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Original article

Orthogeriatric assessment of patients over 75 years of age with a proximal femur fracture: Predictors of 6-month mortality

Camille **Collin** [a], Charlotte **Bimou** [b], Christian **Mabit** [a], Achille **Tchalla** [c], Jean-Louis **Charissoux** [a], Pierre-Sylvain **Marcheix** [a, *]

a Service d'orthopédie-traumatologie, CHU Dupuytren. 2, Avenue Martin Luther King, 87042 Limoges, France

b EA 6310 HAVAE Handicap Activité Vieillissement Autonomie Environnement, Université de Limoges. 33, rue François Mitterrand, 87032 Limoges, France

c Service de médecine gériatrique, CHU Dupuytren. 2, Avenue Martin Luther King, 87042 Limoges, France

Corresponding author:

Pierre Sylvain Marcheix, Service d'orthopédie-traumatologie, CHU Dupuytren. 2, Avenue Martin Luther King, 87042 Limoges, France

Email: psmarcheix@orange.fr

Telephone: 05-55-05-55-55

Fax: 05-55-05-67-53

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Abstract (425 words)

Introduction:

Proximal femur fractures are common and dangerous in older adults, given the high short-term mortality rate. While surgical treatment is vital, medical orthogeriatric care may reduce the 6-month mortality rate; however, this has not been determined on a broad scale in France. This led us to conduct a retrospective study to answer the following questions: 1) Does delayed surgical treatment impact the 6-month mortality rate? 2) Are there correctable medical factors that impact the 6-month mortality?

Hypothesis:

Delayed surgical treatment is not an isolated risk factor for higher 6-month mortality after proximal femur fracture.

Methods:

We included all patients 75 years or older who had suffered a proximal femur fracture requiring surgical treatment. This allowed us to analyze the medical records of 476 patients retrospectively. We documented their comorbidities and pre-, intra- and postoperative characteristics. A univariate then multivariate analysis was done to identify risk factors for mortality at 6 months.

Results:

In the univariate analysis, time to surgery of more than 48 hours increased the risk of dying at 6 months by 1.5 fold (Odds ratio (OR) = 1.57 / 95% CI: 1–2.48 / p = 0.04). However, this risk factor was not significant in the multivariate analysis since it is not an independent risk factor. In the multivariate analysis, anticoagulants (OR = 2 / 95% CI: 1.13–3.50 / p = 0.02), dementia (OR = 2.2 / 95% CI: 1.32–3.59 / p = 0.002), peripheral artery disease (OR = 2.9 / 95% CI: 1.10–7.70 / p = 0.03), 2-point drop in hemoglobin count from preoperative to postoperative (OR = 1.9 / 95% CI: 1.05–3.12 / p = 0.04), male sex (OR = 1.82 / 95% CI: 1.05–3.12 / p = 0.04), age above 85 years (OR = 5.26 / 95% CI: 1.49–5.26 / p = 0.002) and Charlson comorbidity index ≥ 7 (OR = 2.13 /95% CI: 1.29–3.52 / p = 0.003) were statistically associated with mortality at 6 months.

Discussion/Conclusion:

Our study found that the patients most at risk for dying within 6 months of a hip fracture were males, older than 85 and have associated medical conditions (Charlson index ≥ 7). Prior anticoagulant treatment increases the time to surgery in our study and therefore increases the risk of these patients dying within 6 months. Treatment of these at-risk patients should ensure that their underlying medical conditions are not made worse, while providing treatment within 48 hours. Patients taking anticoagulants must be monitored carefully to ensure surgical treatment is not delayed.

Level of evidence: IV, retrospective study without control group

Keywords: Hip fractures; Risk factors; elderly patients; mortality at 6 months; comorbidities

1. Introduction

Osteoporotic fractures are a global health problem. Proximal femur fractures are one of the most common osteoporotic fractures [1]. We estimate that one-third of those over 65 years of age and one-half of these over 85 years of age fall at least once per year [2]. In France, the annual incidence is 50,000 hip fractures in women and 16,000 in men, with a mean age of 83 years [3].

These fractures are responsible for a high number of deaths. The intra-hospital mortality in France was 2.8% in 2008 [4]. Mortality during the postoperative course of these fractures is approximately 10% at 1 month, 20% at 6 months and 33% at 1 year [5]. The risk of dying after a proximal femur fracture is 5 to 8 times greater in the first 3 months postoperative than in an age-matched control group without fracture [6]. In the literature, the risk factors for mortality at 1 month are advanced age, male sex, high ASA score, impaired walking before the fracture and preoperative anemia [7]. The impact of time to surgery on the 6-month mortality rate varies depending on the patient's medical condition [8]. Some studies have shown that the time to surgery is an isolated risk factor increasing the 6-month mortality [9-10], while other studies have not found an effect of time to surgery on postoperative mortality [11]. Thus the medical literature shows that the impact of the time to surgery on the 6-month mortality rate varies depending on the patient's medical conditions [8-12]. According to Lewis and Waddel [10], having a time to surgery of more than 5 days did not seem to impact the survival of patients who were ASA 3-4. These authors recommend using a score to determine which patients should be operated within 24 hours of the fracture event [8]. The Delaveau et al. study [13] showed that mortality was reduced when patients were operated within 24 hours of the fracture; however, their study excluded patients taking direct oral anticoagulants, and consequently those with comorbidities requiring these therapeutic agents.

To define the impact of time to surgery and comorbidities specific to each patient on the 6-month mortality risk, we did a retrospective study on the surgical treatment of proximal femur fracture in adults over 75 years of age. We sought to answer the following questions: 1) Does delayed surgical treatment impact the 6-month mortality rate? 2) Are there correctable medical factors that impact the 6-month mortality after proximal femur fracture in older adults? We hypothesized that delayed surgical treatment is not an isolated risk factor for higher 6-month mortality after proximal femur fracture.

2. Methods

2.1 Study design and data collection

This was an observational, single-center, retrospective study done in our orthopedics and trauma surgery department of patients seen between 1 January 2017 and 31 October 2018. We included all patients 75 years or older who had suffered a proximal femur fracture diagnosed on radiographs and requiring surgical treatment. Only patients over 75 years of age were included because these patients systematically underwent an orthogeriatric assessment in our department to obtain an accurate assessment of their medical condition. Exclusion criteria were the presence of an additional fracture or a pathological fracture.

The following data was collected for each patient:

- Epidemiological data (age, sex, place of residence, American Society of Anesthesiologists score – ASA [14], comorbidities)
- Preoperative data (type of fracture, time to surgery)
- Intraoperative data (type of surgical procedure, type of anesthesia used)
- Postoperative data (weightbearing, change in hemoglobin from preoperative to postoperative, length of hospital stay, discharge destination).

The patients were followed for at least 6 months to determine the number of deaths during the postoperative course of these proximal femur fractures.

2.2 Study population and comorbidities

A total of 476 patients were included with 366 being women (77%) (Table 1). The average patient age was 87 years (range 75–103). The ASA score was 3 or higher in 338 patients (71%) (Table 2). Most patients were living at home before the fracture (305 patients, 64%). The most frequently found comorbidities were high blood pressure in 61% (290 patients), kidney failure in 40% (193 patients) and dementia in 37% (176 patients).

2.3 Type of fracture and treatment

The fracture was pertrochanteric in 53% (251 patients), femoral neck in 43% (205 patients) and trochanter–diaphysis junction in 4% (20 patients).

The mean time to surgery was 2.59 days ± 2.05 (0–18). Thirty patients were operated within 24 hours of the fracture (6%), 139 patients between 24 and 48 hours (29%), 104 patients between 48 and 72 hours (22%) and 203 more than 72 hours later (43%). General anesthesia was used in 350 patients (74%) and spinal anesthesia in 126 patients (26%).

The pertrochanteric fractures were fixed with a short nail in 234 patients (86%), long nail in 17 patients (4%) and compression plate in 16 patients (3%). For the femoral neck fractures, a hemiarthroplasty was done in 173 patients (84%), total hip arthroplasty in 34 patients (17%), screw fixation in 1 patient (0.5%) and head–neck resection in 1 patent (0.5%).

The mean drop in hemoglobin from preoperative to postoperative was 2.9 g/dL ± 1.2 (0–7.6). The mean length of hospital stay was 10.94 days ± 5.48 (5–18 days). There were 12 intra-hospital deaths (2.5%).

Upon leaving the hospital, 283 patients (61%) were discharged to a post-acute rehabilitation (PAR) unit, 132 patients (29%) were discharged to a nursing home, 39 patients (8%) were discharged to home, 3 patients returned to their assisted living facility (0.6%) and 7 patients were transferred to another hospital ward (1.5%).

2.4 Assessment methods

The various comorbidities that we identified are listed in Table 1. The main comorbidities were cardiovascular risk factors, history of vascular disease, degenerative diseases, cardiac and pulmonary disease, history of cancer, kidney or heart failure, pre-existing psychiatric illness, smoking and alcoholism. The age adjusted Charlson comorbidity index (ACCI) was calculated for each patient. This index is predictive of the mortality risk of a specific patient [15].

2.5 Statistics

Quantitative variables were described by their mean ± standard deviation. Qualitative variables were expressed as counts and percentages. A univariate analysis was done followed by a multivariate analysis. To be included in the initial multivariate model, the variables had to be significant at ≤ 0.25 in the univariate analysis. The multivariate model was simplified by using backward stepwise selection to come up with the final model. The relevant interactions between the variables selected for the final model were determined. A significance threshold of 0.05 was chosen for all the statistical testing. SAS software was used (version 9.4, SAS Institute, Cary, NC, USA).

3. Results

Predictors of 6-month mortality

Figure 1 summarizes the patients' follow-up and mortality. Thirty patients were lost to follow-up (6%) at a mean of 72 days (4–160). The 6-month mortality was 22% (107 patients). Tables 3 and 4 show the results of the univariate and multivariate analyses done to identify predictors of 6-month mortality.

The univariate analysis showed that a time to surgery of more than 48 hours after the fracture increased the risk of patients dying within 6 months by 1.5 times (OR = 1.57 / 95% CI: 1–2.48 / p = 0.04). However, this risk factor was not significant in the multivariate analysis, since it cannot explain the excess mortality observed by itself. The mean time to surgery was 3.9 days for the 87 patients taking anticoagulants (± 2.0) versus 2.3 days in the 389 patients not taking anticoagulants (± 1.9) (p< 0.0001). Of the 87 patients taking anticoagulants, 43 were operated more than 72 hours after the fracture (49%).

A decrease of 2 or more points in hemoglobin level from preoperative to postoperative or the presence of an anticoagulant treatment were associated with a two-fold increase in mortality. The presence of heart failure or ventricular fibrillation (VF) was associated with increase mortality within 6 months after surgery. The same was found for patients with chronic obstructive pulmonary disease or peripheral artery disease (PAD) in the lower limbs. The 6-month mortality was 3 times higher in patients over 85 years of age and for patients with an ACCI ≥ 7 (Figure 2). The risk was 2 times higher in male patients, patients with dementia and patients who were ASA ≥ 3 (Tables 3, 4).

In the multivariate analysis, age ≥ 85 years was associated with a 5-fold increase in the risk of dying within 6 months (OR = 5.3 / 95% CI: 1.49–5.26 / p = 0.002). The presence of PAD in the lower limb was associated with a 3-fold increase in the risk of dying within 6 months (OR = 2.9 / 95% CI: 1.10–7.70 / p = 0.03) (Table 4). Taking anticoagulants or having an ACCI ≥7 was associated with a 2-fold higher risk of death. Dementia, a 2-point drop in hemoglobin levels from preoperative to postoperative and the male sex were also associated with a 2-fold risk of dying within 6 months (Table 4).

4. Discussion

4.1 Time to surgery and 6-month mortality

Our study hypothesis was confirmed. The univariate analysis showed that the risk of a patient dying within 6 months was 1.5 higher when the surgical procedure was done more than 48 hours after the fracture occurred. However, time to surgery was not an independent risk factor for 6-month mortality in the multivariate analysis. Our study showed that anticoagulant treatment and its underlying medical conditions played a role in lengthening the time to surgery. Several other studies have shown the importance of reducing the time to surgery to less than 48 hours to reduce excess mortality [12-16]. In a review of literature by Lewis and Waddell in 2016 [11], fast recourse to surgery (between 12 and 24 hours) is recommended for patients in relative good general health (ASA 1 and 2). For the other patients, any comorbidities must be identified and treated as quickly as possible to minimize the delay in starting surgical treatment [11].

4.2 Medical factors impacting 6-month mortality

Anticoagulants

In our univariate and multivariate analyses, on-going anticoagulant therapy was an independent risk factor for 6-month mortality (risk increased by 2). Nearly half the patients taking anticoagulants in our study had a time to surgery of more than 72 hours. According to Caruso et al. [17], warfarin treatment increases the time to surgery and thereby the mortality rate. Thus, it seems necessary to implement a protocol involving vitamin K or its derivative to rapidly achieve INR < 1.5. This protocol should be initiated when the patient is admitted to the emergency room by administering a 10 mg dose of vitamin K upon arrival and then 10 mg twice per day until the surgical procedure [18]. For patients taking platelet aggregation inhibitors such as clopidogrel, Veronese et al [19] recommend doing the surgical procedure 24 hours after stopping this treatment. For patients taking the clopidogrel-aspirin combination, only the aspirin should be continued. For other platelet inhibitors such as prasugrel or ticagrelor, a minimum pause of 48-72 hours seems necessary, especially since they are contraindicated for spinal anesthesia [20]. Oral anticoagulants should not always delay starting the surgical treatment (daily blood tests, target concentration below 30 ng/ml) [21].

Ventricular fibrillation

Our univariate analysis showed that patients who have ventricular fibrillation have a 3-time higher risk of dying within 6 months. This finding was not confirmed in the multivariate analysis, meaning that it is not an independent risk factor; it only potentiates other risk factors found in our study, such as anticoagulant intake. Also, ventricular fibrillation was not found to be a risk factor for death in other studies. Smith et al. [22] were the only ones to find that 1-year mortality was 2 times higher in patients with an abnormal EKG.

Anemia

Our study found that a 2-point drop in hemoglobin after the procedure was associated with a 2-time higher risk of dying within 6 months. In the literature, a low preoperative hemoglobin level is a risk factor for mortality in the first 30 days [5] and at 1 year [23]. The need for blood transfusion was associated with an increased risk of death at 2 years in the study by Ercin et al. [24]. Transfusion should only be done if the hemoglobin is less than 8 g/100 ml or if the anemia is not well tolerated [25]. In at-risk patients with several comorbidities and who have anemia preoperatively, the surgical procedure should be as least invasive as possible to limit intraoperative bleeding [26]. In patients with true femoral neck fractures, hemiarthroplasty or total hip arthroplasty with a dual mobility implant should be offered. A dual mobility implant does not cause additional blood loss and it helps to reduce the risk of dislocation [27-30]. In pertrochanteric fractures, the type of fixation does not appear to impact the mortality rate of these patients [31]. These fractures can only be treated by arthroplasty without increasing the risk of complications and mortality [32].

Heart and kidney failure

Like Athar et al. [33], we found a higher risk of death within 6 months in patients suffering from heart or kidney failure. This increased mortality can be explained by the need to do additional preoperative examinations, thereby increasing the time to surgery. These additional examinations should be obtained within 24 to 48 hours [16]. The literature shows that kidney failure increases the risk of intra-hospital mortality following proximal femur facture. In this context, hydration must be optimized and hyponatremia corrected to limit the risk of increased mortality [33-34].

Other risk factors

In our univariate analysis, PAD and dementia were independently associated with increased 6-month mortality. PAD was associated with a 2.9 times greater risk and dementia with a 2.2 times greater risk. These findings are consistent with those in the literature [35]. According to Wood et al. [36], dementia was the most important predictor of mortality at 6 months. Early orthogeriatric care of patients who have cognitive disorders is needed to prevent confusion and thus the risk of another fracture and death [37].

Moreover, in our study, ACCI ≥7 and ASA score ≥3 were associated with a higher risk of dying within 6 months. According to Lewis and Waddell [11], the ASA score is predictive of the mortality risk after proximal femur fracture; the higher the ASA score the higher the risk of complications. Lastly, our study confirms published data that the 6-month mortality is higher in male patients and in those over 85 years of age [38-39]. Men have a risk of dying within 6 months that is 1.8 times greater than women, while patients who are over 85 years of age have a 5.3 times greater risk [6-39].

4.3 Limitations and strengths

This study has the typical limitations associated with a retrospective study. However, the study population was large, homogeneous (patients over 75 years of age with a proximal femur fracture) and was based on in-depth medical analysis with systematic preoperative orthogeriatric assessment. While our study only looked at mortality within the first 6 months postoperative, the increased mortality observed after this type of fracture mainly happens during this period [5]. The large amount of missing data in the ASA score prevents us from drawing conclusions about the impact of this score on the 6-month mortality rate. Since we are unable to determine why the surgical treatment was delayed in our retrospective study, we initiated a prospective study to answer this question, looking at medical and organizational reasons.

5. Conclusion

Our study found that the patients most at risk for dying within 6 months of a hip fracture are males, over 85 years of age and have comorbidities (Charlson comorbidity index ≥ 7), especially pre-existing dementia and PAD. Prior anticoagulant treatment increases the time to surgery in our study and therefore increases the risk of these patients dying within 6 months. Medical and surgical management of these at-risk patients should ensure that their underlying medical conditions are not

made worse, while providing treatment within 48 hours. Patients taking anticoagulants must be monitored carefully to ensure surgical treatment is not delayed.

Conflict of interest:

Camille Collin, Pierre-Sylvain Marcheix, Charlotte Bimou, Achille Tchalla: no conflict of interest related to this study or outside of it.

Christian Mabit, Jean-Louis Charissoux: Educational consultants for Medacta

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Author contributions:

Camille Collin, Pierre-Sylvain Marcheix: designed study, wrote article

Charlotte Bimou: statistical analysis

Christian Mabit, Achille Tchalla, Jean-Louis Charissoux: critical review of article

Figure captions

Figure 1: Flow diagram summarizing the study design

Figure 2: Mortality at 6 months after proximal femoral fracture as a function of the Charlson comorbidity index [15]

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Table 1: Comorbidities observed in our population

Comorbidity **(Number of missing data – %)**		**n (%)**
Number of patients		476
Degenerative neurological diseases (no missing data)	Dementia	176 (37%)
	Parkinson	21 (4%)
Psychiatric disorder (no missing data)		119 (25%)
Cardiovascular risk factors (no missing data)	High blood pressure	290 (61%)
	Dyslipidemia	120 (25%)
	Diabetes	68 (14%)
Ventricular fibrillation (no missing data)		105 (22%)
Anticoagulant therapy (no missing data)		87 (18%)
History of vascular disease (no missing data)	Peripheral arterial disease	23 (5%)
	Angina	63 (13%)
	Stroke	67 (14%)
Heart failure (no missing data)		53 (11%)
Kidney failure (clearance < 60 ml/min) (2 missing data; 0.4%)		193 (40%)
Cancer (no missing data) advanced cancer		105 (22%) 60 (13%)
Lung disease (no missing data)	Chronic obstructive pulmonary disease	31 (6%)
	Asthma	10 (2%)
Smoking (no missing data)		42 (9%)
Alcoholism (more than 2 drinks per day for women; more than 4 per day for men) (no missing data)		14 (3%)

Table 2: Epidemiological data for our study population

Epidemiological data (Number of missing data – %)	**n (%)**
Number of patients	476
Sex (no missing data)	
Female	366 (76.9%)
Male	110 (23.1%)
Mean age (no missing data)	87.5 ± 6 (75-103)
ASA score [14] (50 missing data; 10.5%)	
ASA 1	7 (1.5%)
ASA 2	81 (17.0%)
ASA 3	250 (52.5%)
ASA 4	86 (18.1%)
ASA 5	2 (0.4%)
Place of residence at time of fracture (no missing data)	
Home	305 (64.1%)
Nursing home	146 (30.7%)
Assisted living facility	18 (3.8%)
Convalescence home	3 (0.6%)
Hospital	4 (0.8%)
Charlson comorbidity index [15] (no missing data)	6.5 ±1.90

ASA: American Society of Anesthesiologists

Table 3: Predictors of mortality at 6 months based on univariate analysis

	Univariate logistic regression		
Predictors of mortality	**OR**	**95% CI**	***p* for k²**
Ventricular fibrillation	2.97	1.81-4.87	**<0.0001**
Anticoagulants	2.57	1.53-4.32	**0.0004**
Dementia	2.02	1.28-3.20	**0.003**
Diabetes	1.09	0.57-2.09	0.78
High blood pressure	1.10	0.69-1.76	0.67
Psychiatric disorder	0.99	0.59-1.64	0.96
Coronary artery disease	1.28	0.67-2.43	0.44
Cancer	0.78	0.44-1.38	0.40
Stroke	1.37	0.74-2.53	0.30
Heart failure	2.51	1.32-4.78	**0.005**
Smoking	0.88	0.39-1.99	0.77
Alcoholism	1.40	0.43-4.58	0.57
Parkinson	0.60	1.17-2.09	0.42
Chronic obstructive pulmonary disease	2.83	1.29-6.21	**0.009**
Asthma	1.50	0.38-5.93	0.55
Hypercholesterolemia	0.92	0.54-1.56	0.76
Multiple sclerosis	/	/	/
Peripheral artery disease	3.40	1.40-8.28	**0.007**
Kidney failure	1.76	1.11-2.78	**0.01**
Hemoglobin drop - ≥ 2 points vs < 2points	 2.28	 1.39-3.71	 **0.001**
Place of residence before fall - Home vs. Nursing home - Hospitalized vs. Nursing home	 0.64 1.77	 0.40-1.03 0.28-11.04	 0.07 0.53
Sex - Male vs. Female	 2.15	 1.30-3.55	 **0.002**
Age - ≥ 85 years vs < 85 years	 2.94	 1.62-5.33	 **<0.001**
Length of hospital stay - 10–20 days vs <10 days - ≥ 20 days vs <10 days	 0.88 1.23	 0.54-1.42 0.57-2.64	 0.60 0.59
Time to surgery - ≥ 48 hrs. vs < 48 hrs.	 1.57	 1-2.48	 **0.04**
Diagnosis - Pertrochanteric vs. true neck - Trochanteric–diaphysis vs true neck	 0.72 0.54	 0.46-1.15 0.15-1.94	 0.17 0.34
Weightbearing - yes vs. no	 0.72	 0.41-1.25	 0.25
Type of procedure - Hemiarthroplasty vs. short nail - THA vs. short nail - Plate and screws vs. short nail - Long nail vs. short nail - Resection vs. short nail - Screw fixation vs. short nail	 1.44 0.24 _ 0.84 _ _	 0.89-2.32 0.05–1.05 _ 0.23-3.08 _ _	 0.12 **0.05** 0.97 0.79 0.99 0.99
ASA [14] - ≥ 3 vs ≤ 2	 2.13	 1.09–4.13	 **0.02**

Anesthesia - General anesthesia vs. spinal anesthesia	1.30	0.75–2.24	0.33
Discharge destination - Nursing home vs. PAR - Home vs. PAR - Transfer vs. PAR	 1.52 0.12 3.90	 0.93–2.47 0.01–0.91 1.31–11.62	 0.09 **0.04** **0.01**
Charlson comorbidity index [15] - ≥ 7 vs ≤ 6	3.42	2.09–5.58	**<0.0001**

PAR: post-acute rehabilitation center, ASA: American Society of Anesthesiologists

Bold red values indicate significant differences

Table 4: Predictors of mortality at 6 months based on multivariate analysis

	Multivariate logistic regression		
Predictors of mortality	**OR**	**95% CI**	***p* for k²**
Anticoagulants	1.99	1.13-3.50	0.016
Dementia	2.18	1.32-3.59	0.002
Peripheral artery disease	2.91	1.10-7.70	0.031
Hemoglobin drop - ≥ 2 points vs < 2points	1.87	1.05-3.32	0.03
Sex - Male vs. Female	1.82	1.05-3.12	0.04
Age - ≥ 85	5.26	1.49-5.26	0.002
Charlson comorbidity index [4] - ≥ 7 vs ≤ 6	2.13	1.29-3.52	0.003

Figure 1: Flow diagram summarizing the study design

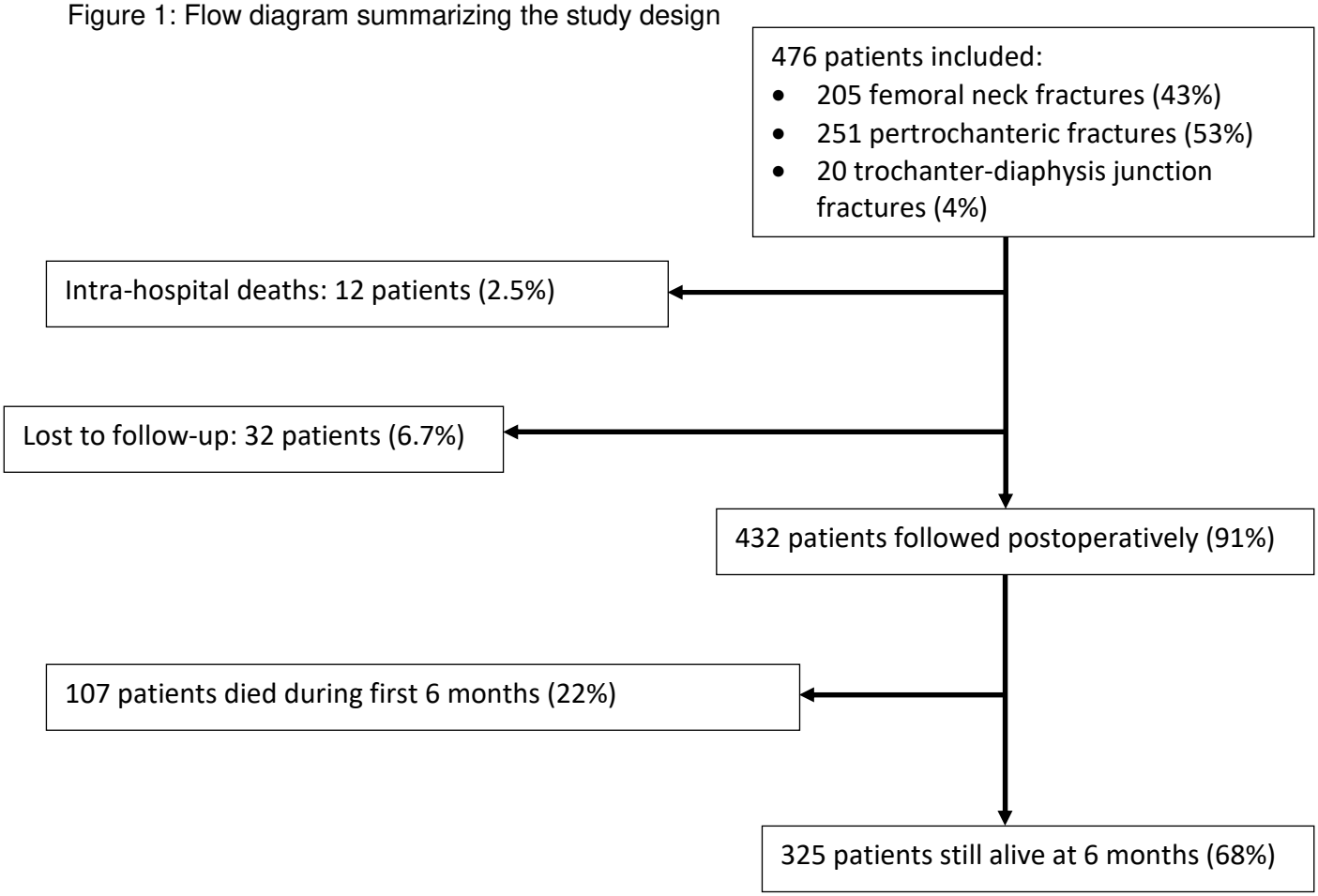


Figure 2: Mortality at 6 months after proximal femoral fracture as a function of the Charlson comorbidity index [15].

