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Pre-operative factors associated with increased mortality in elderly patients with a hip fracture: A cohort study in a developing country

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ABSTRACT

Background: Hip fractures are a public health problem worldwide, and several factors are involved with post-operative mortality. The aim of this study was to identify the pre-operative factors associated with increased mortality in elderly patients with hip fractures in a developing country during the first post-operative year.

Methods: An ambidirectional cohort study was conducted with patients $\geq$ 65 years of age who underwent hip surgery due to a hip fracture caused by a fall from a standing position. Socio-demographic data, time to surgery, and comorbidities measured by the Charlson Comorbidity Index (CCI) were recorded. One-year mortality from all causes was the primary outcome, and 30-day and 6-month mortality were the secondary outcomes. Log-rank test was used to evaluate survival, and Cox's proportional hazard regression was used to detect the factors associated with increased mortality.

Results: 478 patients who underwent hip surgery were included in this study. The mean age was 80.2 ± 9.9, and 297 (62%) were females. There were 150 (31.4%) deaths at the end of the first follow-up year, and the mean of surgical delay was 8.8 days $\pm$ 6.4. Patients who underwent surgery during the first 4 days (Log-rank test < 0.001) after hip fracture occurred and patients with a CCI $\leq$ 2 (Log-rank test < 0.001) showed better survival (90%), comparing to mortality (52%) of patients with a CCI $\geq$ 3 and surgical delay > 4 days. The age $\geq$ 80 years (Hazard ratio 2.55 (HR), 95% confidence interval (CI) 1.70 to 3.84, $p < 0.001$), CCI $\geq$ 3 (HR 1.61, 95% CI 1.14–2.26, p 0.006), surgical delay > 4 days (HR 2.41, 95% CI 1.38–4.21, p 0.006), and haemoglobin < 10 g/dl (HR 1.51, 95% CI 1.06–2.15, p 0.02) were associated with increased 1-year mortality. In addition, 30-day mortality was associated with age $\geq$ 80 years (HR 4.15, 95% CI 1.98–8.70, $p < 0.001$), CCI $\geq$ 3 (HR 1.80, 95% CI 1.08–2.99, p 0.023), pre-surgical time >48 h (HR 3.0, 95% CI 1.58–5.92, p 0.001), and surgical delay > 4 days (HR 3.0, 95% CI 1.33–6.81, p 0.008); and 6-month mortality was associated with surgical delay > 4 days (HR 2.72, 95% CI 1.42–5.23, p 0.003), and haemoglobin < 10 g/dl (HR 1.56, 95% CI 1.04–2.33, $p < 0.028$).

Conclusions: Surgical delay greater than 4 days and Charlson Comorbidity Index $\geq$ 3 were found as factors associated with increased mortality, along with anaemia < 10 g/dl and age $\geq$ 80 years. A similar mortality rate was found in this study compared to the rates reported by the literature, despite a surgical delay of 8.8 days.

Introduction

Hip fractures (HFs) are a public health problem worldwide [1], and it is the most common fracture among osteoporotic elderly people [2]. Every year HFs affect more than 1.5 million people, and it is expected that this problem will increase exponentially to 2.6 million by 2025 and to 4.5 million by 2050, secondary to the aging of the population [3].

After an elderly person has had a hip fracture, mortality rates vary depending on the time of measurement. The proportion of mortality at 1 month is 13.3% (1.2%–16.3%), at 6 months is 15.8% (7.9%–26.7%) and at 1 year is 24.5% (7.8%–35%) [1]. There are systematic reviews (SRs) that were conducted to identify the pre-operative factors associated with increased mortality. Surgical delay has been associated with an increased risk of death [4–6].

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Other associated factors which have also shown strong evidence of mortality are multiple comorbidities, advanced aged, male gender and high American Anaesthetists Society (ASA) Score grading [1].

Clinical guidelines recommend that elderly patients should undergo surgery within the first 48 h after hospital admission [7,8]. However, the effect of early surgery on mortality is still controversial, due to the low quality of evidence [7]. Particularly in developing countries the uncertainty about the effect of early surgery may be even greater, as some studies have shown similar post-operative mortality rates, despite having a long delay before surgery. The time between the fall and subsequent fracture, and the hospital admission can be greater than 3 days. Patients can undergo surgery 11 days after hospital admission, showing a mortality rate of 13% at one year post-operative [9]. In contrast, in developed countries patients may be admitted to hospital during the first 6 h after the trauma [10,11], and receive surgical treatment within the first 24 h after the fracture [11], finding similar mortality rates at one year post-operative.

Additionally, SRs on the effect of timing of hip surgery on mortality have not included studies from developing countries, despite having carried out exhaustive searches for this literature [4–6]. Conversely, SRs related to identifying factors associated with increased mortality other than pre-operative time included studies from developing countries. However, they only accounted for less than 3% of the studies [1]. For this reason evidence regarding factors associated with increased mortality in developing countries is limited. Therefore, more evidence should be generated in order to address treatment strategies.

The objective of this study was to identify the pre-operative factors associated with increased mortality of elderly patients with hip fractures in a developing country during the first post-operative year. Two hypotheses were addressed: 1. Surgical delay would not have any effect on increasing mortality during the first post-operative year in a developing country. 2. Multiple comorbidities measured through Charlson Comorbidities Index would be associated with a higher risk of mortality.

Materials and methods

An ambidirectional cohort study was conducted with patients $\geq$ 65 years of age who underwent hip surgery due to a hip fracture caused by a fall from a standing position. They were treated during 2010 and 2015 at a referral hospital in Bogotá, Colombia. Patients with hip fractures due to oncologic diseases, periprosthetic fractures, multiple fractures and previous history of surgery due to an ipsilateral or contralateral hip fracture were excluded. Patients who were not properly registered in the hospital records were also excluded from the study.

Patients included in this study were land transferred to the institution from cities or small towns of the state, and also from isolated areas of the country. As soon as patients arrived to the hospital, they were treated by the departments of orthopaedics and traumatology, internal medicine, and anaesthesiology. When it was necessary, some cases were evaluated by other medical or surgical specialties. After patients were discharged, they had follow-up care in our institution or in hospitals of their hometowns. All of them had telephone follow-ups by the department of orthopaedics and traumatology, through which mortality was obtained. One-year mortality from all causes was the primary outcome, and 30-day and 6-month mortality were the secondary outcomes.

The retrospective data were collected from clinical records by two physicians, and a third physician verified the retrieved information. Discrepancies of the data were resolved between them, otherwise a fourth physician was consulted to reach consensus. The prospective data (mortality) was independently assessed by two physicians. Socio-demographic data were recorded as well as living arrangements, which were divided into categories, such as: alone, in a nursing home or with someone. Length of stay (LOS) was also measured, and it was calculated from the day of hospital admission to the day of discharge.

Four days were selected as the cut-off point for surgical delay based on the characteristics of the hospital. As a referral hospital for isolated places, it was estimated a priori that patients can take 2 days on average to be admitted to the institution, due to their transportation by car ambulances. Another 2 days were added, taking into account the recommendation that patients should undergo hip surgery after admission by clinical guidelines [7,8]. Surgical delay time was also divided into pre-admission time, and pre-surgical time. Pre-admission time was defined as the time between the occurrence of the fracture and hospital admission, and pre-surgical time as the duration between hospital admission and surgery.

The measured comorbidities were those included in the Charlson Comorbidity Index (CCI), and a CCI $\geq$ 3 was selected as the group of patients with a higher probability of mortality according to previous studies [12]. The CCI took into account 19 medical conditions, giving a value depending on their severity. One point was considered for pathologies such as: myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, connective tissue disease, peptic ulcer disease, mild liver disease and diabetes. Two points were assigned to hemiplegia, moderate or severe renal disease, diabetes with end organ damage, any tumour, leukaemia, and lymphoma. Three and six points were given to moderate/severe liver disease, and metastatic solid tumour or acquired immune deficiency syndrome (AIDS) respectively [13]. Appendix 1 shows the definition of each medical condition in the CCI.

Patients were also categorised based on the classification of the American Society of Anaesthesiologists (ASA), which stated five categories. ASA I indicated healthy patients, ASA II and ASA III patients with mild and severe systemic diseases respectively. ASA IV was assigned to patients with severe systemic diseases that were a constant threat of life, and ASA V to moribund patients that need an operation to survive [14]. In this study, patients were split into two categories for the analysis, patients with ASA I or ASA II, and patients with ASA $\geq$ III.

Hip fractures were classified into intracapsular and extracapsular fractures. The distinction between the two types of fractures was made through x-rays by orthopaedic surgeons. Moreover, haemoglobin values of the patients were obtained at the moment of hospital admission, and a haemoglobin of 10 g/dl was considered as cut-off for the analysis [15].

Statistical analyses

Initially, a descriptive analysis of the variables was carried out in which categorical variables were presented in proportions and percentages. For continuous variables measurements such as mean, standard deviation (SD) and range were used. Kaplan-Meier was used to construct cumulative survival curves to the exposed and unexposed groups for each of the two variables of interest, surgical delay >4 days and Charlson Comorbidity Index $\geq$ 3. The Log-rank test determined if any difference found between the exposed and non-exposed groups were statistically significant.

Cox's proportional hazard regression was used to evaluate the effect not only of the two variables of interest, but also with other covariates on the survival; this statistical analysis was carried out for each of the outcomes. Variables were screened one-at-a-time (univariate analysis), and then variables with p-values of 0.15 or less resulting from this analysis were included in the multivariate analysis. Backward elimination method was used to obtain the