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Abstract

Background

The non-operative management of splenic injury in children is widely recommended and possible in over 95% of cases. However, practice appears to vary between centres.

Method

The Trauma Audit and Research Network (TARN) database was interrogated to determine the management of isolated paediatric splenic injuries in hospitals in England and Wales. Rates of non-operative management, length of hospital stay, readmission and mortality were recorded. Management in paediatric surgical hospitals was compared to that in adult hospitals.

Results

Between January 2000 and December 2015 there were 574 cases. Children treated in a paediatric surgical hospital had a 95.7% rate of non-operative management compared to 75.5% in an adult hospital ($p < 0.0001$). A splenectomy occurred in 2.3% of children in hospitals with a paediatric surgeon and 17.2% in those treated in an adult hospital ($p < 0.0001$). There was a significant difference in the rate of non-operative management in children of all ages. There was some improvement in NOM in adult hospitals in the later part of the study, but ongoing significant differences remain.

Conclusion

The management of children with isolated splenic injury is different depending on where they are treated. The rate of non-operative management should be improved, particularly in hospitals without a paediatric surgeon present.

Background

The importance of splenic preservation in children sustaining splenic injury is widely recognised, however reports continue to show variations in treatment depending on where children are managed and by whom¹⁻⁴.

There is evidence that the rate of non-operative management is higher if children are treated in dedicated paediatric centres and that those treated in adult trauma centres are more likely to be managed surgically⁴⁻⁵.

The aim of this study was to determine whether a difference exists in England and Wales in the management of children with isolated splenic injury in paediatric hospitals and adult hospitals.

Methods

The Trauma Audit and Research Network [TARN] was interrogated.⁶ Children between the ages of 0 and 16 who had sustained isolated splenic injuries between January 2000 and December 2015 were identified. “Isolated” was defined as not having any other injuries that would affect management; those with Abbreviated Injury Scores (AIS) of 1 or 2 in other body regions were included⁷.

The main study outcomes were the rate of non-operative management; blood transfusion; length of hospital stay; rate of readmission to hospital; and mortality in children managed in paediatric surgical compared to adult hospitals. Details of the injury were recorded and their severity scored, using the Abbreviated Injury Scale (AIS), based on imaging or operative findings⁷. The AIS grade of injury was determined by trained coders in the individual NHS trusts and verified by TARN. Information on re-admission to hospital has been routinely collected since October 2005. Outcome, in terms of survival or death, was based on assessment at discharge or 30 days, whichever was first.

Each hospital within the TARN database was assigned a status as either being a paediatric surgical centre or an adult centre. The definition of a paediatric surgical hospital was one in which there was an in-house paediatric surgeon on the full time staff. Adult hospitals were those who did not have a paediatric surgeon present. Outcomes were compared between children managed in adult and paediatric hospitals. Outcomes were compared in the early and later part of the study period (2000-2007; 2008-2015), and in different ages of children (0-10 years; 11-15 years)

Statistical tests were used to determine statistical significance, with a p value of <0.05 deemed statistically significant. Chi-square test and Fisher’s exact test (if the numbers were small) were used for comparative data.

Results

There were 574 isolated paediatric splenic injuries reported to TARN between January 2000 and December 2015.

There were 21 hospitals defined as paediatric surgical centres and 95 hospitals defined as adult. Of the 574 children, 301 were treated in paediatric centres and 273 were treated in adult centres. The demographics in terms of age, gender and the spread of severity of injury were comparable. (table 1) Blunt trauma accounted for 99.7% of all splenic injuries. The overall rate of non-operative management was 86.1%. Of eighty children who had an operation, 54 had a splenectomy, and 26 had spleen conserving surgery.

The rate of non-operative management was 95.7% in paediatric surgical hospitals, with a 2.3% splenectomy rate compared with 75.5% in adult hospitals ($p < 0.0001$) with a 17.2% splenectomy rate ($p < 0.0001$). The median length of stay was 5 days in adult hospitals compared to 7 days in paediatric hospitals. Re-admission rates were very low for both paediatric (0.2%) and adult (0.4%) centres. There were no deaths. (table 1)

Table 2 shows the number of patients treated operatively according to the grade of injury. Whilst the distribution of grade of injury was similar in those treated at adult and paediatric hospitals, the operative rates are markedly higher in adult hospitals for all grades of injury. Of note grade 5 injuries treated in paediatric hospitals had a higher non operative management rate (90.5%) than grade 2 injuries treated in adult hospitals. (86.3%). There were 11 children with grade 2 splenic injuries treated operatively in adult hospitals (13.7%).

The majority of children who underwent operative management did so within the first 24 hours after injury. (In adult centres 74.6%, paediatric centres 61.5% - table 3) Only 2.6% of children managed non-operatively received a blood transfusion, compared to 17.5% of children managed operatively. (table 4)

Young children (0-10) with splenic injury were managed non-operatively in 85.2% of cases in adult hospitals, compared to 95.1% in paediatric hospitals ($p=0.026$). In children aged 11-15, 70.6% were managed non-operatively in adult hospitals and 96.1% of cases in paediatric hospitals ($p<0.00001$).

NOM and LOS were assessed at different historical time periods. The rate of NOM increased from 65.2% between 2000-2007 in adult hospitals to 78.9% between 2008-2015. In paediatric surgical centres the rate of NOM was similar in both time periods (96.4% vs 95.4%). The length of stay was longer in paediatric hospitals regardless of management, and length of stay was shorter between 2008-2015 compared to 2000-2007.

Discussion

Until the 1960s most authorities recommended splenectomy for all children with traumatic rupture and cited mortality rates up to 100% if surgery was not promptly performed⁸. Knowledge of overwhelming post splenectomy infection (OPSI) increased and non-operative management gradually became the standard of care⁹⁻¹⁰.

Several large studies have shown that over 95% of splenic injuries in children can be managed conservatively, even in those with severe injuries, with low morbidity and mortality¹¹⁻¹². However, the rate of surgical intervention varies significantly between centres^{1-4,13-16}. Differences in management have been demonstrated between paediatric and adult centres, in trauma centres and in non-trauma centres, in rural and urban and in high volume compared to low volume centres¹³⁻¹⁶.

Our examination of the TARN database has shown a significant difference in the rate of non-operative management of splenic injury in children treated in paediatric surgical hospitals (95.7%) and adult hospitals (75.5%) in England and Wales between 2000 and 2015. A splenectomy occurred in 2.3% of children in hospitals with a paediatric surgeon and 17.2% in those treated in an adult hospital. There was a very low rate of readmission to hospital and there was no mortality in any child with an isolated splenic

injury in this 16-year period.

There has been an improvement in the rate of NOM in adult hospitals more recently (increasing from 62.5% to 78.9% between 2000-2007 and 2008-2015), however there is still a significant discrepancy and rates of NOM in paediatric surgical centres have been >95% throughout. The number of cases managed in adult hospitals compared to children's hospitals was similar despite there being far fewer paediatric hospitals (21 v. 95). The resultant increased case load in paediatric centres may have influenced decisions on management.

In this study a comparison of management was made for children in a paediatric surgical centre or an adult hospital that also looked after children. If there was at least one full time paediatric general surgeon present in the hospital it was designated as a paediatric surgical centre regardless of whether the centre was designated as a trauma centre by the Department of Health. During the study period a small number of hospitals changed status in our designation, due to staff and department moves, and this was taken into account in the analysis.

There was a trend towards more children having surgery greater than 24 hours after injury in paediatric hospitals compared to adult hospitals (38.5% vs 25.4%), and the rates of splenic salvage surgery were higher in paediatric hospitals (46.1% paediatric vs 29.8% adult). These results did not reach statistical significance but suggest that as well as more patients having non-operative management in paediatric centres, there may have been more patients who had a trial of NOM that was ultimately unsuccessful, and potentially a greater emphasis placed on splenic preservation. There were significant differences in the rate of non-operative management across all age groups but the most marked difference was in children between the ages of 11-15. We hypothesise that this is because adult surgeons are more likely to seek advice on management in younger children.

There are multiple controversies in the management of children with traumatic splenic injuries such as the use of blood products; the role of angio-embolisation; splenic salvage surgery and the optimal method of non-operative management including ICU

care, the length of stay in hospital for observation, bed rest and follow up imaging. Evidence based guidelines have been created and updated to best assess these parameters¹⁷⁻²⁰. As a population based study, the reasons and decisions for non-operative/ operative management, and subsequent care were outside of the scope of this study.

The recommended LOS in hospital has decreased over the past 2 decades¹⁷⁻²⁰. In this study children treated in both adult and paediatric centres were kept in hospital less time in the more recent time period after both operative and non-operative management.

This is the first study in the UK comparing management of isolated splenic injury in children. Children with splenic injuries, even those with severe injuries, can be managed conservatively with low morbidity and mortality. The management of trauma in the UK has changed in recent years. The introduction of Major Trauma Centres and Trauma Units across England and Wales began in 2012 and is now comprehensive. There are 27 trauma centres in NHS England and Wales where this study was conducted - 5 that purely manage children. Ideally children should be managed in dedicated high volume paediatric surgical hospitals but in practice adult general surgeons will often be involved in their care. It is important for all surgeons treating injured children to be competent in managing splenic injuries and to be aware that the vast majority children can be safely managed non-operatively regardless of the grade of splenic injury. An effort needs to be made to address the unsatisfactory management differences reported here between hospitals in England and Wales and to improve the current standard of care in all hospitals.

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Tables

Table 1 Demographics and management of splenic injuries in adult and paediatric surgical centres

	Adult centres	Paediatric surgical centres	P value
Total number	273	301	
Male gender	75.8%	75.4%	
Median age (IQR)	12.5 (9.7-14.4)	12 (8.1-14.2)	
Non-operative management n (%)	206 (75.5%)	288 (95.7%)	p<0.0001
Operative management n (%)	67 (24.5%)	13 (4.3%)	P<0.0001
Splenectomy n (%)	47 (17.2%)	7(2.3%)	p<0.0001
Length of stay - median (IQR)	5 days (2-7)	7 days (5-9)	
Readmission to hospital	12 (0.4%)	5 (0.2%)	p=0.08
Mortality	0	0	

Table 2: Comparing rates of non-operative management at different grades of injury (AIS) in adult and paediatric surgical centres. NOM= Non-operative management

Severity of injury	n = patients treated in adult centres	n = patients treated in paediatric centres	NOM in adult centres n (%)	NOM in paediatric centres n (%)
2	80	106	69 (86.3%)	104 (98.1%)
3	119	113	87 (73.1%)	106 (93.8%)
4	51	61	37 (72.5%)	59 (96.7%)
5	23	21	13 (56.5%)	19 (90.5%)
Overall	273	301	206 (75.5%)	288 (95.7%)

Table 3 Timing of Surgery after injury

Site type	Operation	n	%	p
Adult centres	< 24 hours after injury	50	74.6%	0.33
	>24 hours after injury	17	25.4%	
Paediatric surgical centres	< 24 hours after injury	8	61.5%	
	>24 hours after injury	5	38.5%	

Table 4. Proportion of patients receiving blood products

Management	Received blood products	n	%
NOM	No	481	97.4%
	Yes	13	2.6%
OM	No	66	82.5%
	Yes	14	17.5%

Table 5 Rate of NOM/OM at different age groups

Site type	Age (in years)	NOM		OM	
		n	%	n	%
Adult centres	0-10	75	85.2%	13	14.8%
	11-15	130	70.6%	54	29.4%
Paediatric surgical centres	0-10	116	95.1%	6	4.9%
	11-15	173	96.1%	7	3.9%

Table 6 Differences in NOM/ LOS depending on year of injury

Site type	Arrival year	Management	n	%	Median LOS (IQR)
Adult centres	2000-2007	NOM	45	65.2%	4 (2-7)
		OM	24	34.8%	7 (6-10)
	2008-2015	NOM	161	78.9%	4 (2-7)
		OM	43	21.1%	6 (5-7)
Paediatric surgical centres	2000-2007	NOM	80	96.4%	9 (6-10)
		OM	3	3.6%	11 (11-12)
	2008-2015	NOM	208	95.4%	6 (5-8)
		OM	10	4.6%	7 (6-10)