**Association for Academic Surgery**

# Mechanism and mortality of pediatric aortic injuries

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### ABSTRACT

*Background:* Aortic injuries are rare, but have a high mortality rate in children and adolescents. We sought to investigate mechanisms of injury and predictors of survival.

*Materials and methods:* The Kids' Inpatient Database (1997—2009) was used to identify cases of thoracic and abdominal aortic injury (*International Classification of Diseases, ninth Revision, Clinical Modification* codes 901.0, 902.0) occurring in children aged <20 y. Bivariate and risk-adjusted multivariate analyses were used to reveal associated diagnoses and procedures and to identify predictors of in-hospital mortality, respectively. Cases were limited to emergent or urgent admissions.

*Results:* A total of 468 cases were identified. Survival was 65% overall, 63% for boys and 68% for girls. The most common mechanism of injury was motor vehicle-related (77%), followed by other penetrating trauma (10%) and firearm injury (8%). On multivariate modeling, boys (odds ratio, 0.15 [95% confidence interval, 0.05, 0.45]) and Hispanic children (0.17 [0.05, 0.60]) had lower associated mortality *versus* girls and Caucasians, respectively. Self-pay patients (6.47 [1.94, 21.6]) had higher mortality *versus* privately insured patients. Children in the fourth income quartile had lower mortality *versus* all income quartile patients. Patients admitted to urban nonteaching hospitals (0.15 [0.04, 0.59]) had lower mortality *versus* those admitted to urban teaching hospitals. Patients with traumatic shock (47.9 [12.3, 187]) or necessitating exploratory laparotomy (13.7 [2.06, 91.4]) had the highest associated mortality overall. Survival increased over the study period between 1997 and 2009.

*Conclusions:* Motor vehicle-related injuries are the predominant mechanisms of aortic injury in the pediatric population. Gender, race, payer status, income quartile, and hospital type, along with associated procedures and diagnoses, are significant determinants of mortality on multivariate analysis.

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## 1. Introduction

Blunt thoracic aortic injury is rarely seen in pediatric patients, making up only 2.1% of pediatric deaths resulting from trauma. However, it is highly lethal, with an initial survival rate of 7% compared with 14% in adults [1]. Some factors explaining the low incidence may include increased compliance of chest wall, lack of arterial disease, and lower force of impact. Around 30% of untreated survivors of acute aortic trauma die within 6 h, 40%–50% within 24 h, and 90% within 4 mo [2].

About 30%–50% of the patients with blunt thoracic aortic injury show no signs of chest trauma, and therefore it is extremely important to have a high level of suspicion when there is a high energy trauma to the thorax, including decelerations, crashes, or compression.

Traditional imagining for these patients includes supine or when possible an upright radiograph followed by thoracic aortography when there are signs of mediastinal hematoma. When the patient is sufficiently stable, computed tomography can be performed and provides the advantages of being noninvasive, permits multilevel visualization of the aorta, and allows evaluation of adjacent organs, but lacks dynamic information and poor visualization of collateral circulation. In fact, some authors report that chest computed tomography angiography has 100% sensitivity and 100% negative predictive value for the detection of thoracic aortic injury [1]. However, others rely on transeophageal echocardiography to diagnose and define aortic injuries [3].

Few studies have been performed with a large cohort to identify the indicators predicting survival after aortic injuries. We amassed a cohort of 468 cases of aortic injuries in pediatric patients to further identify determinants for survival in this population.

## 2. Materials and methods

The Kids' Inpatient Database (KID) is a national sample of pediatric admissions, maintained by the Healthcare Cost and Utilization Project, Agency for Healthcare Research and Quality. Each triennial release, available from 1997–2009, comprises approximately 2–3 million nonweighted cases. Diagnosis and procedure codes associated with each admission are coded using the *International Classification of Diseases, ninth Revision, Clinical Modification* (ICD-9-CM).

KID was used to identify pediatric and adolescent patients aged <20 y with thoracic or abdominal aortic injury (ICD-9-CM 901.0, 902.0). Demographic, socioeconomic, clinical, and hospital characteristics were examined for predictors of mortality. Associated diagnoses, procedures, and mechanism of injury were defined by their respective ICD-9-CM codes. Cases were limited to emergent or urgent admissions, and weighted to project national estimates. Patients with dispositions coded as "transfer to short term hospital" and "other transfers, including skilled nursing facility, intermediate care, and other type of facility" were excluded from survival analyses in an effort to avoid potential duplicate reporting from the receiving hospital. All analyses were limited to available data points.

Binary logistic regression models were constructed to identify determinants of mortality. Risk-adjustment was performed using the Elixhauser method, which has been validated in multiple previous retrospective outcome analyses [4–6]. Continuous variables are presented as median (interquartile range) and compared using Student's *t*-test or Mann-Whitney *U*-test as appropriate. Categorical variables are compared using the chi-square test or Fisher's Exact test as appropriate. All analyses involving total charges were standardized to 2009 US Dollar values, according to the U.S. Department of Labor [7]. All statistical analyses were performed using SPSS Statistics, version 21.0 (IBM, Armonk, NY).

The Institutional Review Board at the University of Miami, Miller School of Medicine (Miami, FL) deemed this retrospective study to be exempt from full review.

## 3. Results

Overall, 468 cases were identified. Hospital survival was 65% for the cohort, 63% for boys and 68% for girls. Average length of stay was 10.7 ± 14.0 d with charges 105,110 ± 121,838 US Dollar. Adolescents (15–19 y) and males comprised most of the group (84% and 79%, respectively). Patients were predominantly Caucasian (45%) and privately insured (51%). Injuries tended to affect patients in the first income quartile (36%) and most presented to large (78%) or urban teaching (83%) hospitals. Additional demographic characteristics are described in Table 1.

Most injuries were reported to occur in the thoracic aorta (72%), whereas abdominal injuries comprised the remainder (29%). Pulmonary contusions (21%) and insufficiency (18%) were commonly associated diagnoses, and approximately 15% experienced traumatic shock. The most common types of aortic repair were suture of artery (24%) and open patch repair (21%). An endovascular repair technique was used in only 4% of patients. Of cases with known mechanisms of injury (n = 105), the most common was motor vehicle-related (77%), followed by other penetrating trauma (10%) and firearm injury (8%). An analysis based on age showed that children <15 y had similar trends in survival, associated diagnoses, and procedures compared with those aged between 15 and 19 y (no significant differences between ages). A notable exception existed with endovascular repairs, as none were performed *via* this approach in children aged <15 y. Regarding the mechanism of injury, most cases were motor vehicle-related (93%), whereas no cases were associated with penetrating trauma in patients aged <15 y. Additional details of these trends are described in Table 2.

On logistic regression modeling of the entire cohort (Table 3), select diagnoses and procedures, along with gender, race group, payer, income status, and hospital type were found to be significant determinants of mortality. Boys (odds ratio [OR], 0.15 [95% confidence interval [CI], 0.05, 0.45]) and Hispanic children (OR, 0.17 [0.05, 0.60]) had lower associated mortality *versus* girls and Caucasian patients, respectively. Self-pay patients (OR, 6.47 [1.94, 21.6]) had higher mortality *versus* privately insured patients. Children in the fourth income quartile had lower mortality *versus* all other income quartiles. Patients