Blunt Abdominal Trauma from Motor Vehicle Collisions from 2007 to 2011: Renal Injury Probability and Severity in Children versus Adults

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Purpose: There are sparse data directly comparing the probability of renal injury in children and adults. The kidney of the child is believed to be more susceptible to blunt injury for a variety of anatomical reasons. In a large cohort we tested the hypothesis that the pediatric kidney is more susceptible to any renal injury and to higher grade injury.

Materials and Methods: We queried the NTDB® (National Trauma Data Bank®) on all hospital admissions following motor vehicle collisions in a pediatric population (age greater than 21 years) and a referent adult population (age 30 to 50 years). Of 111,172 children who were admitted after motor vehicle collisions 1,093 had renal injury.

Results: Of the 111,172 children admitted to the hospital following motor vehicle collisions 59,385 had abdominal trauma and 1,093 had renal injury. In a multivariate logistic model adjusting for overall ISS (Injury Severity Score), region, year, driver/passenger status, presence of restraint or an airbag, we found that children had 48% higher odds of renal injury compared to adults ages 30 to 50 years (OR 1.48, 95% CI 1.32–1.66, $p < 0.001$). Furthermore, children were at 33% higher risk for high grade renal injury (OR 1.33, 95% CI 1.05–1.69, $p = 0.919$). The effect remained when restricting analysis to patients with concomitant liver and spleen injuries ($p < 0.001$).

Conclusions: In a large national cohort of children, blunt renal injury following motor vehicle collisions is rare but substantially more common than in adults. The odds of high grade renal injury are approximately 50% higher in children. A greater index of suspicion and a lower threshold for renal imaging is prudent for children with blunt abdominal trauma from motor vehicle collisions.

Key Words: kidney; accidents, traffic; abdominal injuries; soft tissue injuries; motor vehicles

Abbreviations and Acronyms

AAST-OIS = American Association for the Surgery of Trauma Organ Injury Scale

MVC = motor vehicle collision

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In the United States, unintentional injury is the most common cause of death between ages 1 and 44 years,[1] and MVCs are the most common cause of injury related death between ages 5 and 24 years.[2] Children in MVCs are known to be at substantial risk for renal injury.[3,4] Therefore, understanding the epidemiology and mitigating the risk of motor vehicle trauma is an important component in the care of children and young adults.

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The relative susceptibility of the pediatric kidney to injury in MVCs is an open question. It has been posited that the pediatric kidney is more susceptible to injury for a variety of reasons, including the relatively large size of the pediatric kidney compared to the remainder of the body, the paucity of fat surrounding the kidney and the compliance of the thorax when the ribs are not yet fully ossified.[5] This hypothesis is bolstered by numerous observations of renal injury in low energy accidental trauma in children.[6–10] It contrasts with the relative rarity with which low energy trauma seems to result in adult kidney injury. However, to our knowledge the susceptibility of pediatric and adult kidneys to injury when each experiences a high energy trauma such as a MVC has not been studied. Direct comparisons between adult and pediatric renal trauma risk have been limited to studies with fewer than 50 pediatric subjects.

A precise characterization of the risk of pediatric renal trauma is important as the pretest probability of injury informs guidelines for trauma management. We aimed to measure the probability of renal injury and high grade renal injury in children and adults in a large national cohort of victims of motor vehicle collisions. We also tested the hypothesis that there would be a difference in the odds of injury based on age.

MATERIALS AND METHODS

The NTDB, a voluntary, nationwide data repository of adult and pediatric patients hospitalized at level 1 to 5 trauma centers, is the largest such trauma database ever assembled.[11] Data are compiled annually. We analyzed NTBD admission years 2007 to 2011 inclusive. Trauma in this database is defined as a ICD-9 discharge diagnosis of 800-959.9, excluding late effects of injury, foreign body cases and superficial injury.

We included all patients with driver (E810.0-E825.0) and passenger (E810.1-E825.1) motor vehicle collision ICD-9 codes. We excluded collisions involving motorcycle operators. To mitigate the potential for selection bias, we performed sensitivity analysis by analyzing a subset of patients with a liver or spleen laceration after a MVC. Because the NTDB is an inpatient database and adult patients with low grade renal injury may be more likely than children to be discharged home without hospital admission, we were concerned that children might be overrepresented in the database. This bias would result in the artificial impression that children were more prone to renal injury than adults. As all patients with splenic or liver laceration would be highly likely to be admitted,[12,13] analyzing this subgroup with respect to renal injury reduced this form of selection bias.

The primary outcome of the analysis was the adjusted odds of renal injury among pediatric vs adult patients admitted after a MVC. We defined patients with renal injury using AIS (Abbreviated Injury Scale) codes 541612, 541622, 541624, 541626 and 541628. These codes were converted to the AAST-OIS according to established methods.[14] The AAST-OIS is an ordinal scale of injury that grades all organ injuries from I to V.[15] We compared children and adults, with age defined as 0 to 21 years for children and 30 to 50 years for adults, in regard to the peak incidence of adult trauma in the NTDB. We examined the odds of any renal injury and of high grade renal injury with the latter defined as AAST-OIS grade 3 or higher.

Continuous variables are expressed as the median and IQR. Predictor variables were analyzed for associations with the outcome (any renal injury or high grade renal injury). On multivariate logistic regression the covariates of ISS, presence of an airbag, presence of a restraint, passenger or driver status, region of the United States and year of analysis were selected a priori, given the potential relationship to the outcome.

We also created a multivariate ordered logit model testing the probability of renal injury grade among the subgroup of MVC patients with liver and/or splenic injury, including visceral organ injury grade. We performed a global analysis including all adult and pediatric patients admitted with renal injury and a second analysis restricting the cohort to only those with concomitant splenic and/or liver injury. On bivariate analysis we used the chi-square test of independence for discrete outcomes and the t-test for continuous outcomes. All statistical tests were 2-sided with $p < 0.05$ considered significant. Analyses were performed using R, version 3.2.0 (https://www.r-project.org/foundation/).

RESULTS

The number of hospitals included in the NTDB range between 429 and 744 annually, including between 30.6% and 33.7% Level 1 institutions and between 33.7% and 34.8% Level 2 institutions. The data set included 111,172 pediatric and 126,736 adult patients who were admitted after MVCs, of whom 1,093 and 763, respectively, experienced renal trauma. Table 1 shows the cohort of pediatric and adult patients with renal injury. Of the adults 79.9% were drivers compared with 51.9% of the pediatric cohort ($p < 0.0001$). [T1]

Table 2 shows the results of logistic regression for the outcome of any renal injury and for high grade renal injury (grades III, VI and V). On the adjusted analysis children had 48% higher odds of renal injury compared to adults 30 to 50 years old (OR 1.48, 95% CI 1.32, 1.66, $p < 0.001$). Furthermore, children were at 33% higher odds of high grade renal injury (OR 1.33, 95% CI 1.05, 1.69, $p = 0.019$). The increased odds of injury remained when restricting analysis to the subgroup of patients with concomitant liver or spleen injuries ($p < 0.001$). [T2]

In our multivariate ordered logit model analyzing the probability of increasing renal injury grade and controlling for ISS, region, year and high or low visceral injury grade, pediatric age was again