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Incidence of Clavicle Fractures in Sports: Analysis of the NEISS Database

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Key word

- clavicle fracture
- epidemiology
- sports-related

Abstract

Our goal was to present current data on the incidence of clavicle injuries presenting for urgent evaluation and to report the sports activities associated with injury. Using the National Electronic Injury Surveillance System (NEISS) database, the number of clavicle fractures presenting to a representative sample of US hospitals was retrospectively calculated and weighted estimates used to extrapolate this data to the US population. Incidence estimates were obtained using validated analyses and US census data, with sports injuries being noted and fractures stratified by sport. A total of 9428 fractures of the clavicle were reported, representing 357155

injuries in the US population over 5 years. The estimated incidence of clavicle fractures in the US presenting for emergency care is 24.4 fractures per 100000 person-years (95% confidence intervals (CI), 22.8–26.1). The peak incidence was highest between ages 10–19 years. Men were nearly 3 times as likely to sustain a clavicle fracture. Sports were a factor in 45% of all clavicle fractures. In sports-related injuries, 16% of fractures occurred from bicycling, followed by football (12%) and soccer (6%). In summary, injuries from bicycling were the most common cause of clavicle fracture, followed by contact sports. Male gender and younger age are risk factors for clavicle fractures.

Introduction

The clavicle connects the axial to the appendicular skeleton and has a distinctive curved shape. Fractures of the clavicle occur most commonly in the mid-shaft, followed by fractures of the lateral aspect and, uncommonly, the medial third [7]. Historically, conservative treatment of clavicle fractures was recommended except in cases of open fractures, floating shoulder injuries, or threatened skin [16]. However, recent evidence suggests improved patient outcomes with open reduction and fixation of displaced fractures of the shaft of the clavicle [8].

While clavicle fractures are thought to occur commonly, there is limited data regarding the population incidence of clavicle fractures or their relationship to sports activities. A recent study presented prevalence data from a large urban hospital, with 20,501 total fractures treated over 11 years, and noted 533 clavicle fractures (2.6%). The majority (81.3%) represented fractures of the midshaft [14]. Nordqvist and Petersson reported that clavicle fractures due to sports increased

over a 30 year period from 2% overall to 21% [11]. While there have been several reports of clavicle injuries by sport [3,9], few authors have focused on sports' correlation with clavicle fractures. Court-Brown et al. noted that clavicle fractures represented a large proportion of sports-related injury in their study of 5953 patients in a single health system, with 195 fractures of the clavicle, of which 60 (30.8%) were sports-related [4].

To date, the data on the epidemiology of clavicle fractures has been limited to small populations or hospital center reports. We present an analysis of the injury database created by the Consumer Product Safety Commission (CPSC), using the United States population for estimation of incidence calculations. Evaluation of sports activities was analyzed with descriptive data from the database sports categories. The purpose of this study is to demonstrate the impact of sports activities on the occurrence of acutely-treated clavicle fractures.

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Materials and Methods

This cross-sectional descriptive epidemiological study evaluated cases of clavicle fracture reported in the CPSC's National Electronic Injury Surveillance System (NEISS) database. Prior to initiation of this study, institutional review board approval was obtained. All ethical standards were maintained during the conducting of this research [5].

The NEISS is a complex probability sample of all injuries presenting to U.S. emergency rooms. The NEISS sample includes 100 hospitals which were designated by stratified, randomized sampling of all United States hospitals with emergency rooms. Stratification assignment was based on both geographic location and emergency room volume data. Data are gathered on all injuries presenting to the 100 hospital probability sample, with each injury assigned a weighted estimate. In order to create sample weights, participating hospitals are classified into 5 categories: one representing children's hospitals and 4 representing hospital emergency departments of varying sizes, including Level I trauma centers. A full description of the sample, design, and utilization is available publicly on the CPSC electronic webpage (<http://www.cpsc.gov/LIBRARY/neiss.html>). The CPSC conducts yearly sampling of all active U.S. emergency rooms which include information regarding total emergency department visits (EDVs). Utilizing this data, adjustments are made to the sampling frame to ensure that hospitals conform to required specifications, and the sampling frame is utilized to adjust the statistical sample weights to account for changes in strata EDVs. Variables included in the standard NEISS case record are: age, gender, date of treatment, race, assigned diagnostic category, injured body part, patient disposition, location where injury occurred, injury due to sports and games, and 2 descriptive narrative fields. Data is updated daily, and missing information is followed up with phone interviews within the first week of injury whenever possible. The NEISS serves as a reliable and validated source for a wide range of epidemiological studies. Information collected by the NEISS sample for all records beginning January 1, 2002 is publicly available online in a database that can be accessed using criteria-based queries.

Using the NEISS database, all injuries coded as fractures about the shoulder were identified retrospectively. Narrative descriptions of all injuries are required by the database and are entered by providers. Each shoulder injury's narrative was reviewed individually and all clavicle fractures captured. The narratives typically did not specify the location of the clavicle fracture (i.e., midshaft, distal clavicle). Multiple trauma injuries which included clavicle fractures (comprising 7076 injuries) were excluded from analysis. Descriptors and codes for sports-related injuries were identified and these injuries included.

NEISS data from January 1, 2002 to December 31, 2006 was used for weighted injury counts. United States census data from 2001 through 2006 was used to estimate the population for calendar years 2002 through 2006. Because the US census data estimates are indexed from July 1 of each year, but the NEISS data is presented in calendar year form, half year US census data was used for incidence rate calculations for 2002 and 2006. Incidence rates with 95% confidence intervals were calculated by age group and gender. Incidence rate ratios were calculated using the lowest incidence rate as the reference group. Sampling standard errors provided in the NEISS documentation were used to calculate 95% confidence intervals for incidence rates. Statistical analysis was performed using SAS version 9.2 (Cary, NC).

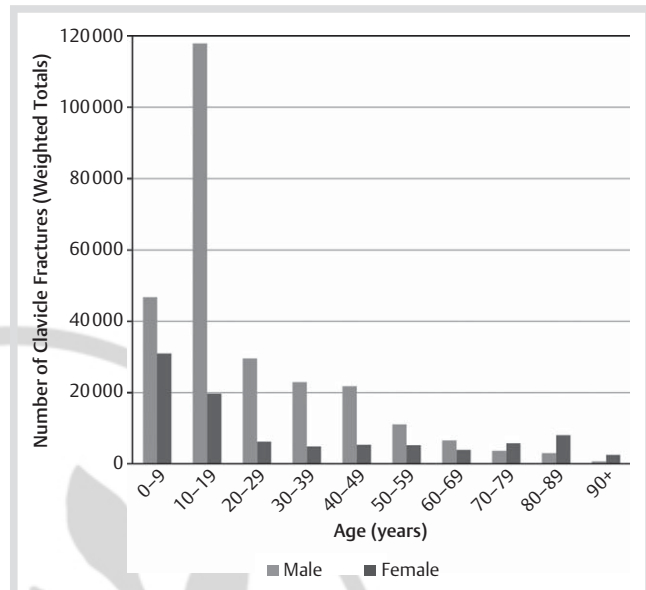


Fig. 1 Clavicle fractures stratified by age and gender, using NEISS weighted estimates.

Results

During the 5 year period 2002–2006, participating hospital emergency departments (EDs) coded a total of 9428 fractures of the clavicle presenting for care. Using weighting estimates, these data represent 357 155 clavicle fractures nationwide, or roughly 71 431 clavicle fractures per year presenting to emergency departments in the US. This results in a calculated incidence of 24.4 fractures per 100 000 person-years (95% confidence intervals (CI), 22.8–26.1), using US census data available for those years.

Younger age was a risk factor for clavicle fractures, with the highest incidence seen in the first 2 decades. Peak incidence occurred in the 10–19 year age group, with an incidence rate of 66 clavicle fractures per 100 000 person-years (95% CI, 60.7–71.2), followed by the 0–9 year age group with an incidence rate of 39.2 injuries/100 000 person-years (95% CI, 35.7–42.7) (◉ **Fig. 1**). Sports-related clavicle fractures were analyzed by decade of occurrence and by sex, and this evaluation showed that the majority of these injuries also occurred in the second decade (10–19 years) in males.

We evaluated the gender differences and noted a clear gender disparity. Men sustained clavicle fractures at an incidence rate of 36.8 fractures/100 000 person-years (95% CI, 34.0–39.5), compared to 12.5 clavicle injuries per 100 000 person-years in females (95% CI, 11.5–13.5). The incidence rate ratio was significant at 2.93 (95% CI, 2.92–2.94, $p < 0.05$) (◉ **Fig. 1**).

Fractures attributed to sports (4 135 fractures, weighted estimate of 161 780 injuries) comprised 45.3% of the clavicle fractures (◉ **Table 1**). Other etiologies included motor vehicle and motorcycle accidents, and falls. Recreational or competitive bicycling was responsible for clavicle fractures in 1 217 males and 188 females and was the most common sports injury in both sexes, with consistent occurrence in all 4 seasons. In men, football ($n=1268$) and soccer ($n=253$) were the second and third most common causes of clavicle fractures. In women, soccer ($n=85$) and basketball ($n=37$) were the most frequent sports causing injury after bicycling. Football, played most commonly in the US in the fall, had a seasonal spike in autumn, while soccer

Sport	Injuries (n)	Weighted estimates of injuries in US population	Percentage of total	Males	Females
bicycling	1 405	57 249	0	1 217	188
baseball/softball	74	3 061	2.61	70	4
basketball	164	5 718	3.9	127	37
skateboarding	191	8 298	6.25	181	10
snowboarding	202	10 031		195	7
skiing	165	8 948	2.9	141	24
rugby	31	1 270		24	7
football	1 306	43 373	8.37	1 268	38
gymnastics	16	309	2.14	10	6
hockey	143	7 040	0.82	135	8
soccer	338	12 712	3.89	253	85
volleyball	8	165	1.06	82	9
wrestling	91	3 500	5.3	55	1

Table 1 Sports related clavicle injuries.

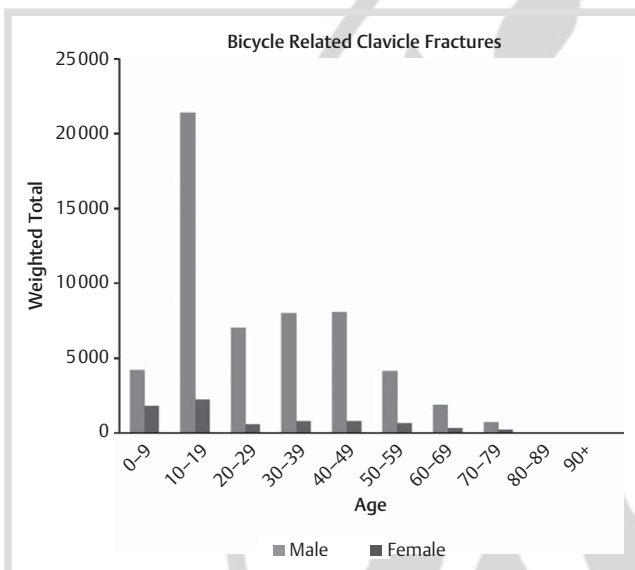


Fig. 2 Sports-related clavicle fractures.

showed a slightly higher occurrence of clavicle fractures in the spring. Fractures due to bicycling had a peak in incidence in 10–19 year olds (weighted total 21 000), with secondary and lower peaks in the 30–39 and 40–49 year groups. In the majority of sports analyzed, men had a higher occurrence of fracture, while women had similar occurrence patterns in lower numbers, but in proportion to men (◉ **Fig. 2**).

Discussion

Clavicle fractures can be season-ending injuries, but little is known about the incidence of these injuries, particularly in relation to sports activity. Specifically, there are limited data pertaining to the epidemiology of such fractures based on large population samples. The annual incidence of clavicle fractures has been estimated to be between 20 and 50 fractures per 100 000 per year, based on small city populations or single regional medical centers [11,12,15]. The percentage of these injuries attributed to sports has not been well-studied. In a study of the epidemiology of sports-related injuries, Court-Brown et al. noted that clavicle fractures had the highest prevalence of injuries secondary to sports, at 30.8% (60/195 clavicle fractures), in a study of all injuries treated at a single center in one year [4].

In previous studies, the most common sports associated with clavicle fracture were rugby, horseback riding, and hockey. In our study, with nearly half (45%) of all clavicle injuries presenting for emergency care due to sports activities, we found that a majority of all clavicle fractures occurred due to bicycling (16%). This was closely followed by football injuries (12%) and then soccer (5.6%). Other studies have noted clavicle injuries due to these mechanisms in smaller populations. Boeke et al. performed a retrospective review of injuries requiring hospital evaluation during an annual 7-day bicycle ride and noted that clavicle fracture made up 44% of all recorded fractures over 4 years [2]. Nowak's prospective study in Uppsala, Sweden also noted that bicycling was the most frequent cause of fracture in men and women, causing 62 of 187 reported clavicle injuries [12].

Both our study and Court-Brown's noted a high percentage of clavicle fractures in contact sports. A study of clavicle fractures in professional football using the NFL Injury Surveillance System noted that 19 players sustained a mid-third clavicle fracture over 5 years [10]. Kaplan et al. reported on the prevalence of shoulder injuries in collegiate football players at the NFL Combine, noting that 50% had a history of shoulder injuries [6]. A total of 10 players, of 336 evaluated, had a history of clavicle fracture, with the highest percentage playing wide receiver positions. Using a publicly available database of acute injuries extrapolated to the US general population as the denominator, we showed an incidence rate of 24.4/100 000 person-years, and noted that 45% of these injuries were attributed to sports activity. To our knowledge, this is the largest demographic sample of patients examined to date. This represents a far more stringent epidemiologic measure than the previous studies of clavicle fracture incidence, which were performed by noting the number of fractures presenting to a single center and extrapolating the incidence from the population estimates of the catchment area. Our study utilized the National Electronic Injury Surveillance System (NEISS) database, which is a stratified, randomized sampling of all United States hospitals with emergency rooms [17] used to query data on all clavicle fractures presenting for treatment over a 5 year period. Data from the NEISS has been previously used in the evaluation of shoulder dislocations [13] and ankle sprains [18].

Clavicle fractures have shown a strong correlation with younger age, as seen in Nordqvist and Petersson's early study, with the highest incidence seen in the under 20 year-old age group [11]. Injuries to the clavicle occur most commonly in the shaft and are sustained due to a direct force applied to the point of the shoulder during sports [1]. The present study also indicated that the groups with persons aged 10–19 years and those aged 0–9 years

had the highest incidence of clavicle fracture. As sports activity is most widespread during childhood and adolescence, this may explain the higher incidence of clavicle fracture in these age groups. These are ages of peak bone development and the vulnerability of the growth plate to injury may also be a factor in clavicle fracture in this population. The exception to these findings is the higher incidence in the 5th decade in women playing volleyball. This may indicate that recreational volleyball leagues account for a higher percentage of clavicle fractures in this age group. In addition, this perimenopausal age group in women represents a period of bone loss and potential osteopenia, with a higher risk for fracture.

The higher occurrence of clavicle fracture in males has also been previously observed. Nowak et al. presented a series in which a total of 187 fractures of the clavicle were identified during a 2-year period with a male/female distribution of 2.2:1. There was a significantly higher incidence in men (71.1/100 000) compared with women (30.5/100 000) ($p < 0.0001$) [12]. Our study also demonstrated a male predominance at 74%, while just over nearly one-quarter of clavicle injuries occurred in females in the US population.

The limitations of this study include coding errors and lack of information about specific fracture location, limiting our ability to provide detailed incidence of fractures based on type and location along the clavicle. The NEISS database can capture only acute injuries presenting for emergency room care, and therefore excludes patients who are treated initially in the outpatient setting or in the training room. Patients who lack health insurance may not present for care, and thus may represent another area not captured in this analysis. Additionally, injuries missed in the emergency room are not included. Finally, there is a difference in sports played in different countries and thus the findings of this study may not be applicable in a global sense. However, this study represents a large data sample of representative injuries in the United States, and our findings may impact education of athletic trainers, team physicians and coaches in sports with a high incidence of these fractures.

In a validated national database, we noted an incidence of 24.4 clavicle fractures per 100 000 persons per year presenting for acute care in the United States. In a large national sample, 45% of these injuries were due to sports activities, most commonly bicycle use, football, soccer and basketball. The peak incidence of these fractures occurs between the ages of 10–19, primarily in males.

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