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Observational Study

Epidemiologic Investigation of Pediatric Distal Humerus Fractures: An American Insurance Claims Database Study

Epidemiology of Pediatric Distal Humerus Fractures

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Abstract

BACKGROUND

Distal humerus elbow fractures are one of the most common traumatic fractures seen in pediatric patients and present as three main types to include: supracondylar (SC), lateral condyle (LC), and medial epicondyle (ME) fractures.

AIM

The aim of this study was to evaluate the epidemiology of pediatric distal humerus fractures (supracondylar, lateral condyle and medial epicondyle) from an American insurance claims database.

METHODS

 A retrospective IBM Truven MarketScan® Commercial and IBM Truven MarketScan Medicare Supplemental databases review of patients 17 years and younger with the ICD 9 and 10 codes for SC, LC and ME fractures. Patients from 2015 to 2020 were queried for treatments, patient age, sex, length of hospitalization, and comorbidities.

RESULTS

A total of 1,133 supracondylar, 154 Lateral condyle, and 124 medial epicondyle fractures were identified. Supracondylar had the highest percent operative at 83%, followed by 78% lateral condyle, then 41% medial epicondyle. Male patients were, on average, older than female patients for both supracondylar and medial epicondyle fractures.

CONCLUSION

Within this insurance claims database, SCs were the most reported, followed by LCs, and finally MEs. Age is a factor for how a pediatric distal humerus fractures, with SCs and LCs being younger than MEs. The peak age per injury per sex is similar to reported historic central tendencies, despite reported trends for younger physiologic development.

Core Tip: Within this insurance claims database, SC were the most reported, followed by LC and finally ME. Age is a factor for how a pediatric distal humerus fractures, with SC and LC being younger than ME. The peak age per injury per sex is similar to reported historic central tendencies, despite reported trends for younger physiologic development.

<u>INTRODUCTION</u>

Distal humerus elbow fractures are one of the most common traumatic fractures seen in pediatric patients and present as three main types to include: supracondylar (SC), lateral condyle (LC), and medial epicondyle (ME) fractures.[1] Historically, SCs are the most common with LCs and MEs trailing after in incidence.[1-3]

The pattern in which the pediatric distal humerus fractures is heavily influenced by both the force vector of injury as well as the remaining unfused ossification centers at the elbow.[4-5] Supracondylar fractures typically occur in children ages five to ten years and are the result of a fall onto an outstretched arm.[3,6] Lateral condyle fractures typically occur in children ages four to ten years and are the result of a varus or valgus applied force to the elbow in extension.[7] Medial epicondyle fractures typically present in an older age group at 9-14 years.[1-2,8-10] Etiology consists of either trauma or an avulsion type injury from an overpull of the flexor-pronator mass.[8-10]

The ossification centers and fusion at the elbow follows a very predictable sequential pattern.[4-5] Factors that influence the timing of ossification center fusion include injury across the physis, systemic diseases such as diabetes and hypothyroidism, endogenous stress hormones and elevated estrogen at puberty.[11] Earlier ages of puberty have been observed in American children over the past three decades.[12-14] This phenomena has implications on the age and injury pattern seen in American children now, in comparison with historic epidemiologic data.

The purpose of this study was to identify current epidemiologic data for pediatric distal humerus elbow fractures between 2015-2020 within this insurance claims database. The goal was to distinguish possible anthropometric differences with historic data. We hypothesized an overall younger central tendency for each of these injuries as compared to historic data, with a larger effect in females when compared with male patients. The clinical application of this investigation is intended to better predict injury patterns and counsel patients on modes of treatment.

MATERIALS AND METHODS

Population

From January 2015 to December 2020, we identified 1,411 patients with an ICD 9 or 10 code designating them as having a SC, LC, or ME fracture. We included the ICD 9 codes 812.41 and 812.51 as well as the ICD 10 codes S42.41 and S42.42 (supracondylar humerus fracture). Also, ICD 9 codes 812.42 and 812.52 as well as ICD 10 code S42.45 (lateral condyle fracture). Finally, we included ICD 9 codes 812.42 and 812.52 as well as ICD 10 code S42.44 (medial epicondyle fracture). Selected patients were queried for CPT code treatments, patient age, sex, length of hospitalization, and comorbidities.

The patients were identified within the IBM Truven MarketScan® Commercial and IBM Truven MarketScan Medicare Supplemental databases. These databases contain de-identified, integrated, person-specific claim data. They are a conglomerate of three separate patient populations. The largest segment contains health information from participating large company employer-based health insurance, the second contains Medicare beneficiaries with supplemental insurance provided by their employer, and the third includes 11 contributing state's Medicaid health information.

Statistical Analysis

Data was organized by injury, patient age and sex. Central tendency was calculated between the 25th and 75th percentile. Normal distribution of continuous variables were assessed with the Kolmogorov-Smirnov test and analyzed with an unpaired t-test. Ordinal data was analyzed with a Chi-Square test or a one-way Analysis of Variance for multiple variables. The comparison of proportions test was utilized for percentage analysis. Data entries were considered statistically significant if p= <.05.

RESULTS

There were 1,133 total supracondylar fractures at an average age of 6.76 ± 3.31 years and 52% male. There were 939 operative patients, 54% of which were male. Operative SC patients were younger than nonoperative patients (6.32 ± 2.81 vs. 8.86 ± 4.53 years, p < .0001). The average age of male SC fractures was 7.04 ± 3.56, with a 50% falling between the ages of 5 and 9 years. The average age of female SC fractures was

6.45 ± 2.98, with a 50% falling between the ages of 5 and 7 years. Male patients were older than female patients (7.04 ± 3.56 vs. 6.45 ± 2.98 years, p = .002) (Table 1, Figure 1).

There were 154 total lateral condyle fractures at an average age of 7.75 ± 4.2 years and 64% male. There were 120 operative patients, 63% of which were male. Operative LC patients were older than nonoperative patients (9.62 ± 4.91 vs. 7.22 ± 3.81 years, p = .009). The average age of male LC fractures was 7.84 ± 4.1, with a 50% falling between the ages of 5 and 10 years. The average age of female LC fractures was 7.59 ± 4.38, with a 50% falling between the ages of 4 and 10 years (Table 2, Figure 2).

There were 124 total medial epicondyle fractures at an average age of 11 ± 3.86 years and 47% male. There were 51 operative patients, 45% of which were male. Operative ME patients were older than nonoperative patients (12 ± 2.58 vs. 10 ± 4.43 years, p = .0045). The average age of male ME fractures was 12.62 ± 3.67, with a 50% falling between the ages of 10 and 15 years. The average age of female ME fractures was 9.62 ± 3.52, with a 50% falling between the ages of 7 and 12 years. Male patients were older than female patients (12 ± 3.67 vs. 9.62 ± 3.52 years, p <.0001) (Table 3, Figure 3).

When comparing across injury types, there was a statistically significant difference in the percentage of operative patients between SC and ME (83% *vs* 41%, p < .0001), and LC and ME (78% *vs* 41%, p < .0001). Operative SCs were younger than LCs (6.32 ± 2.81 *vs* 9.62 ± 4.91 years, p < .0001) as well as MEs (6.32 ± 2.81 *vs* 12 ± 2.58 years, p < .0001). Operative LCs were younger than MEs (9.62 ± 4.91 *vs* 12 ± 2.58 years, p = .001). There was a statistical difference observed in sex between operative SCs (52% male), LCs (63% male), and MEs (45% male, p < .05) (Table 4).

DISCUSSION

Pediatric distal humerus fractures are commonly encountered and therefore warrant continued epidemiologic investigation. SCs were the most represented within this database, followed by LCs and finally MEs. American children may be undergoing developmental changes at earlier timepoints than in previous generations or in non-Western countries. This study identified differences in age and sex between the three

injury types as well as in percent operative between injury types, with MEs having the lowest and SCs the highest operative rate.

Multiple contemporary studies have identified younger ages at which American female children and, to a lesser extent, male children undergo puberty.[12-14] A leading theory is directly linked with the simultaneous youth obesity epidemic in America.[15-17] Adiposity increases circulating estrogen and not only can initiate puberty, but it also has been found to directly close the physis.[11,17-20] Despite these population-wide trends, the effect on the distal humerus physis has not been shown in orthopaedic literature. Peering back on previous epidemiologic published studies provides a comparison to our current landscape. One of the earliest pediatric elbow fracture epidemiologic studies was collected from 1950-1979 in Sweden and found SC fracture average age to be 7.4+/-3.1, LC 8.7+/-3.9 and ME 12+/-2.3.[21] More recently, a Canadian study published results from 2002-2010 and found an interquartile range of 3 to 6 years for all supracondylar fractures.[22] Epidemiologic data has been published on non-Western populations with lower childhood obesity rates.[23-24] A 2013 Iranian study identified 8.1 ± 2.31 years old as the average age for all pediatric elbow fractures.[25] Similarly, an Indonesian study collecting data between 2009 to 2018 found the average age for all pediatric elbow fractures at 7.3 years.[26] Within this American patient database, we did not observe any large age shifts from previous generations or for non-Western countries. Additional comparison studies can be found in: (Appendix A-C).

Our study identified differences in patient sex distribution across the various fracture types. The 1998 study by Cheng at al. identified the sequence for the six pediatric elbow ossification centers and demonstrated males lag about two years behind females.[5] Our data coincides with the sex differences in ossification centers and physeal maturation with male patients being older than female patients on average in SC and ME fractures.[4-5] The highest percentage of operative male patients were those with LC fractures, while the lowest percent operative males were those with ME fractures. In previous studies, ME fractures occur more frequently in a male population, likely due to mismatch between muscular strength and ME fusion site.[7-9] Our study identified

more female ME fractures, possibly due to increase in overall ligamentous laxity, larger elbow carrying angle, and continued increased involvement of women in overhead athletics.[27-32]

Limits of the study

There were several limitations to this study. The data is retrospective in nature and collected from a de-identified insurance claims database, so we were unable to read operative notes, review radiology exams, and analyze patient factors such as mode of injury, time from injury, body mass index and follow-up. We also could only compare chronologic age and not bone age, which may be a better metric for this age group.

CONCLUSION

Within this insurance claims database, SCs were the most reported, followed by LCs and finally MEs. Age is a factor for how a pediatric distal humerus fractures, with SCs and LCs being younger than MEs. The peak age per injury per sex is similar to reported historic central tendencies, despite reported trends for younger physiologic development. These results will more accurately predict the type and treatment of distal humerus fractures in an American pediatric population.

ARTICLE HIGHLIGHTS

Research background

Distal humerus elbow fractures are one of the most common traumatic fractures seen in pediatric patients and present as three main types to include: supracondylar (SC), lateral condyle (LC), and medial epicondyle (ME) fractures and as such warrant continued, updated epidemiological evaluation.

Research motivation

The American pediatric population may be physiologically maturing at younger rates as compared to previous generations. This study looks at common pediatric elbow injuries in relation to age and sex.

Research objectives

Patient age, sex, injury type and treatment type for three common distal humerus fractures.

Research methods

Database retrospective review.

Research results

SCs were the most reported, followed by LCs and finally MEs.

Research conclusions

Age is a factor for how a pediatric distal humerus fractures, with SCs and LCs being younger than MEs.

Research perspectives

The peak age per injury per sex is similar to reported historic central tendencies, despite reported trends for younger physiologic development.

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PRIMARY SOURCES

1   Kyle J. Klahs, Matthew Hagen, John Scanaliato, Carolyn Hettrich, Kelly V. Fitzpatrick, Nata Parnes. "Geriatric proximal humerus fracture operative management: a Truven Health Analytics database study (2015-2020)", Journal of Shoulder and Elbow Surgery, 2023

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