1	0	0	0	2
Total	**1**	**14**	**18**	**19**	**3**	**55**

Figure 1: *Distribution of time of surgery against treatment.*

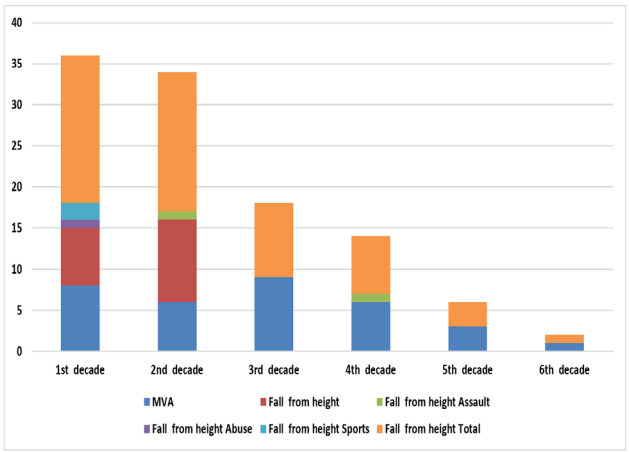
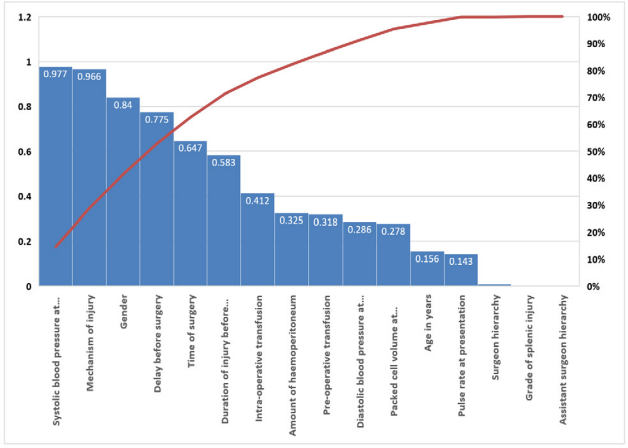


Figure 2: *Factors determining splenectomy.*



Discussion

Foundational research conducted by paediatric surgeons approximately three decades ago demonstrated the viability of non-operative management (NOM) for splenic injuries. [27-28] Despite distinct structural disparities between the adult and paediatric spleen, this conservative paradigm has been successfully extrapolated to adult trauma care. Furthermore, the evolution of sophisticated medical imaging has facilitated not only the precise stratification of injury severity but also the application of interventional radiology. Specifically, angiography and embolisation have emerged as vital adjunctive therapies for patients who remain unstable during standard non-operative protocols [29].

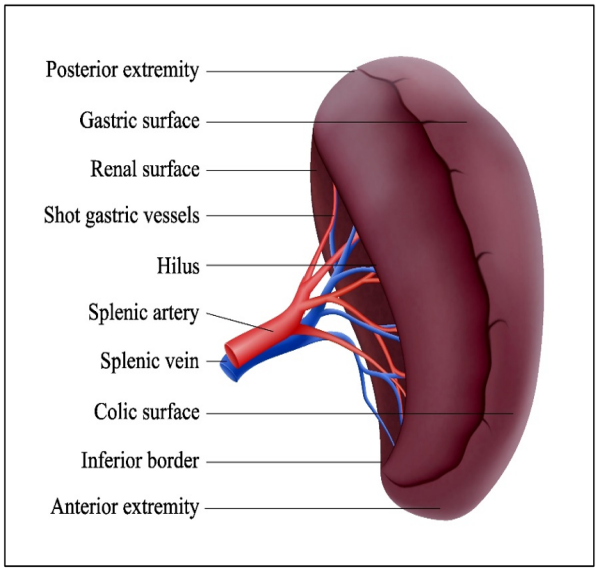
Operative intervention is indicated exclusively for patients who remain refractory to conservative strategies or angioembolisation. Specifically, the decision to convert to surgery is driven by sustained hemodynamic instability evidenced by a declining hematocrit—or the presence of a persistent contrast blush following embolisation procedures. Intraoperative protocols prioritize splenic salvage to mitigate the risk of Overwhelming Post-Splenectomy Infection (OPSI). [30] Since its initial description in 1952, OPSI has been a significant concern, with reviews citing an annual incidence of 2.2–4.4% in children and less than 1% in adults, alongside a mortality rate of 0.58%, regarding prophylaxis, while vaccination against encapsulated pathogens is ideally administered two weeks prior to elective splenectomy, this timeline is unfeasible in trauma settings. Consequently, mandatory vaccination is required prior to hospital discharge, supplemented by re-vaccination every 5–10 years and antibiotic prophylaxis to address potential vaccine failure. [31-34] furthermore, antibiotic prophylaxis remains the preferred regimen during pregnancy, as pneumococcal vaccination is contraindicated until the postpartum period.

Due to the suboptimal immunogenicity of polysaccharide vaccines in infants, antibiotic prophylaxis is mandated as the primary preventive measure for children under two years of age; consequently, the full vaccination schedule is typically deferred until after the second birthday. [35] Comprehensive post-splenectomy care also necessitates rigorous health education. Patients must be counseled on the heightened risk of sepsis, the imperative for immediate diagnostic and therapeutic intervention upon symptom onset, and the necessity of strict adherence to antimalarial prophylaxis. Furthermore, carrying medical identification is considered essential. [36] However, within our specific clinical setting, the majority of the patient population.

Pediatric management of asplenia is complicated by the immature immune response to polysaccharide vaccines in children under two years of age. This physiological limitation necessitates the use of antibiotic prophylaxis until full immunization can be effectively administered after the second birthday. While standard post-splenectomy protocols mandate comprehensive health education specifically regarding infection risks, early diagnosis, medical identification, and strict adherence to antimalarial prophylaxis the practical efficacy of these measures is often compromised in the local setting. Due to high rates of attrition in follow-up clinics, long-term medical management is frequently unreliable; therefore, surgical strategies prioritizing splenic salvage are imperative to avoid the lifelong sequelae of asplenia.

Data analysis indicates a significant correlation between the mechanism of injury and the rate of total splenectomy. Patients involved in high-velocity incidents, such as motor vehicle accidents (MVAs) and falls from height, exhibited higher splenectomy rates, likely due to the substantial kinetic energy transfer causing extensive physiological damage that necessitated surgical intervention. Conversely, sports-related trauma, characterized by lower energy impact, was associated with higher rates of splenic preservation. The severity of the injury appears to be a function of the energy magnitude; notably, the majority of Grade III injuries and all Grade IV and V injuries were concentrated within the high-impact cohorts. These findings underscore the need for strict enforcement of motor vehicle safety legislation and enhanced parental supervision to mitigate fall risks, particularly among the pediatric and adolescent population (aged <20 years). Splenic salvage surgery is strongly advocated for hemodynamically stable patients presenting with isolated, intermediate-grade injuries, provided that damage control protocols are not immediately indicated. In developing economies, the prioritization of organ preservation is critical due to the endemicity of malaria and tick-borne diseases. Preserving splenic function is essential to mitigate the incidence and severity of these infections, as well as Overwhelming Post Splenectomy Infection (OPSI). This approach is further justified by significant challenges in continuity of care; high rates of loss to follow-up frequently result in a failure to administer necessary post-splenectomy vaccinations and prophylactic antimicrobials (Figure 3).

Figure 3: *Spleen injured image.*



Contrary to the hypothesis that impact magnitude dictates injury severity, this study found no statistically significant correlation between the specific mechanism of injury and the grade of splenic trauma. Instead, the extent of injury may be attributed to the insufficiency of intrinsic anatomical buffers, specifically the cushioning provided by the stomach medially, the left lung's inferior lobe superiorly, and the transverse colon inferiorly. Furthermore, the integrity of the ligamentous suspension system comprising the phrenicolienal and gastrolienal ligaments is critical. A failure of this 'anchoring' effect allows for excessive mobility during impact, subjecting the spleen to heightened acceleration and deceleration shear forces. Ultimately, the degree of trauma appears to be a function of the rapidity of the impact relative to the biomechanical capacity of these protective mechanisms to absorb the shock [36-37].

While the primary intraoperative objective is immediate survival, the surgical team must simultaneously determine the intervention that offers the optimal long-term outcome for the individual patient [38]. This decision-making process involves a critical risk-benefit analysis, weighing the potential complications of splenic salvage against the morbidity associated with persistent hemorrhage, re-laparotomy, and the necessity for massive transfusion. Furthermore, in the African epidemiological context, the significant risk of Overwhelming Post-Splenectomy Infection (OPSI) and other endemic pathologies

must be integrated into the surgical strategy. Consequently, reducing trauma-related morbidity requires a dual approach: the implementation of robust injury prevention strategies and the focused training of early-career surgeons in organ-sparing techniques [39-40].

Conclusion

The severity of splenic injury resulting from blunt abdominal trauma may be determined more by the failure of anatomical protective mechanisms than by the specific mechanism of the trauma itself. Preventive measures, such as the enforcement of motor vehicle safety legislation and increased parental supervision, play a significant role in mitigating high-energy impacts to the spleen. Regarding surgical intervention, splenic salvage techniques are recommended for hemodynamically stable patients with isolated, intermediate-grade injuries, provided that damage control protocols are not immediately indicated. Consequently, it is imperative that early career surgeons achieve proficiency in organ-sparing techniques. This is particularly critical in developing regions where poor patient compliance with follow-up care exacerbates the risks of asplenia, including Overwhelming Post-Splenectomy Infection (OPSI) and severe complications from malaria and tick-borne diseases.

Recommendations and Future Research

Prioritize Hemodynamic Status Over Injury Grade The absolute indication for immediate splenectomy remains hemodynamic instability (refractory hypotension or persistent tachycardia) that does not respond to initial resuscitation. While high-grade injuries (AAST Grade IV-V) correlate with higher failure rates of non-operative management (NOM), the patient's physiological status should dictate the surgical decision more than the anatomical injury seen on a CT scan. Implement Early Angioembolization (SAE) for "Soft" Indications In hemodynamically stable patients with high-grade injuries or evidence of active contrast extravasation ("blush") on CT, Splenic Artery Embolization (SAE) should be utilized to increase splenic salvage rates. This is particularly crucial in facilities where 24-hour monitoring capabilities are limited, acting as a "prophylactic" measure against delayed rupture.

Mandatory Vaccination and Education Protocols If splenectomy is determined to be unavoidable, a strict protocol for post-splenectomy vaccination (Pneumococcal, Meningococcal, and H. influenzae type must be initiated before discharge. In developing regions with high malaria or tick-borne disease burdens, patients must receive specific education on febrile illness management, as the loss of the spleen significantly impairs the body's ability to clear intra-erythrocytic parasites.

Adopt a Lower Threshold for Surgery in Elderly Patients Age >55 is a significant independent predictor of NOM failure due to a thinner splenic capsule and reduced physiological reserve. In this demographic, "watchful waiting" carries higher risks; therefore, surgeons should have a lower threshold for early splenectomy or aggressive embolization to prevent catastrophic failure of conservative management.

Standardize "Failure of NOM" Criteria Institutions should define clear "trigger points" for converting from conservative management to splenectomy. A drop in hemoglobin requiring >3-4 units of packed red blood cells (PRBCs) within 24 hours, or the development of new peritoneal signs, should prompt immediate surgical intervention rather than continued observation.

Conflict of Interest

The authors declare no conflict of interest

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