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SCIENTIFIC ARTICLE

Perioperative complications and mortality in elderly patients following surgery for femoral fracture: prospective observational study

Talita de Almeida Barbosa[a,b,*], André Moreira Fogaça de Souza[c], Fábio Caetano Oliveira Leme[d], Letícia Dalla Vecchia Grassi[c], Fabio Bussolan Cintra[d], Rodrigo Moreira e Lima[e], David Nicoletti Gumieiro[f], Lais Helena Navarro e Lima[g]

[a] *Universidade Estadual Paulista (Unesp), Faculdade de Medicina, Botucatu, SP, Brazil*
[b] *Cooperativa dos Anestesiologistas de Ribeirão Preto, Ribeirão Preto, SP, Brazil*
[c] *Universidade Estadual Paulista (Unesp), Faculdade de Medicina, Graduação em Medicina, Botucatu, SP, Brazil*
[d] *Santa Casa de São Carlos, São Paulo, SP, Brazil*
[e] *Universidade Estadual Paulista (Unesp), Faculdade de Medicina, Serviço de Anestesiologia, Botucatu, SP, Brazil*
[f] *Universidade Estadual Paulista (Unesp), Faculdade de Medicina, Departamento de Cirurgia e Ortopedia, Botucatu, SP, Brazil*
[g] *Universidade Estadual Paulista (Unesp), Faculdade de Medicina, Departamento de Anestesiologia, Botucatu, SP, Brazil*

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KEYWORDS
Femoral fractures;
Postoperative complications;
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Mortality

Abstract
Background and objectives: Perioperative management of femoral fractures in elderly patients has been studied to determine modifiable causes of complications and death. The aim of this study was to evaluate the mortality rate and its causes in the elderly population with FF. We also evaluated perioperative complications and their association with postoperative mortality.
Method: In this prospective and observational study, we evaluated 182 patients, by questionnaire and electronic medical record, from the moment of hospitalization to one year after surgery. Statistical analyzes using the multivariate Cox proportional hazards model and Kaplan-Meier curves were performed to detect independent mortality factors.
Results: Fifty-six patients (30.8%) died within one year after surgery, and the main cause of death was infection followed by septic shock. The main complication, both preoperatively and postoperatively, was hydroelectrolytic disorder. For every one-unit (one-year) increase in age, the odds ratio for death increased by 4%. With each new preoperative complication, the odds ratio for death increased by 28%. Patients ASA III or IV had a 95% higher odds ratio for death than patients ASA I or II.

* Corresponding author.
E-mail: talita_ab1@hotmail.com (T.A. Barbosa).

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Conclusions: Increasing age and number of preoperative complications, in addition to ASA classification III or IV, were independent factors of increased risk of death in the population studied. The mortality rate was 30.8%, and infection followed by septic shock was the leading cause of death.
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PALAVRAS-CHAVE
Fraturas do fêmur;
Complicações pós-operatórias;
Fatores de risco;
Mortalidade

Complicações perioperatórias e mortalidade em pacientes idosos submetidos a cirurgia para correção de fratura de fêmur: estudo prospectivo observacional

Resumo
Justificativa e objetivos: O manejo perioperatório das fraturas de fêmur em pacientes idosos tem sido estudado com o intuito de determinar causas modificáveis de complicações e óbito. Este estudo tem por objetivo avaliar taxa de mortalidade e suas causas na população idosa com fraturas de fêmur. Avaliamos também complicações perioperatórias e sua associação com mortalidade pós-operatória.
Método: Neste estudo prospectivo e observacional, avaliamos 182 pacientes, por questionário e prontuário eletrônico, desde o momento da internação até um ano após a cirurgia. Análises estatísticas pelo modelo multivariado de riscos proporcionais de Cox e curvas de Kaplan-Meier foram feitas para detectar fatores independentes de mortalidade.
Resultados: Cinquenta e seis pacientes (30,8%) obituaram em até um ano de pós-operatório, sendo que a principal causa determinada de óbito foi infecção seguida de choque séptico. A principal complicação, tanto pré quanto pós-operatória, foi distúrbio hidroeletrolítico. Para cada aumento de uma unidade (em ano) na idade, a razão de chance de vir a óbito aumentou em 4%. A cada nova complicação pré-operatória apresentada, a razão de chance de óbito aumentou em 28%. Os pacientes ASA III ou IV apresentaram razão de chance de óbito, em um ano, 95% maior do que aqueles ASA I ou II.
Conclusões: O aumento da idade e do número de complicações pré-operatórias, além da classificação de ASA III ou IV foram fatores independentes de risco aumentado de óbito na população estudada. A taxa de mortalidade foi de 30,8%, sendo que infecção seguida de choque séptico foi a principal causa determinada de óbito.
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Introduction

Perioperative medicine may be defined as a multidisciplinary, integral and individualized care to offer the best possible support for surgical patients from the moment of surgical indication until their complete recovery. This view of surgical patient care expands the role of anesthesiologists beyond the operating room.[1] Concerns about the perioperative period and its consequences, such as decompensation of pre-existing diseases, complications, and death, have increased in recent years.[2] The continuous improvement in the quality of services and care provided to surgical patients is the expectation of modern anesthetic practice, particularly in the context that increasingly older and critically ill patients are admitted to hospitals for increasingly complex procedures.

Population aging is a worldwide phenomenon and it is estimated that by 2050 there will be more than 2 billion people over the age of 60 in the world,[3] with projections of 28 million elderly people in Brazil in 2020.[4] This context is of fundamental importance due to the fact that most surgical procedures is performed on older adults.[5]

Surgery to repair a femur fracture (FF) is an example of this phenomenon.[6] In a projection for 2040 in the United States it is predicted that more than 450,000 individuals will present with FF per year.[7] These data are especially important because FFs are responsible for a large decline in quality of life in the year following its occurrence.[8] Thus, FFs constitute a global public health problem.

The presence of comorbidities associated with advanced age in FF patients may explain the increased risk for postoperative complications and perioperative mortality.[9] Femoral fracture results in trauma, pain, bleeding, and immobility. Thus, it is possible that pathophysiological processes associated with fracture, such as acute inflammation, stress, hypercoagulability and catabolic state, may contribute to increase these risks.[10] These pathophysiological processes may not be present in the same proportion in patients undergoing coxarthrosis surgery, which may explain the higher risk of mortality in patients undergoing FF surgical repair, as observed by Le Manach et al.[9]

In this context, the Royal College of Physicians' guidelines recommends FF surgical repair within the first 24 hours after hospital admission. Delay of more than 48 hours between admission time and surgery increases the ratio for 30-day mortality by 41%.[11]

In a recent paper, the mortality rate after one year of FF repair was 23.6% in patients aged 65 and over in a university hospital in southern Brazil.[12] However, national studies of perioperative complications and mortality rate are scarce in the literature. Thus, it is necessary to investigate what are the main complications, mortality rate, and their specific causes in this population in order to intervene in the so-called modifiable causes. Therefore, this study objective was to evaluate the mortality rate and its specific causes in the elderly population with FF undergoing surgical treatment. As secondary outcomes, we also evaluated the perioperative complications present in this population and their association with postoperative mortality.

Methods

Following approval by the Research Ethics Committee of the Faculdade de Medicina de Botucatu (FMB), Review No. 873.831, of November 2014, we proposed a prospective, observational study based on perioperative evaluation of patients of both sexes, $\geq$ 60 years of age, admitted to the Hospital das Clínicas (HC), Faculdade de Medicina de Botucatu (FMB), Unesp, for surgical repair of FF, from December 1, 2014, to November 30, 2015. The inclusion of patients in the study was through a convenience sample, enrolling all those admitted to HC-FMB diagnosed with FF in the period described above. Patients with musculoskeletal disorders of other origins, under the age of 60, who refused to give written informed consent, and those who died before surgery or had their medical conduct changed for conservative treatment were excluded from the study.

Patient follow-up began at the time of admission and continued for up to one year after surgery. The study data were collected from a detailed pre-anesthetic questionnaire, prepared before surgery from the HC-FMB electronic medical records, and from a perioperative questionnaire (immediate postoperative and outpatient follow-up) developed by the researchers with information on demographic data, socioeconomic status, and quality of life.

Postoperative evaluation was done in person during hospitalization, when the questionnaire was applied to patients. If they were unable to respond, the instrument was applied to the patient's companions. After discharge, patients were evaluated by phone contacts at the 1st and 12th months after surgery. This follow-up aimed to identify the occurrence of postoperative complications, in addition to death and its probable causes.

The perioperative complications assessed included hydroelectrolytic disorder (HED); cardiac events (changes in electrocardiogram, acute myocardial infarction (AMI), heart failure (HF), acute pulmonary edema (APE); delirium; pulmonary, renal and vascular complications; surgical site infection (SSI); need for reoperation; thromboembolic complications; stroke; and death. HEDs analyzed were sodium and potassium, which were considered present when the value found was outside the normal range adopted by the kit used in the institution. We use the KDIGO criteria to diagnose renal changes.[13] Cognitive changes were not evaluated according to specific protocol. Thus, fluctuations in the level of consciousness, mental confusion or previously non-existent stereotyped behavior were considered positive criteria for this modality and were considered as delirium. The other complications were documented when there was a specialist medical diagnosis. For example, we included the AMI complication in those patients who had a clinical picture suggestive of the disease and, when evaluated by a staff cardiology specialist, it was diagnosed and treated. Rate and causes of early ($\leq$ 30 days) and late (> 30 days) postoperative mortality were also evaluated.

Statistical analysis

The collected data were evaluated in order to identify risk factors for death within one year after FF repair. Analyzes were performed using IBM SPSS Statistics v.21.

Past demographic and epidemiological data were assessed descriptively.

Correlation between categorical variables and death within one year was assessed using the chi-square test. After this initial screening, each variable with $p < 0.05$ for chi-square test was selected to elaborate the stratified Kaplan-Meier survival model; the difference between the strata was calculated using the log-rank test. To perform the multivariate Cox proportional hazards model, each survival curve was evaluated according to the presence of proportional hazards, so only those meeting this criterion were added to the Cox model. The stepwise technique was used in the multivariate model. Variable importance was defined by measuring the statistical significance of the coefficient associated with the variable for the model. Thus, we obtained the complete model with the main risk factors for postoperative mortality for this population and how each factor increases the patient's odds of death during the analysis period.[14] We chose to use the Cox model due to the possibility of analyzing the time until the occurrence of the event of interest, in the case of death, with adjustment by covariates. With this model, it is possible to estimate the risk ratio between the categories of a single variable. The level of significance used was $p < 0.05$. Wald test was used to evaluate the degree of significance of each coefficient in the regression model.

Results

Two hundred and ten patients were initially included in the study. Twenty-eight were excluded due to the reasons shown in Figure 1. Therefore, 182 patients were included for final data collection. The results presented refer to data collected from the pre-anesthetic questionnaire, electronic medical records, and postoperative phone calls to the 182 patients enrolled in the study. For each question in the questionnaire, it was presented the answer given by the patients or companions who were able to answer the question. Thus, not all questions were answered by all patients (or companions) included in the study. Therefore, the sample presented

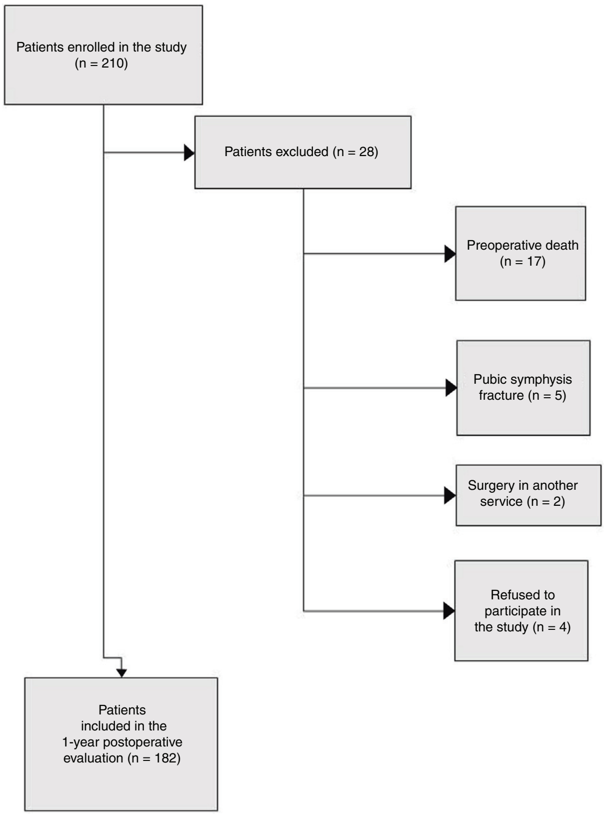

Figure 1 Flowchart of patients who completed the study and reasons for exclusion.

Table 1 Distribution of patients undergoing surgery for FF repair according to age, sex, physical status (ASA), BMI, ethnicity, education, and family income.

Variables	FF (n = 182)	
	n	RF (%)
Sex (n = 182)		
Female	140	76.9
Male	42	23.1
ASA (n = 182)		
I or II	83	45.6
III or IV	99	54.4
Variables	FF (n = 182)	
	n	RF (%)
BMI (n = 182)		
BMI <	18	9.9
BMI ≥18.5 to <25.0	85	46.7
BMI ≥25.0 to <30	59	32.4
BMI ≥30	20	11.0
Variables	FF (n = 162)	
	n	RF (%)
Ethnicity (n = 162)		
Yellow	1	0.6
White	115	71.0
Latin	41	25.3
Black	5	3.1
Variables	FF (n = 157)	
	n	RF (%)
Education (n = 157)		
Did not study	41	26.1
Elementary	91	58.0
Primary	15	9.6
Secondary	2	1.3
University graduate	8	5.1
Variables	FF (n = 157)	
	n	RF (%)
Household income (n = 157)		
<1salary	32	20.4
1 to 3 salaries	101	63.7
4 to 8 salaries	22	14.0
9 to 12 salaries	1	0.6
> 12 salaries	1	0.6

in each table or graph may differ from the total sample of participants.

Anthropometric and sociodemographic profile and physical status according to ASA classification

Table 1 presents data regarding anthropometric, sociodemographic, and physical status according to ASA classification of patients included in the study. The average age of patients was 78.7 ± 9.1 years. The study population was predominantly white and female. Most patients were classified as physical status ASA III or IV and the most prevalent previous diseases were systemic arterial hypertension (42.3%), diabetes mellitus (18.1%), and hypercholesterolemia (16.5%) (data not shown in the Table). Regarding education and family income, it was noted that patients have a low level of education and low family income.

Length of hospital stay

Table 2 describes the type of anesthesia used and the time interval between fracture, hospitalization, and surgery. It was noted that the vast majority of patients underwent neuraxial blockade. The intervals between fracture and medical care were prolonged.

Perioperative complications and mortality rates and causes

Perioperative complications were frequent in the study population and are described in Table 3. Some complications occurred before surgery, and 41.8% of patients had preoperative complications. Postoperative complications were even more frequent. Of the patients included in the study, 57% had some postoperative complication. Data are shown in Table 3 in number of patients who presented the complication and also in relative frequency, presented as a percentage in parentheses.

Table 2 Distribution of patients undergoing surgical FF repair according to type of anesthesia, interval between fracture and surgery, interval between fracture and hospitalization, and interval between hospitalization and surgery.

Type of anesthesia	FF (n = 182)
	n (RF %)
Neuraxial blockade	155 (85.2)
General anesthesia	13 (7.1)
Neuraxial blockade + general anesthesia	14 (7.7)
Time (days)	FF (n = 182) Mean ± standard deviation (minimum time–maximum time)
Between fracture and hospitalization	2.3 ± 4.8 (0–32)
Between hospitalization and surgery	5.9 ± 7.8 (0–90)
Between hospitalization and discharge	10.4 ± 13.4 (2–126)
Between fracture and surgery	8.1 ± 9.2 (0–94)

RF, relative frequency (calculated by dividing the subgroup's *n* by total *n* of patients).

Table 3 Distribution of patients who underwent surgical FF repair according to preoperative and postoperative complications.

Complications	Preoperative *n* (RF %)	Postoperative *n* (RF %)
Delirium	16 (8.8)	26 (14.3)
Arrhythmia	2 (1.1)	8 (4.4)
Stroke	3 (1.6)	2 (1.1)
Septic shock	–	7 (3.8)
Depression	–	3 (1.6)
Coagulation disorder	1 (0.5)	13 (7.1)
Hydroelectrolytic disorder	34 (18.7)	34 (18.7)
High urea	26 (14.3)	10 (5.5)
AMI	2 (1.1)	–
Surgical site infection	–	8 (4.4)
Heart failure	–	5 (2.7)
UTI	5 (2.7)	21 (11.5)
AKI	26 (14.3)	16 (8.8)
Pneumonia	3 (1.6)	20 (11.0)
Sepsis	4 (2.2)	3 (1.6)
PTE	3 (1.6)	7 (3.8)
DVT	–	5 (2.7)

KDIGO criteria. RF, relative frequency (calculated by dividing the subgroup's *n* by total *n* of patients); AMI, acute myocardial infarction; UTI, urinary tract infection; AKI, acute kidney injury; PTE, pulmonary thromboembolism; DVT, deep vein thrombosis.

Due to complications in the perioperative period, two (1.1%) patients required postoperative dialysis, while four (2.2%) required orotracheal intubation (OTI) preoperatively and 11 (6.0%) postoperatively. Admission of patients to the intensive care unit (ICU) was also required in 1.6% of the preoperative patients and in 3.3% of the postoperative patients. Hospital readmission was required in 28 patients (15.5%), nine (4.9%) of which underwent reoperation. Finally, blood transfusion was required in 4.4% of patients before surgery and in 8.2% of patients after surgery.

Table 4 shows the distribution of mortality causes according to the time interval between surgery and death, with 14 deaths occurring within the first 30 postoperative days. The mortality rate in our study was 7.7% in the first 30 days and 30.8% in one year.

The following continuous variables were selected in order to be added to the Cox regression model: age, weight, height, BMI, total hospitalization time, time between fracture and surgery, time between fracture and hospital discharge, time between hospitalization and surgery, total sum of medications, and total sum of preoperative complications. Of these, only age (odds ratio – OR = 1.036, CI = 1.004–1.070) and sum of preoperative complications (OR = 1.227, CI = 1.059–1.422) were significant ($p < 0.05$) to be added to Cox multivariate model.

From the analysis of survival curves according to Table 5, only the variables that allowed proportional risks in the univariate Kaplan-Meier model were added to the Cox proportional hazard model. Figs. 2–4 show the one-year survival curves.

As shown in Table 6, only three of the variables that were associated with death in the univariate analysis remained associated in the multivariate logistic regression analysis. Thus, we can say that in our study, for each increase of one unit (in years) in age, the odds ratio of death increased by 4%. Similarly, with each new preoperative complication presented by the patient, the odds ratio of death increased by 28%. In patients classified as ASA III or IV, the odds ratio of death increased by 95% compared with patients classified as ASA I or II.

Discussion

In our study, 182 patients who underwent FF surgical repair were followed from admission to one year postoperatively. The most prevalent perioperative complications were hydroelectrolytic disorder, acute kidney injury, and delirium. The one-year mortality rate was 30.8%, with infection followed by septic shock being the leading cause among the determined causes of death. Using Cox regression model, age (in years), sum of preoperative complications, and physical status classification (ASA III and IV) increased the odds ratio of death.

The university hospital in which the study was performed is a tertiary hospital, which serves 68 municipalities in the region and covers a population of two million people.[15] The Brazilian public health model follows the rules of the Unified Health System (Sistema Único de Saúde – SUS). Thus, the flow of patients to reach the tertiary hospital in which the research was made is tortuous, since it is a referenced hospital. Therefore, many patients spent days with fractures in their hometown without surgical care. This explains why the day of hospitalization may differ from the day of fracture. This fact is of fundamental importance in the prognosis of FF patients. Morrissey et al. observed a 1.8% increase in mortality risk every hour after surgery, which is significant

Table 4 Distribution of causes of mortality according to the time interval between surgery and death and cause of mortality in patients undergoing surgical FF repair.

Causes of postoperative death	0-30 days	31-365 days	Total FF
FF	*n* (RF %)	*n* (RF %)	*n* (RF %)
Cardiac	–	4 (9.5)	4 (7.1)
Infection followed by septic shock	3 (21.4)	14 (33.3)	17 (30.4)
Hemorrhagic shock	–	1 (2.4)	1 (1.8)
Respiratory failure	2 (14.3)	5 (11.9)	7 (12.5)
PTE	4 (28.6)	–	4 (7.1)
Undetermined	4 (28.6)	16 (38.1)	20 (35.7)
Others	1 (7.1)	2 (4.8)	3 (5.4)
Total (n = 182)	14 (7.7)	42 (23.1)	56 (30.8)

RF, relative frequency (calculated by dividing the subgroup's *n* by the total *n* of patients/deaths); Others, metabolic acidosis and acute lung edema; PTE, pulmonary thromboembolism.

Table 5 Log-rank test for survival curves for each variable associated with death.

Variable	Log-rank	*p*
ASA	10.080	< 0.001
Preoperative transfusion	5.501	0.02
Preoperative pneumonia	9.372	0.002
Preoperative PTE	19.133	< 0.0001
Postoperative transfusion	21.037	< 0.0001
Postoperative cardiac arrhythmia	6.200	0.01
Delirium	5.984	0.01
Postoperative OTI	42.812	< 0.0001
Postoperative septic shock	5.423	0.02
Postoperative HED	48.881	< 0.0001
Postoperative AKI	11.461	< 0.001

PTE, pulmonary thromboembolism; OTI, orotracheal intubation; HED, hydroelectrolytic disorder; AKI, acute kidney injury.

after 24 h of hospitalization.[16] In our study, the average waiting time between the day of hospitalization and the day of surgery was 5.9 days. Nichols et al., in a study conducted in hospitals in the United States, showed that most patients waited one day for surgery and one fifth of them waited three days or more.[17] Our results, therefore, fall short of those found in other referral hospitals in developed countries.

Time between fracture and surgery is much discussed in the literature. Most studies are observational because randomized controlled trials would not be considered ethical. Lee et al. suggested that if surgery is performed within the first 48 hours after the fracture there will be lower rates of perioperative complications.[18] In the present study, the time interval between fracture and surgery was not associated with increased mortality. However, no statistical analysis was made regarding the association between this time interval and perioperative complications.

In the resolution of the American Academy of Orthopedic Surgeons, there are data showing that patients with more pre-existing comorbidities are those at greater risk when waiting more than 48 hours for surgery.[19] With fewer comorbidities, there were no major complications with the waiting time of 3–4 days.

It is worth noting that in the present study, the incidence of preoperative complications was relevant, probably due to the high prevalence of ASA III and IV patients associated with delayed fracture resolution. As an example, 8.8% of preoperative patients with FF had delirium, while 14.3% had acute kidney injury and 18.7% had HED. Moreover, 1.6% of patients had clinical and radiological findings compatible with preoperative pneumonia. This usually occurs in 0.3%–3.2% of FF patients in the world literature.[20] In the 30-day survival analysis using the Kaplan-Meier curve, Patterson et al. showed a difference between patients with and without preoperative pneumonia, emphasizing that patients with pneumonia evolved with shorter postoperative survival.[20] Similarly in our study, for each preoperative complication added to the patient, there was an increase in the odds ratio of death.

Regarding the type of anesthesia used, there was a predominance of patients undergoing neuraxial anesthesia in the present study. There was no association, however, between type of anesthesia, perioperative mortality. Similarly, White et al., in a retrospective study with patients undergoing surgery for FF repair, evaluated the influence of the type of anesthesia used for this purpose, the postoperative mortality rate of patients. The authors concluded that there was no difference in mortality up to five days, wellup to as up to 30 days, when patients underwent general anesthesia versus regional anesthesia (spinal anesthesia).[21] Similarly, in a meta-analysis, Van Waesberghe et al. showed no difference in 30-day mortality between the general, neuraxial anesthesia groups of patients undergoing surgery for FF repair. In-hospital mortality, length of stay, however, were lower in the group of patients undergoing neuraxial anesthesia compared to those undergoing general anesthesia.[22]

Regarding postoperative complications, the need for hospital readmission of surgical patients is not a rare event and may be related to unfavorable outcomes. As for FF, a study of 732 patients over 65 years of age who underwent surgical treatment showed that 8.3% were readmitted to the hospital within the first 30 days after surgery.[23] The main cause for hospital readmission was clinical disease exacerbation (hypertension), followed by respiratory problems, particularly pneumonia.[23] Regarding the need for using health

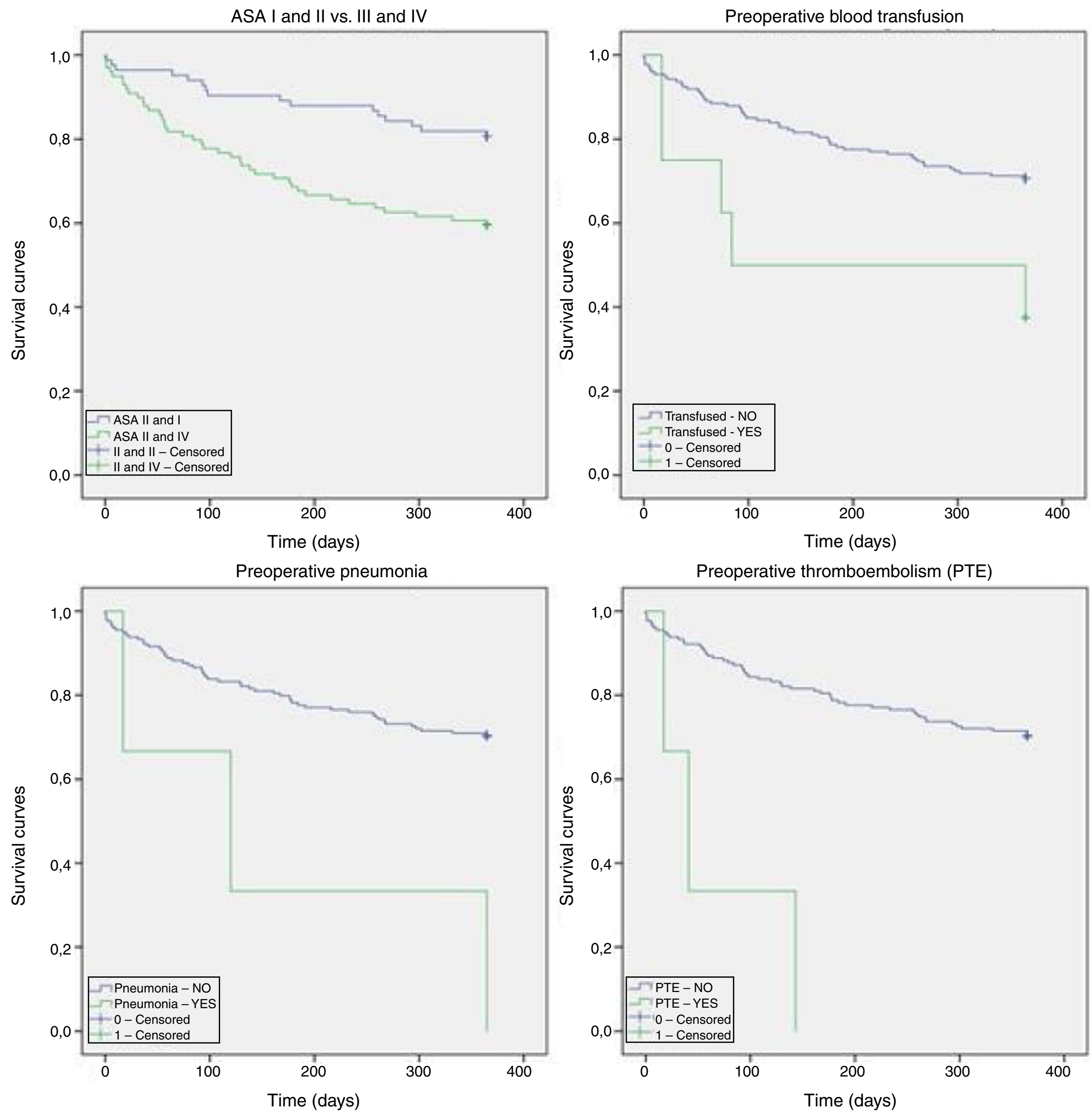

Figure 2 One-year survival curves according to ASA physical status, preoperative blood transfusion, preoperative pneumonia, and preoperative PTE.

services, 15.5% of FF patients included in our study required hospital readmission.

Venous stasis, intimal vessel injury, and hypercoagulability states are the pathophysiological triad involved in greater risk of deep vein thrombosis (DVT) and preoperative thromboembolism (PTE).[24] Operating table supine position, anatomical positioning of limbs, effect of anesthesia, and duration of surgical anesthetic procedure contribute to venous stasis during surgery.[25] According to data from the present study, DVT occurred in 2.7% of FF patients, while postoperative PTE affected 3.8% of patients. A study with patients undergoing FF surgical repair, recruited between 2008 and 2013, showed a PTE frequency of 0.1%.[26] Another study, also by Japanese authors, showed that the incidence of perioperative PTE, considering all types of surgery, decreased in 2011 compared to 2002 due to the implanted prophylaxis program.[27] Our study did not evaluate the antithrombotic prophylaxis protocol for these patients.

Several factors were related to death in FF patients. However, after surgical repair, the only ones that remained independent predictors of mortality were age, ASA physical status, and sum of preoperative complications in Cox regression analysis.

A study performed in Estonia with a population of patients undergoing FF surgical repair which included 2383 men and 5552 women over 50 years of age showed that there is a higher risk of death within the first three to six months of fracture and that the risk over the 10-year study period continued to accumulate. Immediate high risk of death occurs in patients aged 80 years and older.[28]

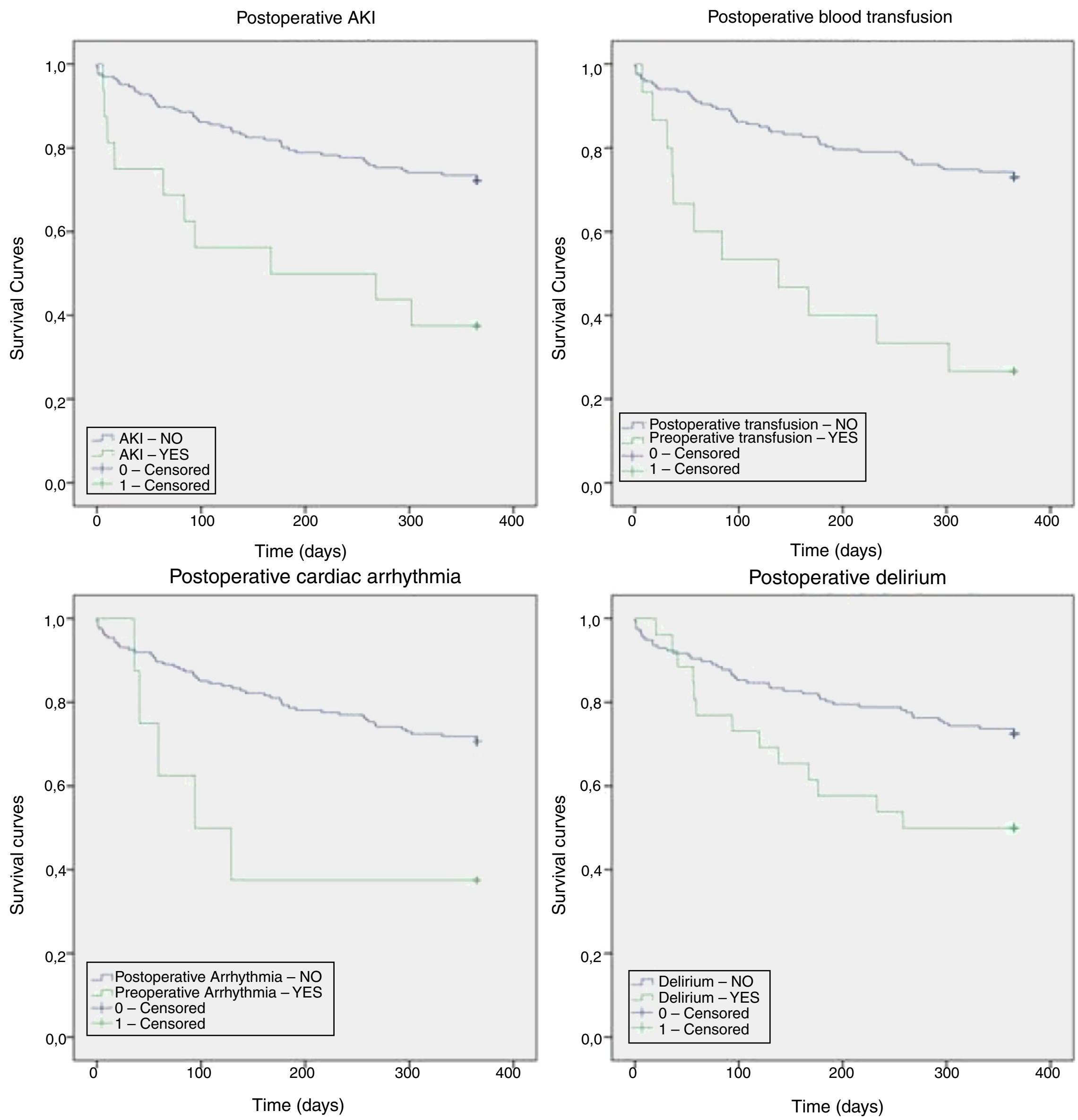

Figure 3 One-year survival curves according to postoperative acute kidney insufficiency (AKI), postoperative blood transfusion, postoperative cardiac arrhythmia, and postoperative delirium.

Another study found a mortality rate of 8.3% within 30 days and 29.3% within one year in patients undergoing FF surgical repair.[29] According to Basques et al.,[30] patients with FF have their life expectancy reduced by 25%, compared to the life expectancy of the same-sex population without FF.

A research performed at the University of Leeds in the United Kingdom found a 30-day mortality rate of 8.7% for patients undergoing FF surgical repair. The main causes of death were pneumonia, AMI, and sepsis.[31] In the first 30 days, our mortality rate was 7.7% and the main cause of death, when identified, was sepsis. Flikweert et al. reported that 1-year mortality rate among patients undergoing FF repair was 27%.[32] Our data show a 1-year mortality rate of 30.8% postoperatively, with infection followed by septic shock being the leading cause of death. A Dutch study also found rates similar to those found in the present study.[33] Causes of mortality in the first 30 days after surgery are often attributed to perioperative factors.[31] Thus, modifiable causes of mortality are more easily addressed and controlled in order to decrease early mortality, that is, until the 30th postoperative day.

The physical status classification suggested by the American Society of Anesthesiologists (ASA) is one of the most reliable prognostic indices for perioperative noncardiac mortality and may also be used to estimate the risk of intraoperative and postoperative complications.[34] ASA classification is addressed in the literature as a predictor for morbidity and mortality in FF patients.[35] Smith et al., in a meta-analysis with more than 540,000 participants, suggested that there are a number of preoperative indicators related to postoperative mortality after surgical FF repair. Among these factors, the patient's ASA physical status was included. Patients classified as ASA III or IV had a 44% higher risk of mortality in the first 12 months after surgery than

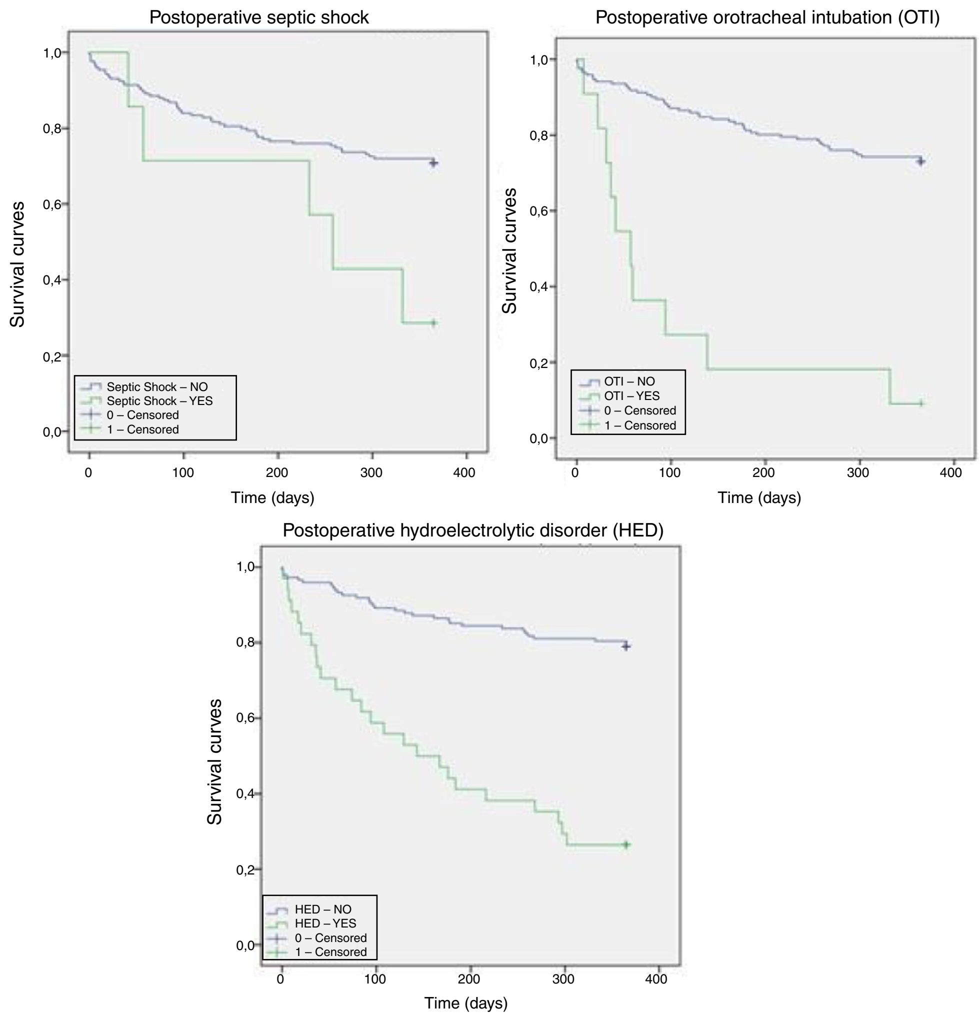

Figure 4 One-year survival curves according to postoperative septic shock, postoperative OTI, and postoperative HED.

Table 6 Cox regression model for mortality.

Variables	Odds ratio	Wald	SE	*p*	CI (95%)
Age (in years)	1.04	4.72	0.02	0.03	1.003–1.068
Sum of preoperative complications	1.28	9.59	0.08	0.002	1.094–1.493
ASA I or II / III or IV	1.95	4.81	0.30	0.03	1.074–3.550

CI, confidence interval.

those classified as ASA I or II.[36] Similarly, ASA III or IV patients included in the present study had a higher odds ratio of postoperative death when compared to patients ASA I or II.

Interestingly, the mortality rate found in this study was higher than that found in another Brazilian population study that found a mortality rate of 23.6% among patients undergoing FF repair in one year.[12] However, unlike of ours, the study was retrospective. Moreover, patients were admitted to the hospital at the time of surgery, having had the initial clinical management performed in another health unit.

Finally, the most frequent cause of mortality for FF patients in our study, as previously mentioned, excluding the 20 patients with undetermined cause, was septic shock (47.2%). We found a high frequency of deaths classified as undetermined cause, as the relatives could not report the cause of death and/or could not access the death certificate of patients. However, when we reviewed these patients clinical history of death, many had sudden death. This data suggests that cardiac causes and the incidence of PTE may be underestimated in the present study.

The present study has some limitations, many of them related to the design itself. When the phone contact was unsuccessful during follow-up, researchers used other methods of actively seeking information, such as home visits. With this attitude we expected to have minimized the loss of data relevant to the study. Still, the pre-anesthetic questionnaire applied depended on the level of understanding of the patients or companions. When we evaluated the level of education of the enrolled population, we realized that the low level of education may have contributed to the difficulty of understanding some of the proposed questions. In addition, we did not directly apply a validated instrument to assess preoperative and postoperative cognitive status. The patients were evaluated by various medical specialties, including clinical and psychiatry, and then the diagnoses were obtained through electronic medical records. This fact may have influenced the results obtained on this complication. Finally, the number of enrolled patients, although relevant, is small when compared to multicenter studies. However, despite the small population sample, the prospective nature of data collection from the Brazilian population is unprecedented in the literature on this subject.

Conclusion

The 30-day and 1-year mortality rates of patients undergoing FF surgical repair were 7.7% and 30.8%, respectively. Increasing age, presence of more preoperative complications, and ASA physical status III or IV were the predictors of mortality in these patients in the first year after surgery. The time between hospitalization and surgery (or fracture and surgery) and some complications (such as HED), despite being considered predictors of mortality in the literature, showed no statistical difference in our studies (COX regression).

Given the above, we believe it is essential that FF patients are promptly referred for definitive treatment and have fast and effective preoperative evaluation, as these are the modifiable factors in which interventions are possible. Measures should be taken to compensate for possible comorbidities and direct efforts towards performing the surgical procedure within the shortest possible time interval after the fracture. Thus, these patients can be prevented from evolving to unfavorable preoperative clinical contexts, which increases postoperative mortality.

Conflicts of interest

The authors declare no conflicts of interest.

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