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Predictive Factors of Death after Surgery for Treatment of Proximal Femoral Fracture*

Fatores preditivos de morte após cirurgia para tratamento de fratura proximal do fêmur

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Abstract

Objective   To evaluate predictive factors of death in patients aged ≥ 70 years old with proximal femoral fracture (PFF) submitted to surgical treatment.

Methods   An analysis of medical records by creating a retrospective cohort with a 6-month follow-up. A total of 124 charts were analyzed after applying the inclusion and exclusion criteria. All of the patients were treated by a single orthopedic surgeon under uniform conditions.

Results   The mortality rate was of 34.7%, and the most common profile was female, 85 years old, and with at least 1 comorbidity. Patients > 85 years old, hospitalized for > 7 days, with at least 1 comorbidity, and staying at the intensive care unit (ICU) had a higher risk of death (2, 2.5, 4, and 4 times higher, respectively).

Conclusion   Regarding the death outcome, although we did not find a statistically significant difference in the topography of the lesion and in its behavior in its coexistence with ICU hospitalization, we believe that further investigations under this perspective are required in a population with the studied profile.

Keywords
► hip fractures
► mortality
► elderly

Resumo

Objetivo   Avaliar fatores preditivos de morte em pacientes de idade ≥ 70 anos com fratura proximal do fêmur submetidos a tratamento cirúrgico.

Métodos   Análise de prontuários médicos, criando-se uma coorte retrospectiva com seguimento de 6 meses. Foram analisados 124 prontuários após a aplicação dos critérios de inclusão e de exclusão. Todos os pacientes foram tratados por um único cirurgião ortopédico em condições de uniformidade.

Resultados   Taxa de mortalidade de 34.7%, sendo o perfil mais comum de paciente o indivíduo do gênero feminino, com 85 anos e ao menos 1 comorbidade. Os pacientes com idade > 85 anos, internação hospitalar por > 7 dias, ao menos 1 comorbidade presente e internação em unidade de tratamento intensivo (UTI) apresentaram maior risco de óbito (respectivamente 2; 2,5; 4; e 4 vezes maior).

Palavras-chave

► fraturas do quadril
► mortalidade
► idoso

Conclusão   Em relação ao desfecho óbito, apesar de não termos encontrado uma diferença estatisticamente significativa no que se refere à topografia das lesões e como estas se comportam no momento em que coexistem junto à internação em UTI, acreditamos na necessidade de maiores investigações sob essa ótica na população com o perfil estudado.

Introduction

Aging is related to morphological, functional, biochemical, and psychological changes that difficult the adaptation of a person to his/her environment, increasing the vulnerability and the incidence of pathological processes that directly interfere in the quality of life and in the mortality of elderly individuals.[1] In this population, proximal femoral fractures (PFFs) represent events of great significance, both in frequency and severity, since they are associated with loss of independence and with a reduction in life expectancy.[1]

It is known that the trauma resulting in PFFs in the elderly is mostly of low energy and related to populational features, such as osteoporosis, malnutrition, decreased visual acuity, impaired cognitive functions, and sarcopenia.[2] In elderly patients, PFFs are correlated with a mortality rate of ~ 30% in the 1st year after the injury, being the main cause of death by trauma in individuals > 75 years old.[3] Some factors show a clear correlation with the increased mortality in PFF patients, such as age, cognitive decline, time elapsed between the triggering event and the surgical approach, pre-fracture mobility capacity, and previous comorbidities.[4,5] The early identification of patients with a higher predisposition to triggering events and complications may help to reduce mortality in this scenario.[6]

Data on the population of the USA highlighted the significance of these fractures; the average number of 250 thousand PFF cases in the 1990s is expected to duplicate or triplicate until 2040.[7] It is believed that this exponential increase is closely related to a higher life expectancy, since the associated risk factors become more prevalent as people grow older.[8] In Brazil, Loures et al[9] found an average total cost of BRL 1,933.79 for patients submitted to surgical PFF correction in the public health system in 2011 and in 2012. In the 2007/2008 period, there were 34,284 intertrochanteric femoral (FIT) fractures in Brazil, and their treatment costed a total of ~ BRL 30.8 million in 2008.[10]

The present study aims to evaluate the factors related to the mortality of ≥ 70 years old PFF patients submitted to surgical treatment and followed-up for 6 months.

Material and Methods

This is an observational, retrospective cohort study. The medical records of 141 PFF patients who underwent surgical treatment from January 2009 to December 2015 by the same senior surgeon were analyzed. Proximal femoral fractures included transtrochanteric or FIT fractures with or without subtrochanteric trace, and femoral neck fractures (FNFs). The treatment of FIT fractures was performed with intramedullary nails (IMNs) or with dynamic hip screws (DHSs), whereas FNF treatment employed hip arthroplasty or inverted pyramid compression (PCP); for statistical purposes, the method type and the selected implant for the treatment of each case were not considered.

For the sample survey, the inclusion criteria were the existence of medical records of PFF patients who underwent surgical treatment in a private hospital in Juiz de Fora, state of Minas Gerais, Brazil, under uniform conditions, performed by the same surgeon-researcher, and emphasizing the premise of surgical approach in the 1st 48 hours after the trauma, as recommended in the literature.[11] Uniformity conditions were defined as similar circumstances regarding structure, classification, therapy, technique, material, and support. The exclusion criteria were: pathological fractures due to neoplasia, fractures not classified as FIT or FNF, patients < 70 years old, and lack of information about the studied variables in the hospital documentation. Patient records that did not present a minimum follow-up of 6 months were also excluded.

The primary outcome was death in the 1st 6 postoperative months. Secondary outcomes were gender, age, total hospitalization days, number of previous comorbidities, lesion (fracture) topography, and hospitalization at the intensive care unit (ICU). Regarding the variable comorbidities, a quantitative evaluation was selected instead of a qualitative analysis. The variable ICU hospitalization was solely based on the indication of the anesthesiology team, with no discussion of its rationale.

The Ethics and Research Committee for research on human beings of our institution approved the present study under the number 69173717.6.0000.5133 at the Certificate of Submission for Ethical Appreciation (CAAE, in the Portuguese acronym) in the Brazilian platform, with the original title *Predictive Factors of Death After Surgery for Fixation of Proximal Femoral Fracture* (*Fatores preditivos de morte após cirurgia para fixação de fratura de fêmur proximal*).

Statistical analysis

The statistical analysis was performed in three stages: univariate, bivariate and multivariate. In the univariate analysis, descriptive statistics characterized the sample through mean, standard deviation (SD), median, interquartile range (IQR), and absolute and relative frequencies. In the bivariate analysis, the chi-squared (χ^2) test or the Fisher exact test, when appropriate, were used to determine the association between each of the independent variables (risk factors), and the dependent variable (outcome: death); moreover, the

death risk, as odds ratio (OR), with a 95% confidence interval (CI), was calculated. The multivariate analysis employed a binary logistic regression. The model was constructed with the Enter method with block input. The logistic model was assessed using Likelihood Value (-2LL), Nagelkerke pseudo R^2, and the Hosmer and Lemeshow test. The statistical significance of each coefficient was analyzed by the Wald test. The predictive capacity of the model was evaluated with a classification matrix, using the value of 0.3 as the cutoff point. Data were analyzed using the statistical software IBM SPSS Statistics for Windows, Version 20.0 (IBM Corp., Armonk, NY, USA), with statistical significance defined as $p < 0.05$.

Results

►**Table 1** presents the general demographics of the patients. The mean age was 84.4 years old ($\pm$6.8 years old), ranging from 70 to 100 years old; most of the patients were female (70.2%), and had at least 1 associated comorbidity (81.4%). Regarding the topography of the lesion, most of the patients presented FIT (62.9%). The death rate in the total sample was of 34.7% at the end of the 6-month follow-up period.

►**Table 2** shows the association between the categorical variables and the outcome (death) using OR as a risk measure. In patients > 85 years old, the death risk is 2-fold higher compared with those < 85 years old. The death risk is also 2.5 times higher in patients hospitalized for > 7 days. Compared with patients with no comorbidities, the death risk in patients with some comorbidity was four times higher. In addition, patients who were admitted to the ICU were four times more likely to die than those who did not. The death risk was similar between men and women and independent of the topography of the lesion ($p > 0.05$). The

Table 1 Features of the Patients of the Study

Variables	n	%
Number of patients	124	100.0
Gender (female)	87	70.2
Age group (> 85 years old)	56	45.2
Hospitalization period (> 7 days)	54	43.5
Number of comorbidities		
0	23	18.5
1	40	32.3
2	35	28.2
3	20	16.1
4	6	4.8
Topography		
FIT	78	62.9
FNF	46	37.1
ICU Admission (yes)	51	41.1
Outcome (death)	43	34.7

Abbreviations: ICU, intensive care unit; FNF, femoral neck fracture; FIT, intertrochanteric fracture.

Table 2 Odds ratio for death risk in patients $\geq$ 70 years old submitted to surgical treatment for proximal femoral fracture

Variable/category	Deaths		p-value	OR	95%CI
	n	%			
Gender					
Male	14	37.80	–	–	–
Female	29	33.30	0.630	0.82	0.37–1.83
Age group					
$\leq$ 85 years old	18	26.50	–	–	–
> 85 years old	25	44.60	0.030*	2.24	1.705–4.76
Hospitalization period					
$\leq$ 7 days	18	25.70	–	–	–
> 7 days	25	46.30	0.020*	2.49	1.17–5.31
Comorbidities					
No	3	13.00	–	–	–
Yes	40	39.60	0.020*	4.37	1.22–15.68
ICU Admission					
No	16	21.90	–	–	–
Yes	27	52.90	< 0.001*	4.01	1.84–8.75
Topography					
FIT	24	30.80	–	–	–
FNF	19	41.30	0.230	1.58	0.74–3.38

Abbreviations: CI, confidence interval; FIT, intertrochanteric fracture; FNF, femoral neck fracture; ICU, intensive care unit; OR; odds ratio.
*Significant differences at χ^2 test ($p < 0.05$).

data analysis also showed that FNF patients who died were older when compared with the other patients ($p = 0.027$) (►**Fig. 1**).

►**Table 3** summarizes the logistic regression coefficients and their significance in the model. The model was valid for the mortality status classification. About 20% of variability in the mortality status can be explained by the model. The model showed an accuracy of 70.2% in death classification, with 81.4% sensitivity (death accuracy) and 64.2% specificity (non-death). The probability of death is higher in older patients, those hospitalized for > 7 days, in the ICU, and presenting with FNF. It is worth noting that hospitalization for > 7 days and FNF were not statistically significant, but they were kept in the model due to the biological plausibility and to improve its final adjustment. The discriminatory power of the model can be deemed acceptable. The area under the curve (AUC) was 0.75 (95%CI = 0.63–0.82; $p = 0.19$) (►**Fig. 2**).

Discussion

A 6-month follow-up period was proposed to compare the mortality rate of the sample both with similar and with 1-year follow-up samples. Our findings were satisfactorily comparable to those of Forster et al;[12] since we have obtained a mortality
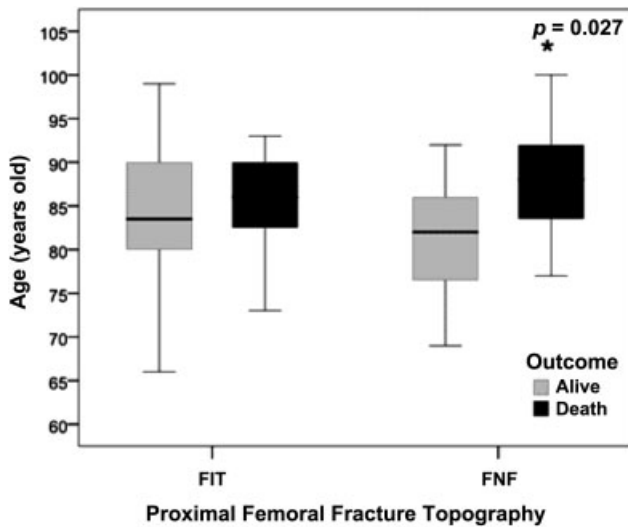
Fig. 1 Comparison of patients with transtrochanteric/intertrochanteric (FIT) or FNF and their outcome in relation to age. *, statistically significant difference, $p = 0.027$.

Fig. 2 Receiver operating characteristic (ROC) curve of the diagnostic capability of the logistic model to discriminate the death outcome in patients ≥70 years-old surgically treated for proximal femoral fracture. AUC, Area under the curve; 95%CI, 95% confidence interval.

rate of 34.7% at 6 months postoperatively, whereas these authors observed mortality rates of 50% after 6 months, and of 56% after 1 year of follow-up. It should be noted that the study by Forster et al is based on a population > 100 years old (mean age of 101 years old), with an average hospital stay of 14 days, which is higher than the data used in our statistical evaluation. As such, we believe that the demographics of Forster et al[12] may justify the higher mortality rates in their study, since our investigation revealed that older age and longer hospitalization periods increase the mortality rate.[13–19] On the other hand, compared to our study, Garcia et al[20] obtained a lower mortality rate at 6 months and at 1 year of follow-up (14% and 30%, respectively), as did Guerra et al,[13] with a 1-year mortality rate of 23.6%. Wood et al[21] and Parker et al[22] observed mortality rates of ∼ 14% at the 1-year follow-up. As such, the differences in the literature regarding the mortality rate in the elderly population with PFF are evident.

In the present study, the postoperative mortality rate was lower than the general mortality rate of individuals > 60 years old in Brazil (34.7% versus 58.6%).[23,24] Although this subject remains controversial in the literature, the mortality rate was not influenced by gender, corroborating the findings of van Laarhoven et al[25] and by Antes et al.[26]

We have opted for a quantitative, instead of a qualitative, evaluation of comorbidities, because we understand that, in general terms, the patients with more severe comorbidities also present a greater number of them. In addition, we assume that the presence of comorbidities considered severe is often a consequence of prior, milder conditions. These inferences are based on a study by Garcia et al,[20] who found an abrupt drop in the number of individuals with > 4 comorbidities when dividing their sample according to the number of conditions presented by each patient; these results are similar to those presented in ►Table 1. In addition, a review of the literature revealed studies showing that the higher number of comorbidities is associated with a worse outcome regarding death, although the severity of the disease was not taken into account.[27,28] Even though we have not evaluated the severity of the conditions nor found a statistically significant difference in the absolute number of comorbidities (our results just allow affirmations regarding the presence or absence of comorbidities), we believe that

Table 3 Logistic model for death probability calculation in patients aged ≥ 70 yearsold submitted to surgical treatment for proximal femoral fracture ($n = 124$)

Variable	Parameter estimation	Standard error	*p-value*	Odds Ratio (95%CI)
Age	0.068	0.033	0.039	1.07 (1.00–1.14)
Hospitalization > 7 days	0.631	0.427	0.140	1.88 (0.81–4.34)
FNF	0.502	0.426	0.239	1.65 (0.72–3.81)
ICU Admission	1.106	0.426	0.009	3.02 (1.31–6.96)
Intercept	- 7.421	2.856	0.009	0.001

Abbreviations: CI, confidence interval; FNF, femoral neck fracture; ICU, intensive care unit.
$\chi^2 = 18.625$; $p < 0.0001$; -2LL = 141.441; R^2 Nagelkerke = 0.19; Hosmer Lemeshow test: $p = 0.83$; Prediction accuracy = 64.5%; *Reference category: transtrochanteric/intertrochanteric fracture with or without ICU admission or femoral neck fracture without ICU admission.
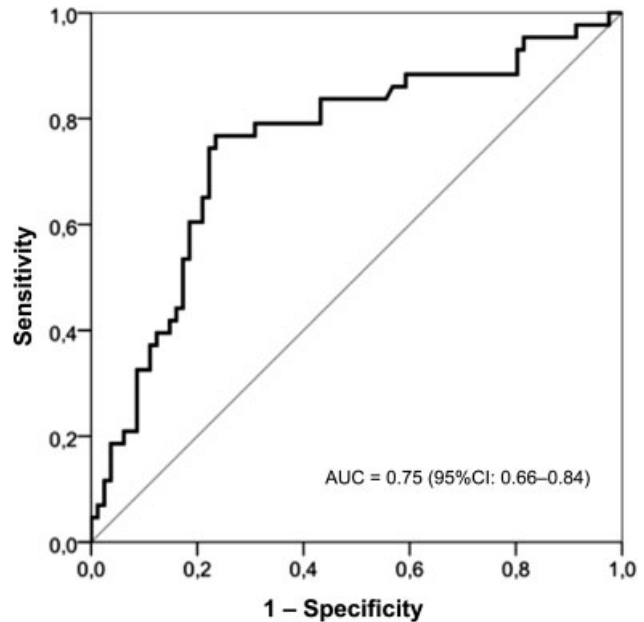
the severity and the number of diseases distinctively interfere in the death of a patient and are difficult to dissociate from it; as such, the solely quantitative comorbidity evaluation does not invalidate a study. Thus, the finding that the risk of death is four times higher in patients with at least one type of comorbidity compared with those with no comorbidities is considered relevant, and it confirms data from Guerra et al,[13] who observed that the absence of comorbidities is associated with their so-called *alive* group, and that the presence of three comorbidities is associated with their so-called *death* group. The same occurs with Shebubakar et al[29] and with Campos et al,[30] who demonstrated that the presence of ≥ 2 comorbidities is associated with an increase in morbidity and mortality rates. Also regarding the choice for a purely quantitative analysis, we also consider that one of our goals was to create a line of reasoning that is reproducible and applicable to the general population, and not to specific groups and to their different levels of pathological involvement (patients with heart, coronary heart, liver disease, kidney or lung diseases, etc.).

Considering the findings presented on ►**Table 3**, in which hospitalization for > 7 days and the presence of FNF did not reach statistical significance, we believe that it is still important to take both variables into account. The former due to the statistical significance and exuberant OR presented in ►**Table 1** (2.5-fold death risk), and the latter for its important OR shown in ►**Tables 1** and 3. As such, we believe that a greater sample size may reveal a significant statistical difference regarding the death outcome according to the topography of the lesion (FIT versus FNF), especially considering the requirement of ICU admission.

Conclusion

The sample studied follows the epidemiological trend established in the literature regarding mean age, gender, and fracture topography related to the mortality of elderly patients with PFF submitted to surgical treatment. Advanced age, comorbidities, longer hospital stay, and ICU admission are also already consolidated as associated to a greater number of deaths in this population, and, similarly, these features were related to a greater mortality in our study.

Regarding the death outcome, although we did not find a statistically significant difference regarding the topography of the lesion and its behavior in its coexistence with ICU hospitalization, we believe that further investigations under this perspective are required in this population. This need is justified because the proposed classification model shows a higher death probability in elderly patients hospitalized for > 7 days, admitted to the ICU and presenting FNF; as such, we ask whether a bigger sample size would result in a statistically significant increase in the death risk of patients > 70 years old with FNF and admitted to the ICU.

Conflicts of Interests
The authors have no conflicts of interests to declare.

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