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Management of blunt pancreatic trauma in children: Review of the National Trauma Data Bank☆,☆☆

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ABSTRACT

Purpose: This study aims to examine the current management strategies and outcomes after blunt pancreatic trauma in children using a national patient registry.
Methods: Using the National Trauma Data Bank (NTDB) from 2007–2011, we identified all patients ≤18 years old who suffered blunt pancreatic trauma. Patients were categorized as undergoing nonoperative pancreatic management (no abdominal operation, abdominal operation without pancreatic-specific procedure, or pancreatic drainage alone) or operative pancreatic management (pancreatic resection/repair). Patient characteristics, operative details, clinical outcomes, and factors associated with operative management were examined.
Results: Of 610,402 pediatric cases in the NTDB, 1653 children (0.3%) had blunt pancreatic injury and 674 had information on specific location of pancreatic injury. Of these 674 cases, 514 (76.3%) underwent nonoperative pancreatic management. The groups were similar in age, gender, and race; however, pancreatic injury grade > 3, moderate to severe injury severity, and bicycle accidents were associated with operative management in multivariable analysis. Children with pancreatic head injuries or GCS motor score < 6 were less likely to undergo pancreatic operation. Overall morbidity and mortality rates were 26.5% and 5.3%, respectively. Most outcomes were similar between treatment groups, including mortality (2.5% vs. 6.7% in operative vs. nonoperative cohorts respectively; $p = 0.07$).
Conclusion: Although rare, blunt pancreatic trauma in children continues to be a morbid injury. In the largest analysis of blunt pancreatic trauma in children, we provide data on which to base future prospective studies. Operative management of pancreatic trauma occurs most often in children with distal ductal injuries, suggesting that prospective studies may want to focus on this group.

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Pancreatic injuries are rare, with an incidence of 0.4% of traumas presenting in both adult and pediatric populations [1–3].The rate of pancreatic involvement may be closer to 10% in cases of significant blunt trauma, and the morbidity associated with these injuries can exceed 60% [4]. The management of blunt pancreatic injury in children has been a source of continued controversy, particularly in cases of ductal disruption, with ongoing debate over the advantages of early definitive resection versus nonoperative management, including potential drainage and delayed repair or resection [5–7]. A recent systematic review concluded that no randomized trials exist to address the question of operative vs. nonoperative management in children with grade III-V blunt pancreatic injuries [8]. Even prior observational studies have been limited by small sample size or lack of generalizability owing to single institutional case series [4,6,9,10].

Given the lack of robust data defining optimal management strategies and expected outcomes in pediatric blunt pancreatic trauma, we used a large, national trauma registry to (1) evaluate the current incidence of blunt pancreatic trauma in the United States, (2) describe the patient characteristics and injury patterns, (3) examine short-term outcomes, and (4) analyze current management strategies.

1. Methods

1.1. National Trauma Data Bank

Supported by the American College of Surgeons and collecting trauma-specific data from more than 900 trauma centers and other hospitals, the National Trauma Data Bank (NTDB) is a rich tool for trauma-related health care providers and researchers. Details of data collection,

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quality assurance, and the NTDB patient population have been previously published [11,12].

1.2. Study population

Trauma patients ≤18 years of age and captured in the NTDB from 2007–2011 were included for analysis. Abdominal trauma was defined as an abbreviated injury scale (AIS) abdominal score of ≥2. Patients were further classified as having pancreatic trauma based on International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) diagnosis code indicating pancreatic injury (Appendix 1 in the online version at http://dx.doi.org/10.1016/j.jpedsurg.2016.05.003). Cases without specific data on pancreas injury location were excluded from the primary analysis.

Details of case demographics, injuries, and clinical outcomes are captured in specific data fields by the NTDB. Data on associated injuries and severity, location and grade of pancreatic trauma, and operative procedures were extracted from AIS, ICD-9 diagnosis, and ICD-9 procedure codes (Appendices 1 and 2 in the online version at http://dx.doi.org/10.1016/j.jpedsurg.2016.05.003). Patients were categorized as undergoing nonoperative pancreatic management (non-OPM: no abdominal operation, abdominal operation without pancreatic-specific operation, or pancreatic drainage alone) or operative pancreatic management (OPM: primary pancreatic resection or repair). Patients were classified into the most aggressive pancreatic procedure (i.e. if a patient had a pancreatic resection and drainage, they were classified as having pancreatic resection). A subgroup analysis was performed to examine only patients with pancreatic duct injuries (grade ≥ 3).

1.3. Outcomes

Our primary outcome was management strategy, as defined above. Pancreatic drainage was defined as operative or percutaneous drainage. Internal drainage via endoscopic retrograde cholangiopancreatography (ERCP) could not be differentiated from ERCP without drainage. Secondary outcomes were mortality and major complications, including the following: acute respiratory distress syndrome (ARDS), wound infection, pneumonia, and sepsis (defined by ICD-9 diagnosis codes). LOS (length of stay) and discharge disposition were also evaluated.

1.4. Statistical analysis

Patient demographic and injury details, operative management, and clinical outcomes were described in the overall population and compared by management strategy (OPM vs. non-OPM). Categorical variables were described with frequency and percentages, and continuous variables were described using median and interquartile ranges. Categorical variables were compared using Pearson's chi-squared or Fisher's exact test, and ANOVA was used for continuous variables.

Using generalized linear models, a multivariable logistic regression was developed to identify factors independently associated with operative management, after accounting for other demographic and injury characteristics. A backward stepwise variable selection method was used, which originally included the following variables: age, gender, race, year of admission, pancreatic injury severity and location, injury severity score (ISS), shock on admission (defined as age-based hypotension), [13] heart rate > 120 on admission, oxygen saturation < 90% on admission, mechanism of injury, Glasgow Coma Scale (GCS) motor < 6, and other significant abdominal injury (AIS ≥ 3). An interaction term between pancreatic injury location and grade was examined. Missing data were handled using complete case analysis, with cases that contained any missing data points being excluded. Hosmer–Lemeshow goodness-of-fit test, calibration plots, and the C-statistic from the area under the curve (AUC) were used to assess model performance and assumptions and found to be appropriate (Appendix 3 in the online version at http://dx.doi.org/10.1016/j.jpedsurg.2016.05.003). p Values of <0.05 were considered significant. R version 3.02 (R Foundation for Statistical Computing, Vienna, Austria) was used for statistical analyses.

2. Results

Of 610,402 pediatric cases in the NTDB during the study period, 1653 children (0.3%) suffered blunt pancreatic injury (Fig. 1). Blunt pancreatic injury occurred in 0.6% of patients with abdominal injuries (all abdominal injuries: n = 257,261), and 78.5% of all pancreas injuries (all pancreatic injuries: n = 2153). After exclusion of cases without specific pancreas injury location, 674 cases (40.8%) remained for complete case analysis. Patients missing data on pancreatic injury location demonstrated similar characteristics to the cohort who had specific injury location data. Notably, operative intervention was greater in those patients with specific pancreas injury location data compared to children without specific pancreatic location, including pancreatic resections (19.6% vs. 8.3%, p < 0.001) and splenectomy (14.2 vs. 8.2%; p < 0.001).

Of the 674 cases with complete data on pancreas injury location, 514 (76.3%) underwent non-OPM. The non-OPM and OPM groups were similar in age, gender, and race (Table 1). Injury characteristics differed between groups (Table 2), with patients undergoing non-OPM more likely to have a GCS < 13 (p = 0.02) and a pancreatic head injury (p < 0.001). OPM patients had higher overall injury severity (p < 0.01), higher rates of pancreatic body injuries (p = 0.02), and higher rates of grade 3 or higher pancreatic injuries (p < 0.001), with a granular examination of OPM rates by pancreatic injury location and grade provided in Fig. 2. No significant differences were seen in mechanism of injury or associated abdominal organ injuries.

The most common procedure for associated injuries in this patient population was splenectomy (14.2%); which differed significantly when comparing non-OPM and OPM patients (7.4% vs. 36.2%; p < 0.001). OPM patients were more likely to undergo a number of different procedures (Table 3). Overall in-hospital mortality was 5.3% in all children with pancreatic injury, with no statistically significant difference between OPM and non-OPM patients in unadjusted analysis (2.5% vs. 6.2%, p = 0.07; Table 4). Major complications occurred in more than 25% of cases, including acute respiratory distress syndrome (ARDS, 8.1%), pneumonia (7.5%), and wound infection (3.7%), with only the latter being significantly different between groups (OPM: 9.5% vs. non-OPM: 1.6%; p < 0.01). Median length of stay (LOS) was 8 days, which was longer in OPM vs. non-OPM in unadjusted comparison (11 vs. 7 days; p < 0.001).

In multivariable logistic regression to identify potential drivers of the decision to operate on a pancreatic injury, several factors demonstrated a significant association with the use of operative management after variable selection and adjustment for potential confounders (Fig. 2), including age > 15 years (AOR: 1.6, 95% CI: 1.1–2.5), pancreas injury grade 4 (AOR: 4.2, 95% CI: 1.9–9.3), pancreas injury grade 5 (AOR: 9.2; 95% CI: 3.9–22.1), moderate to severe ISS (AOR: 2.3, 1.4–3.8), and bicycle (AOR: 2.0, 1.1–3.4) or struck injuries (AOR: 1.9, 1.1–3.4). Pancreatic head injuries and decreased mental status on presentation (GCS motor score < 6) were associated with non-OPM. Notably, other significant abdominal injuries and vital signs on presentation did not demonstrate an association with operative management. A subsequent analysis to examine the interaction between pancreatic duct injury (grade ≥ 3) and pancreatic injury location found no significant interactions, indicating that the role of ductal injury on operative planning was independent of its location. It should be noted that the interpretation of grade 5 pancreatic injuries is complicated by these injuries being obligate pancreatic head injuries. Because odds ratios are multiplicative, a grade 5 injury will always include both the OR of 9.2 (grade 5 injury) and 0.4 (pancreatic head injury), which provide a combined adjusted OR of 3.7 before consideration of other factors (Fig. 3).

In further analysis of patients with pancreatic duct injury (grade ≥ 3), we found that nearly half of these patients underwent OPM. Pancreatic

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