Patterns of Pediatric Mandible Fractures in the United States

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IMPORTANCE The mandible is arguably the most frequently fractured facial bone in children. However, facial fractures are rare in children compared with adults, resulting in few large studies on patterns of pediatric facial fractures.

OBJECTIVE To report the patterns, demographics, and cause of pediatric mandible fractures across the United States.

DESIGN, SETTING, AND PARTICIPANTS A retrospective analysis was conducted of the Healthcare Cost and Utilization Project’s National Emergency Department Sample from January 1 to December 31, 2012, using the International Classification of Disease, Ninth Revision, codes for mandible fractures (802.20-802.39) among patients 18 years and younger who presented to emergency departments. Demographics, fracture site, and fracture mechanism were analyzed to identify factors associated with fractures. Analysis was conducted from July 9 to July 28, 2015.

RESULTS There were 1984 records, representing a weighted estimate of 8848 cases of pediatric mandible fracture. The mean patient age was 14.0 years (95% CI, 13.6-14.3). The male to female ratio was 4:1 and females were comparatively younger, with a mean age of 12.5 years (95% CI, 11.8-13.1; P < .001). The most frequently fractured sites were the condyle, in 1288 patients (14.6% [95% CI, 12.6%-16.5%]), and the angle, in 1252 patients (14.1% [12.4%-15.9%]). Associated intracranial injuries occurred in 756 patients (8.5% [7.1%-10.0%]), and cervical spine fractures occurred in 393 (4.4% [3.5%-5.4%]). The fracture site and mechanism of injury varied with age and sex. For patients 12 years and younger, the most frequent fracture site was the condyle, accounting for 636 fractures (27.9% [24.2%-31.6%]), and the most frequent cause was falls, accounting for 692 fractures (30.3% [25.9%-34.8%]). In teenaged patients (13-18 years), the angle was the most frequent fracture site, accounting for 1157 fractures (17.6% [15.6%-19.6%]), and the most frequent cause was assault, accounting for 2619 fractures (39.9% [36.4%-43.3%]). For male patients, the angle was the predominant site, accounting for 1053 fractures (15.0% [13.1%-16.8%]), and the leading cause was assault, accounting for 2360 fractures (33.5% [30.2%-36.9%]). For female patients, the condyle was the most frequent site, accounting for 369 fractures (20.3% [16.0%-24.6%]), and the leading cause was falls, accounting for 422 fractures (23.2% [18.6%-28.0%]).

CONCLUSIONS AND RELEVANCE In this study, age and sex disparities among pediatric mandible fractures were identified. Younger patients and female patients tend to have condyle fractures caused more commonly by falls while older patients and male patients tend to have angle fractures caused by assault.

LEVEL OF EVIDENCE NA.
Facial fractures are a rare occurrence in children compared with adults. However, traumatic injuries account for significant morbidity and mortality in children. Recent data from the Centers for Disease Control and Prevention report trauma as the leading cause of pediatric mortality in the United States. \(^1\) Anatomical differences between the craniofacial skeleton of adults and children contribute to the differences in the rate of facial fractures. In young children, the cranium accounts for a higher proportion of the craniofacial skeleton than in adults and the cranium protects the facial skeleton from trauma. The cranium to face ratio is 8:1 at birth and decreases to 2.5:1 in adulthood. \(^2\) Thus, the risk of facial fractures increases with age owing to the increasing proportion of the facial skeleton. In addition, children in general are less likely to be involved in activities associated with traumatic injuries seen commonly in adults.

The mandible is the most commonly fractured facial bone in children. In an analysis of the National Trauma Data Bank by Imahara et al, \(^3\) the mandible accounted for 32.7% of all facial fractures in children. Given the rarity of pediatric facial fractures, most studies on this subject have been limited to single institutional experiences. \(^4\) A broader understanding of the cause and epidemiological characteristics of facial fractures in children will help improve prevention and management strategies.

Sponsored by the Agency for Healthcare Research and Quality, the Healthcare Cost and Utilization Project (HCUP) has gathered the largest collection of longitudinal hospital care data in the United States, to our knowledge. These data have enabled studies on conditions that could not previously be easily studied at the national level. The purpose of this study was to examine the cause and epidemiological characteristics of pediatric mandible fracture using the 2012 HCUP Nationwide Emergency Department Sample (NEDS). The 2012 NEDS contains 31 million records from a 20% stratified sample of hospital-based emergency departments (EDs). Weights are provided in the database to allow calculation of national estimates. \(^5\) The NEDS does not contain any identifiable patient information.

### Methods

Following approval from the University of Michigan Institutional Review Board, we analyzed mandible fractures recorded in the 2012 NEDS (data from January 1 to December 31, 2012). Records of children 18 years and younger were selected using the *International Classification of Diseases, Ninth Revision (ICD-9)*, codes for mandible fractures (802.20-802.39). The database included the following mechanism of injuries: motor vehicle collision (MVC), assault, and falls. Sports injuries were determined using ICD-9 Ecode (E8494) and other causes of injury were categorized as other. The mechanism of injury and fracture type (anatomical site) were analyzed by age and sex. For age group analysis, patients were stratified into 2 categories based on dentition development. Patients 6 years and younger (primary dentition) were combined into 1 group with those aged 7 to 12 years (mixed dentition). The second group consisted of patients aged 13 to 18 years (secondary dentition). The primary and mixed dentition groups were combined to comply with the HCUP data use agreement that prohibits reporting categories with fewer than 10 records. Likewise, owing to their low numbers, coronoid fractures were combined with unspecified fractures to comply with the HCUP data use agreement. Associated cervical spine and intracranial injuries were identified using Clinical Classification Software codes. This software is used by HCUP to conglomerate clinically relevant ICD-9 codes in diagnostic groups. The Clinical Classification Software codes 233 and 231 (ICD-9 codes 805.00-805.18) correspond with intracranial injury and cervical spine fractures, respectively. Analysis was conducted between July 9 and July 28, 2015.

Weighted statistics for national estimates with 95% CIs were calculated using the discharge weights, strata, and cluster elements of the sampling design provided in the database for a domain analysis of the subset of pediatric mandible fractures. Age and sex were compared across fracture type and cause of injury using linear and logistic regression models, respectively, adjusted for the complex survey design (PROC SURVEYREG and SURVEYLOGISTIC procedures in SAS). All statistical analyses were performed using SAS, version 9.4 (SAS Institute).

### Results

The 2012 NEDS estimates 8848 pediatric ED visits for mandible fractures from an unweighted frequency of 1984 records in a complex survey sample. This number represents 0.03% of the 6 848 951 records of pediatric ED visits in the NEDS. *Table 1* summarizes the characteristics of children in the 2012 NEDS with mandible fractures. The mean age at the time of presentation was 14.0 years (95% CI, 13.6-14.3). Most fractures (6570 [74.3%]) occurred in children between the ages of 13 and 18 years. Fractures were most common in males, with a male to female ratio of 4:1. The mean age in males (14.3 years [95% CI, 14.0-14.7]) was significantly lower than in females (12.5 years [95% CI, 11.8-13.1]) (P < .001). Most patients (2864 [32.4%]) fall within the lowest household income group.

The leading etiologies of mandible fractures included assault (2663 [30.1%]), falls (1519 [17.2%]), and MVC (1141 [12.9%]). The cause of injury varied with age and sex (*Table 2*). Falls caused 691 fractures (30.3%) in the younger age group (<12 years), followed by MVC (368 [16.1%]). Assault was the leading cause of fractures in the older age group (13-18 years), accounting for 2619 fractures (39.9%). The leading causes of fractures in females were falls (422 [23.2%]) and MVC (400 [22.0%]). In males, the leading cause of fractures was assault (2360 [33.5%]).

The most common anatomic sites of fractures were the condyle, in 1288 patients (14.6% [95% CI, 12.6%-16.5%]),

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and angle, in 1252 patients (14.1% [95% CI, 12.4%-15.9%]). Fracture site varied with age and sex (Table 2). In the younger age group, the predominant fracture site was the condyle (636 [27.9%]), with a small proportion occurring elsewhere. In the older age group, the most frequent fracture site was the angle (1157 [17.6%]), followed by the condyle (652 [9.9%]) and ramus (623 [9.5%]). Average age varied across fracture sites (Figure). The mean age among patients with condyle and alveolar fractures was significantly lower than that of all other fracture sites. Sex-based analysis showed that the 2 leading fracture sites in both sexes were the condyle and angle. In males, condyle fractures accounted for 13.1% (n = 919) and angle fractures for 15.0% (n = 1053) of all mandible fractures. In females, condyle fractures accounted for 20.3% (n = 369) and angle fractures for 10.9% (n = 199). The proportion of females in the condyle fracture cases (28.6% [95% CI, 23.6%-35.3%]) was significantly higher than the expected 20% observed in the overall mandible fracture subset.

The location of the fracture was related to the cause. Angle fractures were most frequently caused by assault (633 [50.6%; 95% CI, 43.5%-57.8%]), whereas condyle fractures were commonly caused by falls (401 [31.1%; 95% CI, 25.2%-37.1%]).

Associated cervical spine and intracranial injuries were seen in 1149 of the patients (13.0%). The most predominant was intracranial injury, which was associated with 756 fractures (8.5% [95% CI, 7.1%-10.0%]); cervical spine fractures were seen in 393 patients (4.4% [95% CI, 3.5%-5.4%]). Most intracranial injuries occurred in the children with condyle (147 [19.5%; 95% CI, 12.6%-26.4%]) or angle (81 [10.7%; 95% CI, 5.9%-15.5%]) fractures.

### Discussion

Prior studies on pediatric facial fractures have been limited to single institutional experiences.4,6-8 Our study presents a
The mean ages of patients with fractures at various mandible sites in the 2012 National Emergency Department Sample.

Age variations can be noted in patients with fractures at the various mandible sites. Patients with condyle and alveolar fractures have the lowest mean age. Vertical lines indicate 95% CIs.

Significant sex- and age-related variations were noted in the cause of fractures. In males, assault is the predominant cause of fractures, whereas falls and MVCs predominate in females. Fractures in younger children are largely owing to falls and MVCs, while assault is the most common cause in older children. These findings reflect the varying behavior patterns seen between the different age and sex groups. Studies have shown that males are more likely than females to be involved in high-risk activities associated with trauma and accidental injuries. Younger children are typically protected from high-risk activities through close adult supervision that declines with age. Reports on the cause of pediatric mandible fractures in the literature have been inconsistent. Some studies have reported violence-related injuries as the leading cause of fractures\(^4,12\) while others point to sports-related incidents\(^3,13\) and MVC\(^3\) as the leading cause of pediatric mandible fractures. Our analysis supports assault as the leading cause of pediatric mandible fractures.

Age, sex, and etiologic differences in the anatomical fracture site were also seen in our analysis. In younger children (≤12 years), the condyle appears to be the most vulnerable site. This finding is consistent with other reports in the literature.\(^14-16\) Older children trend toward an adult fracture pattern, with the angle being the most frequently fractured site. The cause also contributes to the fracture pattern. Angle fractures predominantly result from assault whereas MVCs and falls commonly cause condyle fractures. This observation corresponds to the fracture patterns seen in the different age and sex groups in our study. In younger children and in females, where the leading cause of fracture is falls and MVCs, the most common fracture site is the condyle. Angle and condyle fractures were most likely to be associated with intracranial injuries, seen in 8.5% of the study population.

The weaknesses of this study are those inherent to retrospective database reviews. Overall accuracy is dependent on correct coding practices. In addition, since the NEDS is a sampling of records of visits to hospital-based EDs, patients seen in non-hospital-based EDs are not captured in the sampling. Despite these shortcomings, this analysis provides a national view on the patterns of pediatric mandible fractures that, to our knowledge, has not been previously described on such a large scale.

**Conclusions**

Significant age and sex disparities exist in the patterns and cause of pediatric mandible fractures. Fractures predominantly occur in older male children, with assault as the main mechanism of injury. The main causes of mandible fractures in females and younger children are falls and MVCs. Fractures can be associated with intracranial and cervical spine injuries; children presenting with mandible fractures should be carefully assessed for these injuries. National database analyses, such as those presented in our study, play an essential role in the creation of diagnostic, treatment, and prevention protocols for rare pediatric injuries.

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**Statistical analysis:** Owusu, Bellile, Sidman. Administrative, technical, or material support: Moyer, Sidman. Study supervision: Moyer, Sidman.

**Conflict of Interest Disclosures:** None reported.

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