

Determinants of splenectomy in splenic injuries following blunt abdominal trauma

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Summary

Introduction. The management of splenic injuries has shifted from splenectomy to splenic preservation owing to the risk of overwhelming post-splenectomy infection (OPSI). This study aimed to identify the factors that determine splenectomy in patients with isolated splenic injuries, with a view to increasing the rate of splenic preservation.

Patients and methods. Files of 55 patients managed for isolated splenic injuries from blunt abdominal trauma between 1998 and 2007 were retrospectively analysed using a pro forma. Management options were classified into non-operative, operative salvage and splenectomy.

Results. The majority of patients suffered splenic injury as a result of motor vehicle accident (MVA) trauma or falls. Splenectomy was undertaken in 33 (60%) patients, 12 (22%) had non-operative management, and operative salvage was achieved in 10 (18%) patients. Significant determinants of splenectomy were grade of splenic injury, hierarchy of the surgeon, and hierarchy of the assistant.

Discussion. MVA injury and falls accounted for the vast majority of blunt abdominal trauma in this study. The rate and magnitude of energy transferred versus splenic protective mechanisms at the time of blunt abdominal trauma seems to determine the grade of splenic injury. Interest in splenic salvage surgery, availability of technology that enables splenic salvage surgery, and the experience of the surgeon and assistant appear to determine the surgical management.

Conclusion. Legislation on vehicle safety and good parental control may reduce the severity of splenic injury in blunt abdominal trauma. When surgery is indicated, salvage surgery should be considered in intermediate isolated splenic injury to reduce the incidence of OPSI.

bloodstream, postoperative vaccination and the use of prophylactic antimicrobials against encapsulated organisms has become mandatory in all splenectomised patients to prevent overwhelming post-splenectomy infection (OPSI).⁵⁻⁷ To minimise the need for vaccination and the risk of OPSI, splenic injury management shifted from splenectomy to splenic preservation in the 1980s.^{4,8} Approaches to splenic preservation include conservative non-operative treatment, angiographic embolisation and operative salvage.^{3,9-13} In our community, however, the majority of patients with splenic injuries from blunt abdominal trauma are still being managed operatively, with a low operative splenic salvage rate.¹⁴⁻¹⁶ Moreover, the majority of our patients fail to attend follow-up clinics and are lost to further assessment, making the incidence of OPSI difficult to determine, and the use of post-splenectomy vaccination and antibiotic treatment difficult to institute.

The objective of this study was to find out the determinants of splenectomy in patients with isolated splenic injuries from blunt abdominal trauma in our community, with a view to increasing the rate of splenic preservation.

Patients and methods

Ours was a hospital-based retrospective descriptive study of isolated splenic injuries from blunt abdominal trauma diagnosed and graded with abdomino-pelvic ultrasound between 1998 and 2007 in the surgical unit of Wesley Guild Hospital, Ilesa, which is a satellite hospital of Obafemi Awolowo University Teaching Hospitals Complex (OAUTHC), Ile-Ife, Nigeria. The hospital serves the health needs of Ekiti State, Ilesa and neighbouring towns. Patients' age and gender, mechanism of injury, pulse rate and blood pressure at presentation, duration of injury before presentation, delay before surgery for those operated on, packed cell volume at presentation, pre-operative transfusion, intra-operative transfusion, amount of haemoperitoneum in those who had surgery, grade of splenic injury (using splenic organ injury scaling system), time of surgery, surgeon hierarchy, assistant surgeon hierarchy and treatment modality were entered onto the pro forma designed for the study.

Treatment modalities were classified into non-operative, operative salvage and splenectomy. Non-operative management was instituted in those patients with sustainable post-

The spleen is the most commonly injured abdominal organ following blunt abdominal trauma.¹⁻³ Management of splenic injuries was traditionally by splenectomy, the main objective being haemorrhage control.^{4,5} With better understanding of immunological functions of the spleen, however, and the role of the spleen in clearing encapsulated organisms from the

resuscitative haemodynamic stability and stable or improving serial abdominal ultrasound findings; those who did not satisfy these criteria were offered operative treatment. Those without sufficient data were excluded from the study.

Statistical analysis was done with SPSS 15 for Windows, using descriptive statistics and linear regression, with significance taken at $p < 0.05$.

Results

Fifty-five patients met the inclusion criteria. There were 36 males and 19 females, with a male:female ratio of 1.9:1. Their median age was 14 years (range 3 - 60). Table I shows the mechanism of injury with respect to age in decades. The prevalence of isolated splenic injury in blunt abdominal trauma decreases with age, with marked differences in the mechanism. Motor vehicle accident (MVA) injury and falling from heights occurred in 50 (91%) patients. In the first 2 decades of life, MVA trauma accounted for 40% of splenic injuries, and falls for 49%. All splenic injuries as a result of falling from a height arose in the first 2 decades. Between the 3rd and 6th decades, MVA trauma accounted for 95% of injuries, the remainder being due to falls and a single case of assault.

The majority of patients suffered moderate to severe splenic trauma, with 40 (73%) sustaining injuries between grades III and V. Higher grades of injury resulted from MVA trauma and falling from heights (Table II). Twelve (22%) patients out of the initial 20 were eventually managed non-operatively. Failed conservative therapy in 6 patients was due to failing haematocrit and haemodynamic instability. Forty-three

(78%) patients underwent laparotomy, with operative salvage in 10 (18%) and splenectomy in 33 (60%) (Table III). There was one postoperative death in the splenectomy group due to acute respiratory distress syndrome from anaesthesia complications. Splenic salvage was achievable in 93% of grade II and 44% of grade III injuries, with electrocautery, and vertical mattress suturing technique with occasional omental overlay or wrapping. None of the patients had angio-embolisation because of lack of facilities.

Non-operative and operative salvage decreased with age (Table IV). Of those in the first 2 decades of life, 17 (49%) splenic injuries were either managed non-operatively or underwent splenorrhaphy, compared with only 5 (25%) in the older decades. Moreover, the rate of splenectomy was higher in those who had their treatment at night (Fig. 1) and in those who sustained their injuries from MVA causes and falling from heights (Table V). Linear regression analysis (Table VI) showed that the significant determinants of splenectomy in this study were the grade of splenic injury and the experience of the surgeon and his assistant: the more experienced the surgeon and his assistant, the higher the rate of splenic preservation at surgery.

Discussion

The pioneering work of paediatric surgeons from about 30 years ago established that splenic injury can be managed non-operatively.^{17,18} Although the paediatric spleen differs structurally from that of an adult, a similar approach has been adopted in adult splenic trauma. Advances in medical imaging have allowed not only accurate delineation of the

TABLE I. MECHANISM OF INJURY V. AGE IN DECADES

Age in decades	Mechanism of injury					Total
	MVA	Fall from height	Assault	Abuse	Sports	
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 II. GRADE OF SPLENIC INJURY V. MECHANISM OF INJURY

Mechanism of injury	Grade of splenic injury					Total
	Grade I	Grade II	Grade III	Grade IV	Grade V	
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

grade of injury, but also therapeutic intervention in the form of angiography and embolisation – a useful adjunct in those not responding to non-operative management.¹⁹⁻²¹

Operative management is reserved for patients not responding to conservative treatment or angiography and embolisation. The indications for abandoning conservative management are: persistent haemodynamic instability with falling haematocrit or persistent contract blush after angio-embolisation. At surgery, the emphasis is on splenic salvage because of the risk of OPSI.^{8,22} Following the first report of OPSI in 1952, several reviews reported an incidence of 2.2 - 4.4% per year in children, and less than 1% in adults, with a reported mortality rate of 0.58%.^{5,17} Vaccination against encapsulated organisms is recommended at least 2 weeks before an elective splenectomy to prevent OPSI; however, this is not practicable in splenectomy for trauma, which makes post-splenectomy vaccination mandatory for all splenectomised patients for trauma before their discharge from hospital, with re-vaccination every 5 - 10 years and additional antibiotic prophylaxis to compensate for the documented occasional vaccination failure.²³⁻²⁵ Moreover, antibiotic prophylaxis is the recommended regimen in pregnancy, when pneumococcal vaccination is better avoided until after delivery.

The effectiveness of vaccination is limited in children, but there is a need for antibiotic prophylaxis before the age of 2 years because of the blunted response to polysaccharide vac-

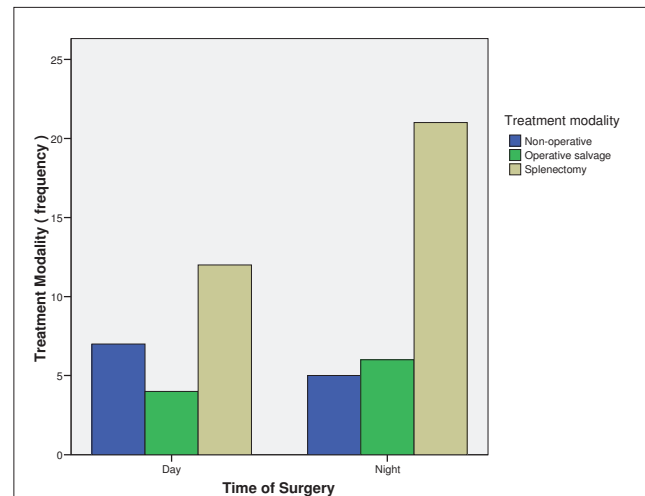


Fig.1. Distribution of time of surgery against treatment modality.

cines; consequently, full vaccination is usually given after the second birthday.²⁵ Post-vaccination health education should be given to all splenectomised patients regarding the risk, the importance of prompt diagnosis and treatment of infection, and the need for strong compliance with antimalaria prophylaxis. It is also essential for them to carry an identification card.²⁵ However, in our environment, the majority of patients

TABLE III. MODALITY OF TREATMENT V. GRADE OF SPLENIC INJURY

Grade of splenic injury	Modality of treatment					Total
	Non-operative therapy	Operative salvage		Splenectomy		
		Failed non-operative	Planned	Failed non-operative	Planned	
Grade I	1	0	0	0	0	1
Grade II	8	2	3	0	1	14
Grade III	3	1	4	3	7	18
Grade IV	0	0	0	0	19	19
Grade V	0	0	0	0	3	3
Total	12	3	7	3	30	55

TABLE IV. MODALITY OF TREATMENT WITH AGE IN DECADES

Age in decades	Modality of treatment			Total
	Non-operative	Operative salvage	Splenectomy	
1st decade	7	5	6	18
2nd decade	3	2	12	17
3rd decade	1	1	7	9
4th decade	1	1	5	7
5th decade	0	0	3	3
6th decade	0	1	0	1
Total	12	10	33	55

TABLE V. MODALITY OF TREATMENT V. MECHANISM OF INJURY

Mechanism of injury	Modality of treatment			Total
	Non-operative	Operative salvage	Splenectomy	
MVA	5	8	20	33
Fall from height	5	1	11	17
Assault	0	1	1	2
Child abuse	0	0	1	1
Sports	2	0	0	2
Total	12	10	33	55

TABLE VI. DETERMINANTS OF SPLENECTOMY

Factors	p-value
Age in years	0.156
Gender	0.840
Mechanism of injury	0.966
Pulse rate at presentation	0.143
Systolic blood pressure at presentation	0.977
Diastolic blood pressure at presentation	0.286
Duration of injury before presentation	0.583
Delay before surgery	0.775
Packed cell volume at presentation	0.278
Pre-operative transfusion	0.318
Intra-operative transfusion	0.412
Amount of haemoperitoneum	0.325
Time of surgery	0.647
Grade of splenic injury	0.002
Surgeon hierarchy	0.008
Assistant surgeon hierarchy	0.001

$p < 0.05$ linear regression.

post splenectomy fail to attend the follow-up clinic, making further management in those patients problematic. For these reasons, every attempt must be made for splenic salvage.

In our study, the rate of total splenectomy was higher in patients who sustained their trauma in MVAs and falling from a height, possibly as a result of the high energy transfer on impact causing physiological damage needing surgical management. Conversely, a low energy impact may account for the higher rate of splenic preservation in patients whose mechanism of injury was sport-related. The magnitude of energy transferred at the time of injury seems to determine the severity of splenic trauma and the need for splenectomy. The majority of patients who had sustained a grade III injury, and all those with grade IV and V injuries, belonged to the groups sustaining high energy impact. There is a need for effective motor vehicle safety legislation; while better parental

control will help to reduce the incidence of injuries from falls, as these all occurred in children <20 years old.²⁶

Splenic salvage surgery should be considered in those who sustained intermediate isolated splenic injury, when the indication for surgery is not damage control in haemodynamically unstable patients.²⁷⁻²⁹ This is necessary in a developing economy such as ours, with endemic malaria and occasional cases of tickbite fever, to reduce the incidence and severity of malaria, OPSI and other infestations post splenectomy,^{23,25,30} as the majority of patients are lost to follow-up or fail to attend follow-up clinics. Consequently, these patients would not receive appropriate vaccination or have access to prophylactic antimicrobials.

The time of operative intervention in our review shows an increase in the night-time splenectomy rate; this may be due to a number of factors, e.g. supporting staff fatigue from the preceding daylight hours' duties, and the fact that most of the emergency surgery at night is performed by junior surgeons who may be unfamiliar with splenic salvage techniques. A linear regression analysis to identify the main determinants of splenectomy in our environment showed three significant factors: the grade of splenic injury, surgeon experience, and assistant experience.

Although one would expect the grade of splenic injury to be determined by the force of impact, the mechanism of injury was not a statistically significant factor in our study. Failure of splenic protective features such as the airbag effect of the stomach medially, the inferior lobe of the left lung superiorly, and the transverse colon inferiorly, could be reasons. Moreover, failure of the anchoring seatbelt effect of the diaphragm on the phrenicolienal and gastrolial ligaments, holding the spleen against the body wall at the time of impact, may predispose the spleen to high deceleration or acceleration stresses. The rate of response of these protective mechanisms and the rapidity of injury may largely determine the degree of splenic trauma.

While higher grades of injury could be associated with haemodynamic instability from blood loss, the vital signs and the packed cell volume at presentation were not significant determinants in our study, which agrees with the findings by Potoka *et al.* in the USA.⁹ There is a need to further evaluate these findings by means of prospective studies.

The roles of the surgeon and assistant surgeon could be influenced by their interest and experience in splenic salvage surgery,¹⁵ the availability of prosthetic material such as

mesh for splenic salvage surgery,³¹⁻³³ and the availability of technology that facilitates splenic salvage surgery, such as an argon beam coagulator^{34,35} or intra-operative laboratory back-up.^{36,37} Such factors warrant further appraisal with prospective studies.

Although the overriding challenge to a surgeon and his assistant intra-operatively is to save life, it is also to determine the most appropriate operative procedure best suited for the individual patient. The risk attached to attempts at splenic salvage must be weighed against the hazard of continued bleeding and the need for re-laparotomy and further blood transfusions. The risk of OPSI or other disease states, especially in the African context, must also be borne in mind. Not only are trauma prevention strategies essential, but also the training of junior surgical staff in methods of splenic salvage.

Conclusion

Failure of splenic protective mechanisms, rather than the mechanism of injury, may be responsible for the grade of splenic injury in blunt abdominal trauma. Motor vehicle safety legislation and parental control may contribute to reducing the causes of high energy transfer to the spleen in blunt abdominal trauma. Splenic salvage surgery should be considered for patients who sustain intermediate isolated splenic injuries, when the indication for surgery is not damage control in haemodynamically unstable patients. Junior surgeons therefore need to be familiar with splenic conservation techniques, which is necessary in a developing country such as ours, to reduce the incidence of OPSI, and minimise the severity of malaria and tick-borne diseases, in view of the fact that the majority of patients fail to attend follow-up clinics.

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