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ORIGINAL ARTICLE

Epidemiology of proximal humeral fractures: a detailed survey of 711 patients in a metropolitan area

Daniele Passaretti, MD*, Vittorio Candela, MD, Pasquale Sessa, MD, Stefano Gumina, PhD, MD

Shoulder and Elbow Unit, Department of Anatomical, Histological, Forensic Medicine and Orthopedics Sciences, Sapienza University of Rome—Policlinico Umberto I, Rome, Italy

Background:: Literature lacks data concerning several epidemiologic aspects of proximal humeral fractures (PHFs).

Methods:: This retrospective study included 711 consecutive patients (209 men, 502 women) who sustained a PHF in the last 3 years. Participants were divided into 2 groups, adults and children. Data regarding age, sex, date, and fracture side were collected. According to the mechanism of injury, we arbitrarily distinguished 7 subgroups. PHFs were classified according to the head-greater-lesser-shaft (HGLS)-Hertel classification and to the Salter-Harris classification using x-ray and computed tomography imaging.

Results:: PHFs represent 5.03% of the overall fractures. The right side was involved in 389 patients (54.7%; $P = .6$). The mean age of male and female patients was 55.4 (standard deviation, 21.9) years and 67.0 (standard deviation, 16.1) years, respectively ($P = .0001$). Significant differences in the trauma mechanism between female patients (street/home low-energy trauma) and male patients (high-energy trauma) were found. A significant correlation between trauma mechanisms from 1 to 5 and fracture patterns H-G-L-S, HL-G-S, HGL-S, and HLS-G was observed. The occurrence of the same patterns significantly varied according to different age subgroups. Considering the pediatric population, a significant incidence of Salter-Harris 2 in both genders was found. No correlation was observed between the fracture patterns and the trauma mechanism.

Conclusions:: PHFs have a higher prevalence and incidence in females and in older age, respectively; they are more frequent in the winter months. In addition, male fractures are due to different traumatic events than those in females. A correlation between trauma and PHF pattern was evident only for adults. Some fracture patterns are correlated with different ranges of age in all patients.

Level of evidence: Descriptive Epidemiology Study

Keywords: Proximal humeral fractures; proximal humeral fractures epidemiology; shoulder fractures; Hertel classification; Salter-Harris classification; proximal humerus trauma mechanisms

Ethical approval statement

*Reprint requests: Daniele Passaretti, MD, Department of Anatomical, Histological, Forensic Medicine and Orthopedics Sciences, Shoulder and Elbow Unit, Sapienza University, Piazzale Aldo Moro 3, I-00185 Rome, Italy.

E-mail address: passaretti.md@gmail.com (D. Passaretti).

Proximal humeral fractures (PHFs) are the seventh most frequent fractures in adults.[23] Prevalence varies from 4% to 10% of all fractures according to several studies performed in different countries and populations.[1,3,9,15,23] In patients aged

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older than 40 years, a linear increase in the incidence is present, and only wrist and femoral neck fractures are more frequent in the elderly population (>65 years).[14,25]

Although many epidemiologic studies on PHFs have been performed, literature still lacks clinical data about several aspects of these fractures, such as the correlation between the fracture pattern and patient demographics, the trauma mechanism, and the time of year in which the fractures occurred.

In the present study, we report a detailed epidemiologic survey of a large consecutive series of patients with PHFs, classified by radiograms and computed tomography scans, occurring in the 3 consecutive years in the population of a metropolitan area.

Materials and methods

All of the patients managed in the Emergency Department of our hospital for a PHF from September 1, 2013, to August 31, 2016, were considered eligible for the present retrospective study.

Patients with PHFs were identified from the clinical record, using the International Statistical Classification of Diseases and Related Health Problems, Ninth Version codes. In particular, we used the code for "closed proximal humeral fractures" (81200, 1, 2, 3; 81209) and "open proximal humeral fractures" (81210, 1, 2, 3; 81219). The total number of fractures treated in the same period in our Emergency Department was also registered to assess the prevalence of PHFs with respect to other fractures.

Clinical records of all patients were examined by 2 of the authors (P.D. and C.V.) to collect information regarding age, sex, date of fracture, fracture side, and mechanism of injury. According to the trauma mechanism, we arbitrarily considered 7 subgroups: 1, low-energy trauma occurred in the street (when walking, running) or on public transport; 2, low-energy trauma occurred at home; 3, sports trauma; 4, high-energy trauma resulting from car, motorcycle, public transport, and pedestrian accidents; 5, work-related injuries; 6, trauma resulting from assault, beatings, theft; 7, no trauma.

We arbitrarily divided the patients in 2 groups: the adult group if they were older than 16 years and pediatric group if they were younger than 16 years. Then, we used patient age to distinguish the adult population into 3 subgroups to evaluate the correlation between age, trauma mechanism, and fracture pattern: (1) patients aged between 16 and 45 years, (2) patients aged between 46 and 75 years, and (3) patients older than 76 years.

All PHFs were assessed by x-ray imaging according to a standard shoulder trauma series consisting of a true anteroposterior view (with the central ray tangential to the glenoid surface), a Velpeau axillary view (with the patient's arm held in internal rotation and the ray is superior to inferior with the patient leaning backward), and a scapular Y view (with the central ray perpendicular to the glenoid).

PHFs were classified according to the head-greater-lesser-shaft (HGLS)-Hertel classification for the adult group[26] and to the Salter-Harris classification for the pediatric group.[24] In about one-third of the cases (196 of 711), a CT with 2-dimensional and 3-dimensional reconstructions of the involved proximal humerus was available and was used to confirm the classification. Each fracture was classified twice by 3 authors (G.S., P.D., and C.V.) at 3-month intervals. When the examiners disagreed, the fracture was classified based on the majority of the opinions. Intrarater and inter-rater reliability were statistically assessed.

Statistical analysis

A descriptive analysis was performed for all of the assessed variables. The exact *F* Fisher test was used to assess any existing difference between age, fracture mechanism, fracture pattern classification, and the time of year of the fracture presentation when considering separately male and female patients. The χ^2 test was used to assess any existing differences between male and female patients for the trauma mechanism in adults and children and any existing difference in the fracture pattern distribution among patients when considering age, traumatic mechanism, and the time of year.

Intrarater and inter-rater reliability were assessed using κ statistics according to Cohen.[5] The κ values for intrarater reliability were calculated for each observer before the mean κ value was obtained. The κ values for inter-rater reliability were calculated for each possible pair of the 3 observers before the mean κ value was obtained.[27] The Landis and Koch criteria were used to assess the obtained data.[12] The κ values are reported as mean and 95% confidence interval (CI). The level of significance was set at alpha = 0.05. IBM SPSS Statistics for Windows 20.0 software (IBM, Armonk, NY, USA) was used.

Results

During the studied period, 711 patients, 209 males (29.4%) and 502 females (70.6%), with PHF were admitted to our Emergency Department. In the same period, 14,126 fractures in 13,955 patients were diagnosed. Maxillofacial or head fractures were not considered in the present study. PHFs represented 5.03% of the overall fractures. Three patients reported a bilateral PHF but were excluded because they had an associated distal humeral fracture.

The mean patient age was 63.6 (standard deviation [SD], 19.1) year, and men and women were aged 55.4 (SD, 21.9) years and 67 (SD, 16.1) years, respectively, which was significantly different ($P = .0001$). There were 682 older than 16 years and 29 patients younger than 16 years. The right side was involved in 389 (54.7%; $P = .6$).

Fig. 1 shows the distribution of PHFs in both genders according to a 2-month classification period: 37.5% of PHFs occurred in colder months (November to February), whereas only 28% occurred in warmer months (May to August). No significant differences were found ($P = .29$).

The distribution of PHFs in both genders according to the different trauma mechanism is presented in Fig. 2. A significantly higher rate was found of trauma mechanisms 1 and 2 in women ($P = .001$) and of mechanisms 3 and 4 in men ($P = .001$). No significant statistical differences were observed when separating the trauma mechanism in a 2-month period ($P = .26$; Fig. 3). A bimodal distribution of fracture mechanisms was found in the male patients when considering the patient's age. A high-energy mechanism of fracture (3 and 4) was found in 30.1% (n = 63) of the male patients