







# MORTALITY AFTER SURGICAL TREATMENT OF PROXIMAL HUMERUS FRACTURES IN OLDER PATIENTS

## MORTALIDADE APÓS TRATAMENTO CIRÚRGICO DAS FRATURAS PROXIMAIS DO ÚMERO EM PACIENTES IDOSOS

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### ABSTRACT

Mortality of patients after osteosynthesis of proximal humeral fractures (PHF) has been poorly studied in contrast to fractures of the proximal femur. Objective: To evaluate the mortality of older patients with PHF undergoing surgical treatment. Methods: Retrospective study of patients undergoing surgical treatment PHF between 2009-2019. Demographic data, Neer classification, and mortality of this cohort of patients were evaluated. Non-categorical variables were tested using the Kolmogorov-Smirnov test. The unpaired t-test (parametric variables) was used. Categorical variables were tested by Fisher's exact test. A Kaplan-Meier mortality curve was constructed. Results: 59 patients were evaluated. There was a predominance of females in the sixth decade of life. The most prevalent fractures were Neer's type III. The highest mortality occurred in the first 4 years after surgery (4.1 + 3.2 years). The only comorbidity capable of changing the survival curve was DM ( $p = 0.03$ ). Conclusion: Overall mortality was 11.3%. The highest mortality occurred in the first 4 years of follow-up. Diabetic patients evolve with earlier mortality and have 7 times more chance of death. **Level of Evidence III, Retrospective Study.**

### RESUMO

A mortalidade de pacientes após osteossíntese de fratura de úmero proximal (FUP) é pouco estudada em comparação com as fraturas do fêmur proximal. Objetivo: Avaliar a mortalidade de pacientes idosos com FUP submetidos a tratamento cirúrgico. Métodos: Estudo retrospectivo de pacientes submetidos ao tratamento cirúrgico FUP entre 2009 e 2019. Foram avaliados dados demográficos, classificação de Neer e a mortalidade dessa coorte de pacientes. As variáveis não categóricas foram testadas pelo teste de Kolmogorov-Smirnov. Utilizou-se o teste t não pareado para variáveis paramétricas. As variáveis categóricas foram testadas pelo teste exato de Fisher. Construiu-se a curva de mortalidade pelo método de Kaplan-Meier. Resultados: Foram avaliados 59 pacientes, havendo predomínio do sexo feminino na faixa dos 60 anos. As fraturas mais prevalentes foram as do tipo III de Neer. A maior mortalidade ocorreu nos quatro primeiros anos pós-operatórios (4,1 + 3,2 anos). A única comorbidade capaz de mudar a curva de sobrevivência foi o diabetes mellitus ( $p = 0,03$ ). Conclusão: A mortalidade geral foi de 11,3%. A maior mortalidade ocorreu nos primeiros quatro anos de seguimento. Pacientes diabéticos evoluem com mortalidade mais precoce e possuem sete vezes mais chance de óbito. **Nível de Evidência III, Estudo Retrospectivo.**

**Keywords:** Humeral Fractures. Mortality. General Surgery.

**Descritores:** Fraturas do Úmero. Mortalidade. Cirurgia Geral.

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### INTRODUCTION

The proximal humerus fractures (PHF) represent between 1% and 7.8% of all fractures and constitute the third most common among older adults, being less prevalent only when compared to fractures of the proximal femur and distal radius.<sup>1</sup> After 50 years of age, the incidence of PHF increases before reaching a peak between 80 and 89 years.<sup>1</sup> Due to the growth of the older population, the number of fractures between 2008 and 2030 is expected to increase by 50%. Thus, most fractures affect older females and result from low-energy trauma, such as falling from one's own height.<sup>1,2</sup>

The epidemiological context of PHF shows that patients suffering from this injury are also affected by other comorbidities such as osteoporosis, gait and/or neurological disorders, diabetes, hypertension, cardiac dysfunctions.<sup>2</sup> Osteoporosis fractures can lead to a worsening in quality of life and may increase mortality in older adults.<sup>3</sup> Most studies are focused on the analysis of mortality after fracture of the proximal femur<sup>4</sup> and demonstrate high mortality mainly between the first and second year after the surgical procedure.<sup>5</sup>

All authors declare no potential conflict of interest related to this article.

The study was conducted at Hospital Estadual Sumaré, Unicamp.

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Theoretically, the PHF has a smaller influence on ambulation and, therefore, a smaller influence on mortality when compared to fractures of the proximal femur. However, some studies have shown that mortality is also high in this cohort of patients.<sup>4,6</sup> There are no Brazilian studies evaluating the mortality of older patients with PHF after surgical treatment. The aim of this study was to evaluate the mortality of older patients with PHF fractures undergoing surgical treatment.

## METHODS

We conducted a retrospective study with analysis of medical records of patients undergoing surgical treatment of proximal humeral fractures in the period between 2009-2019 in a reference hospital. Demographic data such as gender age, comorbidities and Neer classification of the fracture were evaluated. The Neer classification of the fracture were evaluated. The Neer classification was defined and recorded in the medical records by the surgeon who performed the surgical procedure.

The death record followed the following search strategy in a sequential manner: Survey of the patient's medical record with verification of whether there is an indication of death; Telephone contacts with patients and/or family members, with the sole purpose of confirming or excluding death of the patient.

The inclusion criteria were: patients undergoing surgical treatment of PHF aged 60 years or older; medical records containing all demographic and radiological data.

Exclusion criteria were: cases without information about death and patients with 2 or more associated fractures. Non-categorical variables were tested using the Kolmogorov-Smirnov test to define the normality of the sample. In the study of these variables, unpaired t-test (parametric variables) was used. Categorical variables were analyzed using the Fisher exact test. The Kaplan-Meier mortality curve was constructed. A significance level of  $p < 0.05$  was considered. The software SPSS statistics, version 27, was used. The study was submitted to the research ethics committee and was approved under CAEE number 30650120.5.0000.5404.

## RESULTS

A total of 131 surgeries were performed in patients with PHF between 2009-2019. In 107 patients, it was possible to know the death record or not. At the end, 59 patients met all the inclusion criteria. There was a predominance of females in the sixth decade of life (Figure 1). The most prevalent fractures were Neer type III. Demographic data are shown in Table 1.

Osteosynthesis with Locking Plate was the treatment of choice in most cases. The surgical techniques used and their frequency are described in Figure 2. A small number of patients were treated<sup>3</sup> with arthroplasty and only one case underwent Jones resection arthroplasty (Figure 2). Most patients (69.4%) had at least one comorbidity. The maximum number of comorbidities was 7 pathologies. The most prevalent comorbidity was Hypertension followed by Diabetes Mellitus (DM). The frequency of comorbidities is described in Figure 3.

Six patients (11.3%) died during the maximum follow-up period of 11 years. Three patients were female and three were male. One patient died on the first postoperative day due to anesthetic complications. The highest mortality occurred in the first 4 postoperative years ( $4.1 \pm 3.2$  years). Mortality was represented by the Kaplan-Meier Curve (Figure 4.) The three most prevalent comorbidities (DM, hypertension and smoking) were tested for association with higher mortality or not. The presence of DM influenced mortality and increased the chance of death by 7.6 times. Other comorbidities, fracture classification, sex and age did not change mortality Table 2.

The only comorbidity capable of changing the survival curve was DM ( $p = 0.03$ ), which led to earlier mortality (Figure 5).

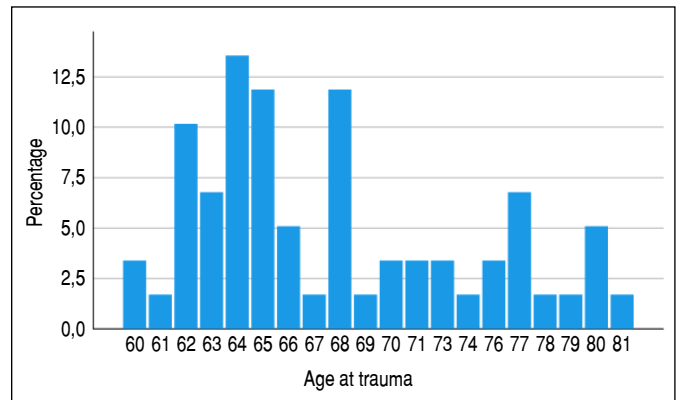


Figure 1. Prevalence × Age of patients.

Table 1. Patient demographics.

Variable	Values
Mean age SD (years)	68.1 5.9
Sex [N (%)]	
Male	22 (37.2)
Female	37 (68.8)
Neer Classification [(N (%)]	
II	20 (34)
III	22 (37)
IV	17 (29)

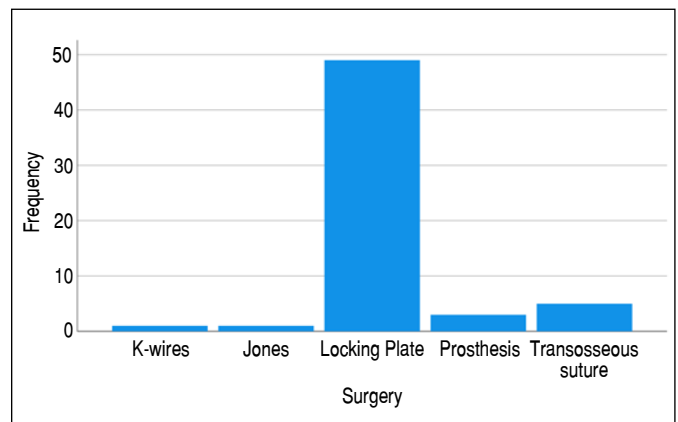


Figure 2. Types of surgery and frequency performed.

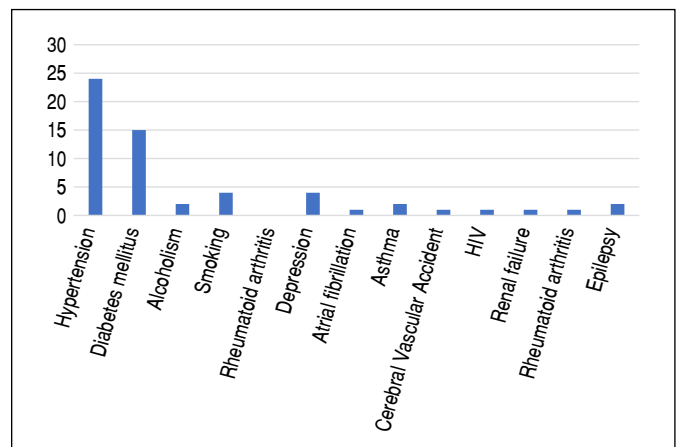


Figure 3. Prevalence by type of comorbidity.

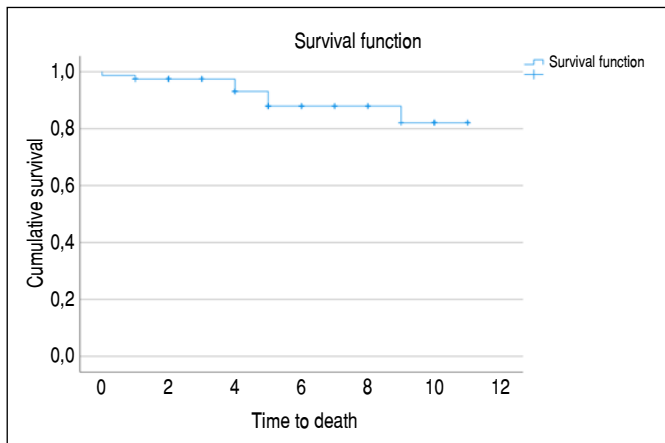


Figure 4. Kaplan-Meier Overall Survival Curve.

Table 2. Number of deaths compared with other clinical and radiological variables.

Variable	Deaths (6)	Alive (53)	p-value	OR <sup>*</sup>	CI <sup>+</sup>
Age (Mean + SD)	67.83 ± 8.15	68.21 ± 5.79	0.88 <sup>(a)</sup>	na	na
Comorbidities [N]					
+ Diabetes Mellitus (16)	4	11	0.032 <sup>(b)</sup>	7.63	1.2-47.2
+ Hypertension (24)	3	21	0.67 <sup>(b)</sup>	1.52	0.28-8.27
+ Smoking (4)	1	3	0.35 <sup>(b)</sup>	3.33	0.29-38.3
Neer Classification					
I (20)	1	19			
II (22)	4	18	0.29 <sup>(b)</sup>	na	na
III (17)	1	16			
Sex					
Female (37)	3	34	1.78 <sup>(b)</sup>	0.37	0.32-9.75
Male (22)	3	19			

\*OR: odds ratio; + CI: confidence interval; <sup>a</sup> Unpaired t-test; <sup>b</sup> Fisher's exact test; + presence; na: not applicable.

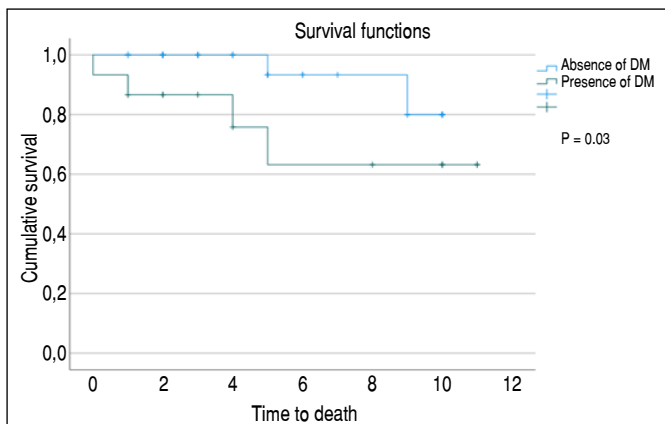


Figure 5. Mortality × presence of diabetes or not.

## DISCUSSION

The prevalence of fracture in the older adults, especially in women over 65 years of age, related to frailty increased due to the greater longevity of the population.<sup>2</sup> Proximal humeral fractures follow this same pattern and may have a prevalence ratio up to 2 times higher in females, in agreement with our results.<sup>6,7</sup>

Osteoporosis, hypertension and DM are also prevalent in this cohort of patients. Thus, some authors consider the fractures that occur in this context of multiple comorbidities as another

indicator of global fragility in the health of patients. Therefore, fractures such as that of the proximal femur, distal radius and proximal humerus would be indirect indicators of organ failure and greater predisposition to mortality.<sup>8</sup>

The postoperative mortality of patients with proximal femoral fracture is widely studied in the literature in contrast to the mortality of patients undergoing surgical treatment of the proximal extremity of the humerus. Mortality in older patients affected by fractures of the proximal femur is high and can occur in up to 36% of this population in one year of follow-up. However, some studies suggest that PHF may be associated with increased mortality in 1 year after fracture.<sup>9</sup> We found 11.3% mortality in the study population during the 11 years of evaluation. The highest mortality reported in this study occurred in the first 4 postoperative years ( $4.1 \pm 3.2$  years). Somesarlo et al.<sup>9</sup> observed a similar mortality: 3.3% during the first year after fracture of the proximal humerus, 7.7% in three years after trauma and 12% at the end of five years.

Patients who progress to death after the occurrence of proximal humeral fracture have a higher incidence of associated comorbidities.<sup>10</sup> The main comorbidities found in our study were also arterial hypertension and DM, in agreement with the literature.

DM is prevalent in the older population and is associated with higher mortality especially in those who have the disease for 10 years or more.<sup>11</sup> In addition, they increase the risk of falls and consequently the prevalence of fractures.<sup>12</sup> In our study, the presence of DM increased the risk of death by 7 times. A Spanish study found a higher chance of early complications and mortality after surgical treatment of fracture of the proximal humerus associated with DM in agreement with our data.<sup>13</sup>

In our study, demographic variables such as sex and age did not influence mortality. An Australian study differs from our results and showed that men are 5.8 times more likely to die than women.<sup>14</sup>

The fracture pattern determined by the Neer classification was not associated with higher mortality. Possibly because it is a cohort of older patients, Neer IV fractures are more related to the intensity of osteoporosis than to the energy of trauma.

Surgical treatment of proximal humeral fractures with arthroplasty, especially reverse arthroplasty, has been increasingly used.<sup>15</sup> The greater indication of arthroplasties is based on better postoperative shoulder function and lower readmission rate<sup>16</sup> and consequently lower cost to the health system when compared to osteosynthesis.<sup>17</sup> However, in our study, osteosynthesis with the locking plate was the most used method. This discrepancy can be explained by the unavailability of reverse arthroplasty in the Brazilian Unified Health System, which so far makes its practice unfeasible. The method of treatment (osteosynthesis or arthroplasty) did not influence patient mortality. Boileau in a French review found a mortality of 21% in 5 years after reverse arthroplasty.<sup>18</sup>

The study presents some weaknesses. As this was a retrospective study, it was not possible to establish control of the groups to reduce bias. In addition, social factors such as independence from household activities that are associated with higher mortality were not studied.<sup>19</sup> Finally, the influence of the use of continuous use medications that can alter mortality was not evaluated.<sup>20</sup> However, to the best of our knowledge, this is the first national study that evaluated the mortality of patients undergoing surgical treatment for proximal humeral fractures.

## CONCLUSION

The overall mortality of older adults subjected to surgical treatment of proximal humeral fracture was 11.3%

The highest mortality occurred in the first 4 years of follow-up.

Diabetic patients evolve with earlier mortality and are 7 times more likely to die than non-diabetic patients.

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