

EPIDEMIOLOGICAL STUDY OF SURGICALLY TREATED HUMERAL SHAFT FRACTURES – A 10-YEAR REVIEW

ESTUDO EPIDEMIOLÓGICO DAS FRATURAS DIAFISÁRIAS DO ÚMERO TRATADAS CIRURGICAMENTE – UMA REVISÃO DE 10 ANOS

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ABSTRACT

Most epidemiological studies do not exclusively address fractures treated surgically but include those with conservative treatment. In Brazil, few epidemiological studies address fractures prevalence undergoing surgical treatment. Objective: To assess the prevalence, demographics, and associated injuries of surgically treated humeral shaft fractures. Methods: A retrospective study between 2009 and 2019 with patients undergoing osteosynthesis of humeral shaft fracture. Categorical variables were assessed using Fisher's chi-square or exact test, and non-categorical variables were assessed using the unpaired t-test. A significance level of 5% was adopted. Results: A total of 115 patients were evaluated. Mean age was 37.9 ± 15.6 years, with a male predominance (66.9%) due to car accidents. The most prevalent fracture type was 12 A3. Open fracture prevalence was 11.3%. Radial nerve damage prevalence was 33% and low-energy trauma was twice as likely. Conclusion: Surgically treated humeral shaft fractures were more prevalent in men, young, and related to high-energy trauma, with a transverse line pattern. Fractures secondary to low-energy trauma had a greater association with radial nerve injury. **Level of Evidence III, Epidemiological, Retrospective Study.**

Keywords: Analytical Epidemiology. Humeral Fractures. Fracture Fixation, Internal. Radial Neuropathy.

RESUMO

A maior parcela dos estudos epidemiológicos não aborda exclusivamente as fraturas tratadas cirurgicamente, mas engloba as de tratamento conservador. No Brasil existem poucos estudos epidemiológicos que versam sobre a prevalência das fraturas submetidas ao tratamento cirúrgico. Objetivo: Avaliar a prevalência, os dados demográficos e as lesões associadas das fraturas da diáfise do úmero tratadas cirurgicamente. Métodos: Estudo retrospectivo conduzido entre 2009 e 2019, com pacientes submetidos a osteossíntese de fratura diafisária do úmero. As variáveis categóricas foram testadas pelo teste qui-quadrado ou teste exato de Fisher, enquanto as não categóricas foram medidas pelo teste t não pareado. Adotou-se nível de significância de 5%. Resultados: Foram avaliados 115 pacientes. A média de idade foi de $37,9 \pm 15,6$ anos, com uma predominância de pacientes do sexo masculino (66,9%) devido a acidentes automobilísticos. A fratura tipo 12 A3 foi a mais prevalente. A prevalência de fratura exposta foi de 11,3%. A lesão nervo radial ocorreu em 33%, principalmente em traumas de baixa energia. Conclusão: As fraturas diafisárias do úmero tratadas cirurgicamente foram mais prevalentes em homens jovens e relacionadas a traumas de alta energia, com padrão de traço transversal. Fraturas secundárias e traumas de baixa energia tiveram maior associação com lesão do nervo radial. **Nível de Evidência III, Estudo Epidemiológico, Retrospectivo.**

Descritores: Epidemiologia Analítica. Fraturas do Úmero. Fixação Interna de Fraturas. Neuropatia Radial.

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INTRODUCTION

In adults, 1 to 3% of all locomotor system fractures are humeral shaft fractures, and these are the second humerus most frequent fracture location (14 to 20%), less prevalent only when compared to the proximal region.¹⁻⁶

Most epidemiological studies of humeral shaft fractures are European and North American.^{4,7,8} Developed countries have a bimodal incidence, with two peaks: young men, related to high-energy trauma, and older women, related to low-energy traumas.^{1,7} In Latin America, a multicenter study showed a predominance in

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young men.⁸ Thus, the country development degree may influence this epidemiology, since automobile accidents are more prevalent in underdeveloped countries and low-energy traumas predominate in developed countries.^{4,8}

Humeral shaft fracture conservative treatment is still the gold standard, since it has high consolidation potential related to good humerus vascularization.⁹ Surgical treatment has precise indications, such as open fractures, floating elbow, bilateral humeral fracture, nerve injuries after penetrating injuries or after closed manipulation, polytrauma, and unacceptable angular deviations.¹⁰

The largest part of epidemiological studies does not address surgically treated fractures exclusively but encompasses those of conservative treatment. Thus, a targeted epidemiological study is fundamental to plan a health system to care for patients.

Brazil shows few epidemiological studies dealing with the prevalence of humeral shaft fractures which underwent surgical treatment.

Objective

To evaluate the prevalence and of humeral shaft fractures surgically treated in a trauma center and its associated lesions and data.

METHODS

A retrospective study was conducted via a survey of humeral shaft fractures medical records surgically treated between 2009 and 2019. Patients still followed up at the outpatient clinic signed na informed consent form. Those discharged by the outpatient clinic were contacted via phone call and provided authorization to have their information used in the study.

Inclusion criteria were age ≥ 18 years, humeral shaft fractures, in which the main trait is outside the Heim square, set up by the AO (Arbeitsgemeinschaft für Osteosynthesefragen), in the humeral proximal and distal segments. The Heim square is a square whose sides have the same length as the widest part of the epiphysis and delimits the ending segments.^{11,12} The square was traced using the program Synapse^R.

Exclusion criteria were patients undergoing conservative treatment, incomplete information on the medical records (clinical and radiological), and pathological fractures.

Demographic data such as sex, age, injury date, trauma mechanism, affected side, fracture classification (according to the AO), fracture classification as exposed or closed, radial nerve associated lesions, and the surgical treatment method employed were researched.

High-energy trauma was considered as accidents with motor vehicles (motorcycle and car), running over, gunshot wound, limb seizures by machines, and falls from height (scaffolding, bridge). Low-energy trauma was considered as fall from one's own height and sprains.

A statistical analysis was performed to evaluate the central trend data. Categorical variables were assessed by Fisher's exact or Chi-square test, and the non-categorical variables by the unpaired t-test. All analyses were conducted in the program PASW statistics 18.0 (SPSS Inc., Chicago, USA), adopting a 5% significance level ($P < 0.05$).

The research project was approved by the Research Ethics Committee under number 42661820.9.0000.5404.

RESULTS

We found a total of 156 patients with humeral shaft fractures from January 2009 to December 2019. Due to incomplete data (clinical or radiological), we excluded 41 patients.

Their mean age was 37.9 ± 15.6 years, with a male predominance (66.9%), a 2:1 ratio when compared to females. Comparing the mean age between genders, women were older (42.4 years) than men (35.7 years) ($p < 0.05$).

We noticed a higher prevalence of the left limb on the fracture's laterality (56.5%). Table 1 shows the demographic data.

The prevalence of fractures was higher in December, lower in February, and stable in other months (Figure 1).

Fractures were classified according to the AO standards. Simple trait (type A) was the most prevalent (70.4%), especially A3 (transverse). Figure 2 describes fractures frequency types.

Patients mostly presented closed fracture and only 13 of them (11.3%) evolved with open fracture, which were associated with high-energy trauma ($p = 0.02$). Gender or age did not interfere in open fractures prevalence.

Regarding the trauma mechanism, high-energy accidents prevailed (72.2%).

A total of 38 (33%) patients were diagnosed with radial nerve associated lesion, which presented a two fold lower risk of occurring in high-energy trauma (OR 0.5; CI 0.32–0.89; $p < 0.05$). However, no association were found between age, gender, open fracture, and radial nerve injury. Table 2 describes the associated lesions.

Table 1. Demographic data

Characteristic	Values/Occurrence
Age [mean (+ SD)] (years)	37.9 \pm 15.6
Sex [No. (%)]	
Male	77 (67)
Female	38 (33)
Laterality [No. (%)]	
Right	50 (43.5)
Left	65 (56.5)

SD: standard deviation.

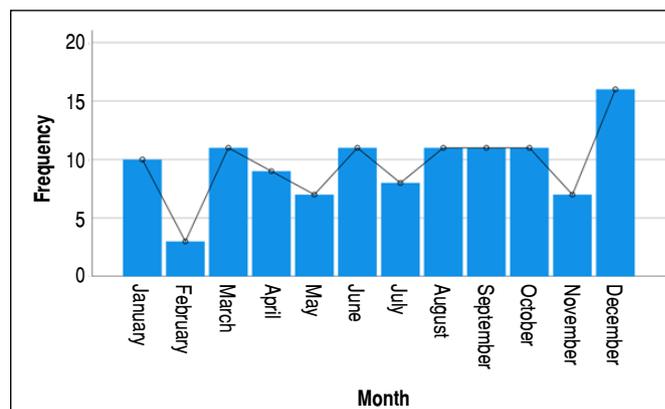


Figure 1. Prevalence distribution per month.

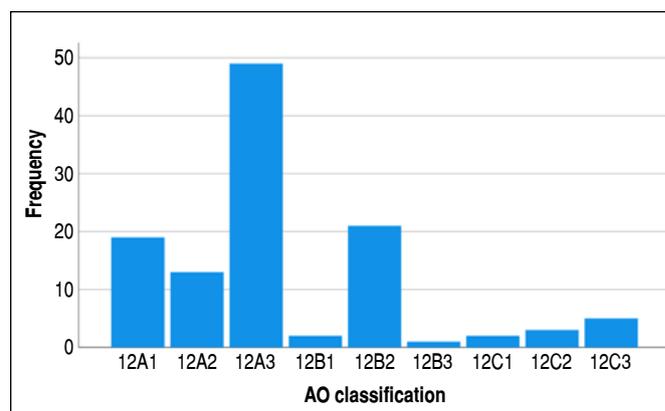


Figure 2. Fractures prevalence according to the AO classification.

The surgeons mostly (73%) used osteosynthesis with DCP plate (dynamic compression plate) via the MIPO technique (minimally invasive plate osteosynthesis), followed by open reduction and internal fixation with DCP plate. Table 3 describes techniques frequencies.

DISCUSSION

The epidemiology of surgical treatment on humeral shaft fractures is little addressed in the literature. Some articles deal with general humeral fractures (concerning several anatomical segments), and on the conservative treatment context.^{2,4,7}

The humeral shaft fractures that occur in developed countries have a bimodal distribution with a first peak in young individuals and a second in individuals over 65 years.^{1,2,4,7} We did not find this same distribution profile here. Our study showed a high prevalence among young adult individuals, with a mean age of 37.9 years. This difference may be explained because the main epidemiological studies are conducted in European countries since in Brazil, as well as in Asian countries, high-energy traumatic events (car accidents and falls from height), involving young victims are more frequent.^{4,8}

The distribution between genders showed a higher prevalence of male patients (66.9%), in an approximate proportion of two men for each woman (2:1). We found a higher mean age in women (42.4 years), as did the literature.⁴ The high number of men with humeral shaft fracture is associated with a greater exposure to traumatic events, especially high-energy ones. In women, the occurrence of fractures at an older age may relate to a greater propensity for age-related osteopenia.^{2,3}

Involvement of the left arm was greater than that of the right arm, agreeing with some other important studies. However, authors have been unable to reach a consensus² on the correlation between affected side and gender, age, associated lesions, type of trait or mechanism of trauma.

Regarding the fracture's distribution throughout the months, our study recorded a considerable increase in December, as well as a significant decrease in February. According to DATASUS data via SIM (*Sistema de Informação de Mortalidade – Mortality Information System*), December presents an increase of approximately

10% in mortality by automobile accidents, as well as a decrease in February.¹³ The increased number of humeral shaft fractures recorded in the period reflects its prevalence since they cause most of these lesions in Brazil.⁸

We classified the fractures into groups and subgroups according to the description proposed by the AO.^{11,12} Tsai et al.⁴ found higher fracture prevalence with simple trait (group A) and a high frequency of subgroup A3 (transverse simple trait).^{2,6,7,10,11,14} We achieved the same results; more than 70% of patients presented simple fracture trait (type A) with a higher prevalence of subtype A3 (42.6%).

Fractures were mostly closed. However, 11.3% of the cases were open fractures, as described by Strohm et al.,³ who found about 10%.⁴ We found a predominance of lesions classified as Gustilo II and III. High-energy traumas favored the occurrence of open fractures, which agrees with the literature.⁷

The association of radial nerve deficit with fracture occurred in 33% of the cases. However, most epidemiological studies show an association of 1.8–18%.^{3-6,10,15-17} A selection bias probably occurred relating the hospital's characteristics (high complexity trauma center), which may have interfered in the increased prevalence of cases referred with greater severity soft tissue lesions and high association with radial nerve injury, as in other countries with similar reference centers.^{4,18}

We found an association between trauma energy and radial nerve injury which low-energy traumas had two fold higher risk ($p < 0.05$). This association disagrees with the literature, which reports an association between high-energy trauma and radial nerve injury. However, Holstein and Lewis¹⁸ described the distal humeral fracture pattern with a spiral trace that evolves with a greater chance of radial nerve injury,^{4,19} and the same, usually, is related to low-energy torsional trauma mechanism.¹⁰

Conservative treatment is still a choice in the approach of humeral shaft fractures. Regarding surgical treatment, open reduction and internal fixation is still considered the gold standard. However, methods using relative stability (intramedullary rod or osteosynthesis with DCP plate via MIPO technique) with bone biological preservation are increasingly being used.^{1,8,9,16}

Thus, our research showed an increasing prevalence of techniques without addressing the fracture focus, especially MIPO. Therefore, a bias occurred, because we started the MIPO technique, which influenced surgeons training and the method choice. According to the latest meta-analyses, the technique shows lower pseudarthrosis rates than conservative treatment, and a better functional outcome for shoulder, especially in the first postoperative year.^{8,16}

Our study has weaknesses, mainly concerning the retrospective design. Moreover, a bias might have occurred in the patients' and treatment method selection (MIPO technique). However, to our knowledge, this is the first epidemiological study in Brazil on the humeral shaft fractures surgical treatment.

CONCLUSION

Surgically treated humeral shaft fractures were more prevalent in men, young, and related to high-energy traumas (car accident), especially in December, and with a transverse trait pattern (AO12A3). Fractures secondary to low-energy traumas were more associated with radial nerve injury.

Table 2. Trauma energy × radial nerve injury.

Radial nerve injury [no. (%)]	Trauma energy		p-value	OR	CI
	High	Low			
Yes	22 (57.9)	16 (42.1)	0.05 ^(a)	0.6	0.36–0.99%
No	58 (75.3)	19 (24.7)			
Open fracture					
Yes	13 (100)	0	0.02 ^(b)	-	-
No	72 (70.6)	30 (29.4)			

a: Pearson chi-square test; b: Fisher's exact test; OR: odds ratio; CI: confidence interval.

Table 3. Surgical technique frequency.

Technique	Frequency	Percentage (%)
MIPO	84	73
ORIF	22	19.1
Intramedullary rod	6	5.2
External Fixator	3	2.7

MIPO: Minimally invasive plate osteosynthesis; ORIF: open reduction and internal fixation.

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