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## Brief Report



### ASSOCIATED INJURIES IN SKELETALLY IMMATURE CHILDREN WITH PELVIC FRACTURES

M. Kareem Shaath, MD, Kenneth L. Koury, MD, Peter D. Gibson, MD, Mark R. Adams, MD, Michael S. Sirkin, MD, and Mark C. Reilly, MD

Department of Orthopaedic Surgery, Rutgers University – New Jersey Medical School, Newark, New Jersey  
Reprint Address: M. Kareem Shaath, MD, Department of Orthopaedics, Rutgers University – New Jersey Medical School, 205 South Orange Avenue, Suite C-1200, Newark, NJ 07103.

**Abstract—Background:** Pediatric pelvic fractures are rare injuries resulting from high-energy mechanisms that warrant an extensive work-up for associated injuries. **Objectives:** We performed a retrospective study to review concomitant injuries in children who suffered a pelvic fracture and have an open triradiate cartilage. **Methods:** Using a database, pediatric pelvic fractures presenting to the authors' institution were extracted. Radiographs and computed tomography scans were reviewed, ensuring that triradiate cartilages were not fused and the pelvic injuries were classified using the Modified Torode Classification. **Epidemiologic data extracted** included Glasgow Coma Scale (GCS), Injury Severity Score (ISS), and Abbreviated Injury Score (AIS). **Results:** Sixty patients met the inclusion criteria, and their average age was 8.3 years (range 2–14 years). There were no mortalities. The most common mechanism of injury was a vehicle striking a pedestrian. There were no significant correlations between GCS, ISS, and AIS. All 60 children (100%) suffered extremity injuries. Nineteen patients required surgical orthopedic intervention, and 6 required operative stabilization of the pelvis. Patients who were struck by a motor vehicle were more likely to have multiple pelvic fractures ( $p < 0.05$ ). Patients with multiple pelvic fractures were more likely to require orthopaedic surgical intervention and require a blood transfusion ( $p < 0.05$ ). Patients who had type III-B or IV fractures were more likely to require a transfusion than patients with III-A fracture ( $p < 0.05$ ). **Conclusions:** Patients sustaining fractures to an immature pelvis are likely to have additional injuries, which may be fatal or disabling if not diagnosed in a timely manner. © 2016 Elsevier Inc. All rights reserved.

**Keywords—**pediatric pelvic fractures; multitrauma; injury burden; pediatrics; orthopedics

#### INTRODUCTION

Pediatric pelvic fractures are rare injuries, accounting for only 1–2% of fractures in children with a reported incidence of 1 per 100,000 children per year (1–6). The morbidity and mortality of these injuries is usually higher when compared to other types of orthopaedic trauma (7,8). These injuries result from high-energy mechanisms that warrant an extensive work-up for associated injuries. Mortality in pediatric patients sustaining pelvic fractures is usually lower than adults with similar injuries (9). Fatal hemorrhage seen in adult patients with pelvic fractures is rare in the pediatric population. The bleeding incurred with pediatric pelvic fractures typically occurs due to associated solid-organ injuries; therefore, identification and treatment of these life-threatening injuries should be the primary focus of the acute management of children presenting with pelvic fractures (10).

The identification of open triradiate cartilage centers is a potentially important distinction when assessing pelvic injuries in pediatric patients. The unfused innominate bone is considerably more flexible, requiring great force to cause fractures of the immature pelvis (11). There is

also greater elasticity at the pubic symphysis and sacroiliac joints of these children (12,13). Due to the high force needed to produce fractures in this group, it would stand to reason that these patients have additional extensive injuries, which may be of even greater concern than the pelvic injury itself.

The classic classification system for pediatric pelvic fractures was developed by Torode and Zeig in 1985. This is based on radiographs alone and considers anatomic as well as mechanical factors, relating mechanism of injury to severity of deformities. Types are as follows: (I) avulsion fractures, (II) iliac wing fractures, (III) simple ring fractures, and (IV) ring disruption fractures (14). Recently, a modification of the Torode system was proposed by Shore et al. using computed tomography (CT) scans in addition to radiographs. It was found to be predictive for significant morbidity and death in multitrauma (15). This modified classification system further divided type III injuries into A and B subclassifications. A III-A injury is a stable anterior ring fracture, whereas a III-B injury is stable but involves both the anterior and posterior ring. Type IV fractures include unstable injuries such as ring disruptions, hip dislocations, and associated pelvic fractures combined with fractures of the pelvis and the acetabulum (15).

Whereas few studies have reported on concomitant injuries in pediatric patients sustaining pelvic fractures, no study specifically focuses on injuries associated with pelvic fractures in patients with open triradiate cartilage (16,17). We performed a retrospective study to review concomitant injuries in children who suffered a pelvic fracture and have an open triradiate cartilage during a 13-year period. The purpose of the study was to quantify and describe the number and type of associated injuries in pediatric patients sustaining fractures to an immature pelvis.

## MATERIALS AND METHODS

After institutional review board approval, we retrospectively reviewed the charts of all trauma patients presenting to our urban, level I trauma center from 2001 to 2014. For inclusion in the study, patients were under the age of 18 years and sustained a pelvic fracture from a blunt-force mechanism. Firearm injuries were excluded. Imaging was reviewed to assess the status of the triradiate cartilage and to classify the pelvic and concomitant orthopaedic injuries. Only patients with a patent triradiate cartilage were included for final review. Authors reviewed both radiographs and CT scans to classify each patient's injury according to the Modified Torode Classification.

For each patient the following epidemiologic data were extracted: age, race, gender, time of presentation,

mechanism of injury, Glasgow Coma Scale (GCS), Injury Severity Score (ISS), units of blood transfused, length of hospitalization, need for surgical orthopaedic intervention, and disposition. Associated injuries were classified as injuries to: head/neck region, face, chest, abdomen, and extremities. The ISS was subdivided to calculate the Abbreviated Injury Score (AIS) for the aforementioned body areas as well.

Statistical analyses were performed on the above-mentioned data. GCS, ISS, and AIS were compared based on injury mechanism and pelvic injury classification. Additional orthopaedic injuries were also evaluated based on mechanism and pelvic injury type. Microsoft Excel (Microsoft Corporation, Redmond, WA) was used to produce descriptive statistics such as mean, median, and standard deviation, as well as to calculate a two-proportions  $z$  test. Statistical significance was set at  $p < 0.05$ .

## RESULTS

Sixty patients met the inclusion criteria of having open triradiate cartilage and a pelvic fracture; demographic data can be found in Table 1. Nearly half (46.7%) of the patients presented between the hours of 6:00 p.m. and 6:00 a.m. Hospitalization statistics can be found in Table 2.

Although the mechanism of injury varied, the most common mechanisms involved an automobile (Table 3). GCS and ISS values were calculated upon admission for each patient (Table 4). There were 7 patients (11.7%) with a GCS of 8 or lower. Of those with a GCS  $< 8$ , 71.4% were pedestrian struck ( $p < .005$ ). The highest ISS correlated with patients that were pedestrian struck with a mean of 18.95 and a median of 16 in that subgroup. When comparing mechanism of injury and AIS, no statistical significance was found (Table 5).

All 60 children (100%) suffered extremity injuries in addition to their innominate bone injuries (Table 6). There was no correlation between the mechanism of injury and pattern of additional orthopaedic injury.

Type and number of pelvic fractures in each group can be found in Table 7, and number of each fracture type in accordance to the modified Torode classification can be

**Table 1. Demographic Information**

Demographic	# of Patients
Gender	19 female 41 male
Age (average)	8.3 years
Race	43 African American 12 Hispanic 5 White

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