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Pleural effusion following blunt splenic injury in the pediatric trauma population ☆,☆☆

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ABSTRACT

Background: Pleural effusion is a potential complication following blunt splenic injury. The incidence, risk factors, and clinical management are not well described in children.
Methods: Ten-year retrospective review (January 2000–December 2010) of an institutional pediatric trauma registry identified 318 children with blunt splenic injury.
Results: Of 274 evaluable nonoperatively managed pediatric blunt splenic injures, 12 patients (4.4%) developed left-sided pleural effusions. Seven (58%) of 12 patients required left-sided tube thoracostomy for worsening pleural effusion and respiratory insufficiency. Median time from injury to diagnosis of pleural effusion was 1.5 days. Median time from diagnosis to tube thoracostomy was 2 days. Median length of stay was 4 days for those without and 7.5 days for those with pleural effusions ($p < 0.001$) and 6 and 8 days for those pleural effusions managed medically or with tube thoracostomy ($p = 0.006$), respectively. In multivariate analysis, high-grade splenic injury (IV–V) (OR 16.5, $p = 0.001$) was associated with higher odds of developing a pleural effusion compared to low-grade splenic injury (I–III).
Conclusions: Pleural effusion following pediatric blunt splenic injury has an incidence of 4.4% and is associated with high-grade splenic injuries and longer lengths of stay. While some symptomatic patients may be successfully managed medically, many require tube thoracostomy for progressive respiratory symptoms.

The spleen is the most commonly injured solid organ in children following blunt abdominal trauma [1]. In both the adult and pediatric literature, selective nonoperative management (NOM) of hemodynamically stable splenic injuries has been adopted as the standard of care [2–8]. With a success rate approaching 90% in the pediatric population, NOM decreases the need for blood transfusions, is associated with shorter lengths of stay, and avoids the morbidity, mortality and costs of operative intervention, as well as the potential for immune-mediated complications such as overwhelming post-splenectomy sepsis [1,2,4,9–12].

Pleural effusion following blunt splenic injury has been described, but not well characterized and may contribute to morbidity and length of stay [12–16]. In children, a few small series have reported an incidence of 2.4% to 18.5% [14–16]. We reviewed our experience with 318 blunt splenic injuries to evaluate the mechanisms, diagnosis and management of pleural effusion in pediatric trauma patients. We hypothesized that pleural effusion would be associated with higher-grade splenic injuries.

1. Methods

This retrospective study was approved by the Penn State Hershey College of Medicine Institutional Review Board (Hershey, PA) and was conducted at the Penn State Hershey Children's Hospital, a verified pediatric trauma center. All patients (ages 0–17 years old) with blunt traumatic spleen injuries were identified from our 2000–2010 institutional pediatric trauma registry. Patients undergoing exploratory laparotomies for splenectomy or for other indications, those requiring urgent tube thoracostomy for pneumothorax or hemothorax, those with pancreatic lacerations or transections, as well as those who did not survive their initial trauma resuscitation were excluded from analysis. Injuries were identified using computed tomography (CT) scan and graded using the American Association for the Surgery of Trauma (AAST) Revised Organ Injury Scaling System [17]. Follow-up chest x-rays were performed at the discretion of the pediatric trauma surgeon using clinical criteria during hospitalization. Patients were considered positive for the development of a pleural effusion if chest x-ray confirmed the presence of pleural effusion and

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Table 1
Patient demographics and injury characteristics.

Variable	All blunt splenic injury	Without pleural effusion	With pleural effusion	Medical management	Tube thoracostomy
	n = 318	*n = 262*	*n =12*	*n =5*	*n = 7*
Age (years), median [range]	13 [0–17]	13 [0–17]	11 [8–17]	13 [10–17]	11 [8–17]
Gender (male)	216 (67.9%)	178 (67.9%)	8 (66.7%)	3 (60.0%)	5 (71.4%)
Race					
White	297 (93.4%)	244 (93.1%)	12 (100%)	5 (100.0%)	7 (100.0%)
Non-White	21 (6.6%)	18 (6.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Transfer	166 (52.2%)	122 (46.6%)	7 (58.3%)	2 (40.0%)	5 (71.4%)
ISS, median [range]	17 [4–75]	17 [4–59]	21 [9–29]	17 [17–26]	25 [9–29]
LOS (days), median [range]	4 [0–43]	4 [1–43]*	7.5 [6–15]*	6 [6-7]**	8 [7–15]**
Splenic injury grade*					
I	59 (18.6%)	50 (19.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
II	75 (23.6%)	67 (25.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
III	95 (29.9%)	82 (31.3%)	2 (16.7%)	1 (20.0%)	1 (14.3%))
IV	70 (22.0%)	53 (20.2%)	7 (58.3%)	3 (60.0%)	4 (57.1%)
V	19 (6.0%)	10 (3.8%)	3 (25.0%)	1 (20.0%)	2 (28.6%)
Concomitant injuries					
Pancreatic laceration	4 (1.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Liver laceration	46 (14.5%)	32 (12.2%)	1 (8.3%)	1 (20.0%)	0 (0.0%)
Kidney laceration (any)	26 (8.2%)	16 (6.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Left-sided	24 (7.5%)	16 (6.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Rib fractures (any)	77 (24.2%)	49 (18.7%)	2 (16.7%)	1 (20.0%)	1 (14.3%)
Left-sided	59 (18.6%)	36 (13.7%)	2 (16.7%)	1 (20.0%)	1 (14.3%)
Right-sided	29 (9.2%)	19 (7.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Pulmonary contusion (any)	99 (31.1%)	63 (24.1%)	2 (16.7%)	0 (0.0%)	2 (28.6%)
Left-sided	33 (10.4%)	21 (8.0%)	2 (16.7%)	0 (0.0%)	2 (28.6%)
Right-sided	22 (6.9%)	20 (7.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Bilateral	44 (13.8%)	22 (8.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Mechanism					
MVC	134 (42.1%)	105 (40.1%)	2 (16.7%)	2 (40.0%)	0 (0.0%)
Bike	31 (9.7%)	27 (10.3%)	2 (16.7%)	1 (20.0%)	1 (14.3%)
ATV	16 (5.0%)	14 (5.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Pedestrian struck	25 (7.9%)	16 (6.1%)	1 (8.3%)	0 (0.0%)	1 (14.3%)
Fall	37 (11.6%)	34 (13.0%)	2 (16.7%)	1 (20.0%)	1 (14.3%)
Animal-related	15 (4.7%)	13 (5.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Recreational	54 (17.0%)	47 (17.9%)*	5 (41.7%)*	1 (20.0%)	4 (57.1%)
Other	6 (1.9%)	6 (2.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Time to effusion diagnosis (days)			1.5 [1–4]	1.5 [1-2]	1.5 [1–4]
Time from diagnosis to chest tube (days)					2 [0–3]
Mortality	13 (4.1%)	1 (0.4%)	0 (0.0%)		
<24 hours	9 (2.8%)	0 (0.0%)	0 (0.0%)		
Operative/Procedural details					
Splenectomy	13 (4.1%)				
Angioembolization	1 (0.3%)				
Laparotomy (for other indication)	2 (0.7%)				
Urgent tube thoracostomy	30 (9.4%)				
Involving left side	27 (8.5%)				

ISS, injury severity score; LOS, length of stay; MVA, motor vehicle collision; ATV, all-terrain vehicle.
* $p < 0.05$ for without pleural effusion vs. with pleural effusion.
** $p < 0.05$ for medical management vs. tube thoracostomy.

their initial trauma chest x-ray or chest CT did not demonstrate evidence of pleural effusion. Tube thoracostomy was performed under the direct supervision of attending pediatric surgeons using conscious or deep sedation provided by a credentialed provider (intensivist or anesthesiologist). Drained pleural fluid was serous but was not routinely sent for further analysis. Patient demographics, splenic injury grade, injury characteristics, development of pleural effusion, treatment and length of stay were assessed.

Mann–Whitney *U*, Fisher's exact and Pearson chi-square tests were used, as appropriate. Multivariate logistic regression was used to identify variables associated with the development of pleural effusion controlling for age, sex, transfer status, low (I–III) vs. high (IV–V) grade splenic injury, mechanism of injury (MOI), as well as concomitant thoracoabdominal injuries, which included pulmonary contusion, rib fracture, and liver and kidney injuries. Injury severity score (ISS) was not included in the regression model given its collinearity with grade of splenic injury. Additionally, pancreatic injuries were not included in the regression model, as all patients with this injury were excluded from analysis. When evaluating factors associated with the development of pleural effusion, covariates were limited to accommodate the small sample size. Statistical modeling could not be reliably performed for the need for tube thoracostomy vs. medical management for pleural effusion because of limited sample sizes. Statistical analysis was performed with using Stata/MP, version 10.1 (Stata Corporation, College Station, TX). A *p*-value of less than 0.05 was considered statistically significant.

2. Results

From January 2000 to December 2010, a total of 6631 admitted pediatric trauma patients were identified for review. There were 318 patients that sustained blunt splenic injuries. Their median age was 13, with the majority being male (Table 1). Thirteen patients (4.1%) required splenectomy for hemodynamic instability caused by organ bleeding; 10 of these splenectomies (11.2%) occurred in the 89 patients with grade IV/V splenic injuries. Two patients (0.7%) underwent laparotomies for other indications and only one patient underwent angioembolization. Four patients (1.3%) had a pancreatic laceration or transection. Additionally, 46 patients (14.5%) sustained a concomitant liver injury, while 26 patients (8.2%) had a concomitant