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Trauma center variation in the management of pediatric patients with blunt abdominal solid organ injury: a national trauma data bank analysis☆,☆☆,★,★★

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ABSTRACT

Background: Nonoperative management of hemodynamically stable children with Solid Organ Injury (SOI) has become standard of care. The aim of this study is to identify differences in management of children with SOI treated at Adult Trauma Centers (ATC) versus Pediatric Trauma Centers (PTC). We hypothesized that patients treated at ATC would undergo more procedures than PTC.

Methods: Patients younger than 18 years old with isolated SOI (spleen, liver, kidney) who were treated at level I-II ATC or PTC were identified from the 2011–2012 National Trauma Data Bank. The primary outcome measure was the incidence of operative management. Data was analyzed using multivariate logistic regression analysis. Procedures were defined as surgery or transarterial embolization (TAE).

Results: 6799 children with SOI (spleen: 2375, liver: 2867, kidney: 1557) were included. Spleen surgery was performed more frequently at ATC than PTC {101 (7.7%) vs. 52 (4.9%); P=0.007}. After adjusting for potential confounders (grade of injury, age, gender and injury severity score), admission at ATC was associated with higher odds of splenic surgery (OR: 1.5, 95% CI: 1.02–2.25; p=0.03). 11 and 8 children underwent kidney and liver operations respectively. TAE was performed in 17 patients with splenic, 34 with liver and 14 with kidney trauma. There was no practice variation between ATC and PTC regarding kidney and liver operations or TAE incidence.

Conclusions: Operative management for SOI was more often performed at ATC. The presence of significant disparity in the management of children with splenic injuries justifies efforts to use these surgeries as a reported national quality indicator for trauma programs.

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1. Background

Over the past 15 years, there has been a major shift from operative to selective non-operative management of solid organ injuries (SOI) in blunt abdominal trauma. Conservative management of hemodynamically stable patients has been acknowledged as the standard of care [1,2].

Stylianos and the American Pediatric Surgery Association Trauma Committee published evidence-based guidelines for the care of hemodynamically stable children with isolated liver or spleen injuries [3,4]. For these patients, a non-operative approach with intense monitoring is now considered the standard of care [1,3,5]. The purpose of these guidelines is to maximize patient safety and clinical outcomes [2,4,6,7]. However the adoption of these guidelines has been varied among different institutions. Previous regional data regarding children treated in adult and pediatric trauma centers demonstrated higher rates of splenectomy in adult centers [8].

Nationwide, pediatric traumas are triaged to both dedicated Pediatric Trauma centers (PTC) and Adult trauma centers (ATC). Adult Trauma centers are categorized to "Level I" or "Level II" based on their adherence to American college of surgeons (ACS) committee on Trauma requirements. In 2006 ACS established verification guidelines for dedicated pediatric trauma centers (PTCs) as either Level I or Level II [9,10]. The aim of our study is to identify differences in management of children with SOI treated at ACS verified Adult Trauma Centers (ATC) versus Pediatric Trauma Centers (PTC).

Abbreviations: ATC, Adult trauma center; PTC, Pediatric trauma center; SOI, Solid organ injury; TAE, Transarterial embolization.

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2. Methods

2.1. Data source

We performed a 2-year (2011–2012) retrospective analysis using the National Trauma Data Bank (NTDB). NTDB is the largest dataset of trauma index cases, sustained by the American College of Surgeons (Chicago, IL). The NTDB contains more than 1.8 million cases, which are contributed by more than 900 trauma centers across the United States and Canada [11].

2.2. Patient population

Patients younger than 18 years of age with SOI after blunt trauma, treated in either level I-II ATC or level I-II PTC were included. Patients transferred from another institution; patients dead on presentation; patients with more than moderate head injury defined by Head Abbreviated Injury Scale (H-AIS>2), patients with multiple solid organ injuries; and patients with missing data on type of solid organ injury were excluded from our study. As of 2012, there were 479 ATCs and 31 PTCs verified by the ACS contributed to NTDB.

2.3. Data points collected

We abstracted the following data points from the NTDB database: demographics (age, gender, ethnicity), type of SOI after blunt trauma (liver, kidney or spleen), Grade of injury, Injury Severity Score (ISS), hospital length of stay (LOS) and ICU length of stay. Patient's injury severity was measured using the Injury Severity Score (ISS) and grade of injury. The AAST liver, Spleen and Kidney radiographic injury grading system was used to grade the injuries. High-grade injuries were defined as grade IV, V spleen and Kidney and grade IV, V, VI Liver injuries [12].

2.4. Study groups

Patients were assigned into two groups based on trauma center: Adult trauma center (ATC) and Pediatric trauma center (PTC). Data was then analyzed for the entire group and individual solid organ cohort. The primary outcome measure was the incidence of operative management for SOI. The secondary outcome measure was the incidence of Transarterial Embolization (TAE), LOS and ICU LOS.

2.5. Statistical analysis

Data are reported as mean (SD) for continuous variables, and as proportions for categorical variables. We performed Student's *t* test for continuous variables and chi-square and Fisher's exact test for categorical variables. Univariate analysis was performed to assess the outcome differences between trauma center groups. Multivariate regression analysis was then used for primary outcome measure to adjust for patient factors and assess if triage to either trauma center groups predicts operative vs. conservative management. All statistical analyses were performed SPSS (version 21.0; SPSS, Inc., Armonk, NY).

3. Results

A total of 6799 pediatric trauma patients with SOI were included, of which 3561 were treated in ATC, and 3238 were treated in PTC. The spectrum of SOI included 2375 spleen, 2867 liver and 1557 kidney injuries. The mean age was 12.6 ± 5.1 years, 4037 (59.3%) were male, 4177 (61.4%) were Caucasians, and mean ISS was 17.7 ± 13.4.

Patients in PTC were younger (11.2±5.4 vs. 14.2±4.3; p=0.001) than patients in ATC. There was no statistical difference in gender (p=0.6) between patients in ATC and PTC. There was no difference in hospital LOS and ICU LOS between the two groups (p=0.04).

Table 1
Comparison of demographics and outcomes between ATC and PTC.

Variables	ATC (n = 3561)	PTC (n = 3238)	p
Age, y,(mean ± SD)	14.2±4.3	11.2±5.4	0.001
Gender			0.001
Males, % (n)	1929 (54.1)	2108 (65.1)	
Females, % (n)	1632 (45.9)	1130 (34.9)	
Race			0.6
Caucasian, % (n)	65% (2314)	58% (1863)	
African American, % (n)	19.6% (700)	17.8% (579)	
Hospital LOS,(mean ± SD)	6.3±8.7	6.5±9.6	0.4
ICU LOS	4.9±7.3	5±7.5	0.8
ISS	17.9±13.4	17.5±13.2	0.2

Table 1 highlights the differences in demographics between patients in ATC and PTC.

4. Spleen injury cohort

2375 patients were found to have spleen injuries. 1314 patients were at ATC while 1061 were at PTC. There was no difference between groups in terms of ISS (p=0.6) or number of high-grade injuries (ATC: PTC, 356: 254; p=0.08). Two patients underwent TAE and spleen surgery. Patients at ATC underwent splenectomy more often than at PTC (101(7.6%) vs. 52 (4.9%); p=0.007). There was no difference in number of patients undergoing TAE (ATC: PTC, 9 (0.68%) vs. 8 (0.75%); p=0.9). Although ICU stays were comparable, patients experienced longer overall hospital LOS at PTC compare to ATC despite undergoing fewer procedures (6.8±11.2 vs. 6.01±8.3; p=0.03). This difference translates to approximately one additional hospital stay at PTC compare to PTC. After adjusting for potential confounders (grade of injury, age, gender and ISS) admission at ATC was associated with higher odds of splenic surgery (OR: 1.5, 95% CI: 1.02-2.25; p=0.03). Table 2 highlights the univariate outcome comparison in spleen injury cohort.

5. Liver injury cohort

2867 patients were found to have liver injuries. 1449 patients were at ATC while 1418 were at PTC. There was no difference between groups in terms of ISS (p=0.9) or number of high-grade injuries (ATC: PTC, 236: 233; p=0.9). Only one patient underwent TAE and liver surgery. There was no difference between ATC and PTC in number of liver operations (0.4% vs. 0.1%; p=0.2) or number of patients who underwent TAE for liver injuries (ATC: PTC, 22 (1.5%) vs. 12 (0.8%); p=0.1). There was no difference between groups in LOS (p=0.7) and ICU stay (p=0.6). After adjusting for potential confounders (grade of injury, age, gender and ISS) admission at ATC or PTC was not predictive of higher number of liver surgery (p<0.05). Table 3 highlights the univariate outcome comparison in liver injury cohort.

Table 2
Outcome comparison between ATC and PTC in spleen injuries.

Variables	ATC (n = 1314)	PTC (n = 1061)	p
Age	13.3 ± 5.1	11.9 ± 4.7	<0.001
Gender			0.01
Male	72.6% (955)	67.8% (720)	
Female	27.3% (359)	32.1% (341)	
ISS	18.2 ± 13.8	17.9 ± 14.1	0.6
High grade	27.1% (356)	23.9% (254)	0.08
Operation	7.68% (101)	4.90% (52)	0.007
TAE	0.68% (9)	0.75% (8)	0.9
LOS	6.01 ± 8.3	6.8 ± 11.2	0.03
ICU LOS	4.7 ± 6.3	5.0 ± 8.2	0.3