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ORIGINAL ARTICLE

Patients aged ninety years and older are exposed to increased risk of one-year mortality after hip fractures

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Abstract

Background The increase in the population over 90 years old suggests an expected surge in the number of extreme elderly patients sustaining hip fractures.

Objective The aim of this study is to identify factors associated with 1-year mortality and determine the conditions that are associated with an unfavorable survival outcome in nonagenarians.

Design Cross-sectional study

Subjects Nonagenarian patients presenting with hip fractures between 2013 and 2018.

Methods Bivariate and multivariate analyses were performed to identify variables associated with mortality, and a survival analysis was conducted to determine whether the Charlson Comorbidity Index (CCI) is associated with mortality.

Results A total of 127 patients, with a mean age of 92.84 years was assessed, identifying 1-year mortality rate in 53.5% of patients. According to the bivariate analysis, requirement of postoperative vasopressor support, transfusion, decompensated heart failure and general anesthesia were associated with a higher probability of 1-year mortality after surgery. Body mass index, health status, dementia or CCI ≥ 3 were not associated with mortality. Similarly, the Kaplan–Meier survival analysis showed no difference in mortality rate of patients with CCI ≥ 3 ($p = 0.282$).

Conclusion Patients older than 90 years with hip fractures have higher mortality rates per year than younger patients. Some associations were found, but more studies are needed to reach final conclusions, which could help identify higher-risk patients and be able to implement additional measures.

Keywords Hip fractures · Aged 90 and older · Postoperative care · Mortality · Risk

Introduction

The increase in population aged 90 years and older results in an exponential growth of the incidence of hip fractures [1]. It is estimated that by 2050, the number of patients with hip fractures will exceed 5 million per year [2], which represents a major challenge for healthcare providers, since mortality rates associated with this condition are still above 20% [3] and older patients might present with more severe comorbidities [4]. Furthermore, the costs related to fracture management and associated complications in this population group also escalate [5, 6].

Older adults comprise patients over 65 years old, and functional and fatal outcomes in this age group have been widely described in the literature [7]. However, there is a lack of data representing the population 90 years and older, which is presumably sicker and frailer than younger patients. Furthermore, fracture patterns and technical requirements for osteosynthesis may be different in older patients with more fragile bones [8, 9], as well as preoperative and postoperative care and factors associated with mortality, whether preventable or not.

Advanced age, dementia and chronic comorbidities, after hip fractures, have been previously associated with mortality in the senior population [4, 7, 10, 11]. However, these estimations might not be extrapolated to extreme elderly patients, since they do not include patients over 90 years old and might be subjected to other confounders or biases related to this age group [2, 4, 12, 13].

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Some studies in hip fractures in patients older than 90 years, published between 2013 and 2020, have reported a death rate of 23.4–42.6% per year in this age group, hospital stays of 25.5 days or prolonged hospitalization (more than 11 days) in 62.2% of patients. Mortality risk factors recorded include an ASA classification greater than 3 and a lengthy time between fracture and surgery. These measurements were taken at 30 days and some of these studies did not include patients in whom conservative management was decided due to their state of health and who, if they had been included, could have increased mortality rate [14–17].

Therefore, the aim of this study is to identify the factors associated with 1-year mortality of nonagenarians who sustained hip fractures and to determine the conditions that are associated with an unfavorable survival outcome.

Methods

This retrospective study included patients over 90 years of age admitted to a single university hospital, Hospital Universitario de La Samaritana (HUS), for the treatment of hip fractures from 2013 to 2018. Patients were identified through the Hospital's Statistics and Medical Records Service using diagnostic codes (ICD-10) registered at admission and discharge. This database was crosschecked with the Orthopedics Service database to reduce the duplication of records. Routine follow-up visits were scheduled in each patient at 2 weeks, 6 weeks and 3, 6, 9 and 12 months. Some patients who were unable to attend follow-up evaluation were contacted by telephone. All patients were monitored for at least 12 months or until the onset of mortality.

Patients with hip fractures secondary to tumoral etiology, concomitant fractures, periprosthetic or peri-implant fractures, patients who sustained polytrauma and those whose medical records were incomplete, were excluded from the analysis. The decision was made not to exclude patients with conservative management in order to have a complete view of 1-year mortality of patients older than 90 years of age with hip fractures.

Variables of gender, age, body mass index (BMI), number and types of comorbidities, dementia, American Society of Anesthesiologists (ASA) classification, the Charlson Comorbidity Index (CCI), in-hospital mortality and mortality during the first year of the fracture were collected. Other variables that might be associated with mortality such as type of surgery, pre- and postoperative hemoglobin, blood transfusion, time lapse between fracture and surgery and length of stay in-hospital were also assessed.

Statistical analysis

Statistical analysis was performed with SPSS version 22 (IBM Corporation, Chicago, IL). Univariate analysis was performed for population characterization. Continuous variables were expressed as means (standard deviations) or medians (interquartile range) and categorical variables were expressed as frequencies and percentages. Normality of distribution was established by the Kolmogorov–Smirnov test. Bivariate analysis was used to compare 1-year mortality (yes/no) after fracture with the variables was assessed. The statistical methods included Student's t test or two-sample Mann–Whitney U test for continuous variables, according to the distribution type, and Chi-squared test for categorical variables.

The analysis of the variables related to survival was carried out using the multivariate CPH model. Patients were stratified according to the bivariate analysis and a subgroup analysis was performed. P values of ≤ 0.05 were considered statistically significant. Survival analyses were conducted with the Kaplan–Meier method, and the log-rank test was used for comparison between the CCI ≥ 3 and < 3 and mortality.

The protocol was presented to the institution's ethics committee and was authorized without modifications since it was a retrospective study that did not require interventions (Fig. 1).

Results

During the period of study, 184 patients at least 90 years of age were admitted to our institution for the treatment of hip fractures. Of these, 57 patients were excluded due to pathological (malignant) fractures, periprosthetic fractures, polytrauma and incomplete medical records.

The mean age was 92.8 (90–106) years, mean BMI was 23.1 ± 3.9 kg/m^2, 70.1% were females, 66.9% of patients were classified ASA 3 and 29.1% had a CCI ≥ 3 (Table 1) and most of them were living at home, in the countryside of our state. The mean lapse between fracture and admission to a peripherical hospital (health centers or basic hospitals) was 3.36 days, and later, patients were referred to our hospital (higher-level hospital in the state). The final time between fracture and surgery in our hospital (time between fracture-assessment in basic hospital-transfer-admission to HUS-surgery) was 7.25 days, although 56.6% (72 of 127) of patients were able to be operated in the first 72 h after admission to HUS. The mean length of stay in HUS was 11.2 (3–55) days.

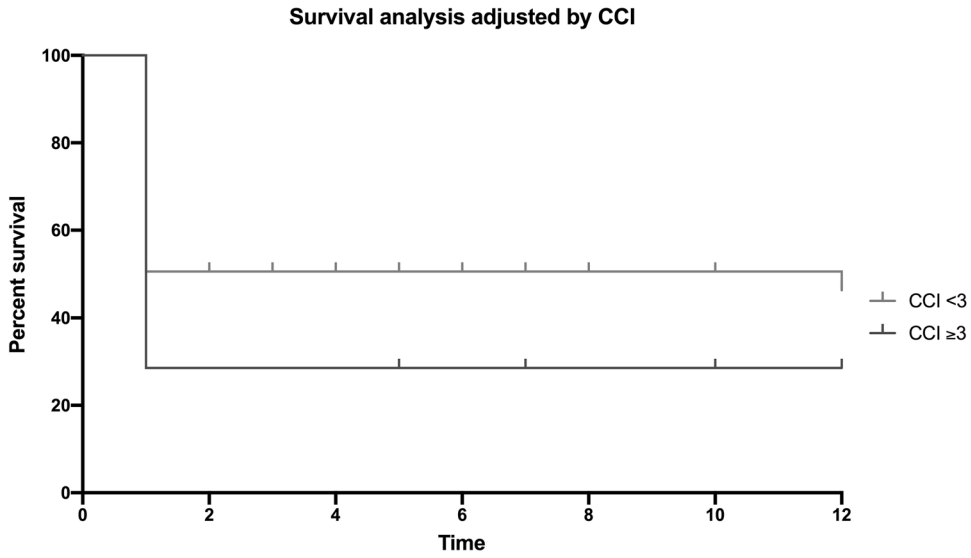

Fig. 1 Survival analysis adjusted by CCI

Fifteen (11.8%) of the 127 patients included in the analysis died in-hospital and 68 (53.5%) patients died during the 1-year follow-up period.

According to the univariate analysis, gender, type of anesthesia, cerebrovascular disease, blood transfusion during surgery, decompensated heart failure and postoperative requirement of vasopressor support were associated with mortality after surgery (Table 2). After the bivariate analysis, the association between decompensated heart failure, requirement of vasopressor support, transfusion and general anesthesia with death after 1 year was confirmed in these patients.

In the multivariate analysis, none of these variables were associated with death (Table 3). Other variables such as BMI, ASA, CCI ≥ 3, number of comorbidities, dementia, renal function, type of fracture, type of surgery, delirium or exacerbation of comorbidities were also not associated with mortality.

In the Kaplan–Meier survival analysis adjusted for Charlson Comorbidity Index (CCI), there were no differences between patients with CCI ≥ 3 and patients with CCI < 3, and the p value (0.282) was not statistically significant.

Discussion

The accelerated growth of the elderly population worldwide has increased the number of patients presenting with fragility hip fractures [1, 2]. Consequently, the literature addressing mortality outcomes of patients over 65 years old is extensive [7, 9, 10], while studies specifically targeting patients over 90 years old are still scarce, and these patients might gradually present with more severe comorbidities [2] that may condition their demise. Even though not statistically significant, nearly 30% of the nonagenarian patients had CCI ≥ 3 as opposed to a younger cohort of patients from the same institution [18].

The study of patients aged 90 years and older is relatively recent, conducted mainly in the last 10 years. However, most of the studies are series or cohorts of small samples, with incomplete data or some biases, such as not including patients in whom conservative management was decided due to poor health [14–17].

Some hip fracture studies–even with patients older than 100 years–have been published. Recently, Blanco et al. carried out a study with 48 centenarian patients, 65 nonagenarians and 63 octogenarians, reporting fewer comorbidities in centenarians compared with nonagenarians and octogenarians but without significant differences in mortality at 30 days and 1 year. However, in each of the 3 groups, the patients who could not be taken to surgery were excluded, without specifying the proportion or the number in each age group. This suggests that the sickest patients were not included and that the mortality rate could have increased compared to younger patients if they were in the centennial group [19].

Other authors, such as Dick et al. and Moore et al. reported, in 2017, mortality rates of over 70% per year, specifically in centennial patients, which could indicate that there is indeed a direct relationship between older age and mortality after a fracture of the hip bone. These series, however, involved few patients and no relationship was reported of mortality with specific risk factors [6, 20].

Given the need to highlight this particular population, we attempted to identify factors associated with mortality in nonagenarian patients, to contribute to the appropriate management and prevention of death from complications arising from hip fractures. Surprisingly, we found a mortality rate of 53.5%, which is significantly higher than what has been described in the literature [2, 9, 13, 21, 22]. This

Table 1 Demographic characteristics of patients

Variable	$N = 127$
	Mean (Range)
Age	92.8 (90 – 106)
BMI[†]	23.2 (16.6 – 35.6)
	Frequency (Percentage)
Gender	
Female	89 (79.1%)
Male	38 (29.9%)
ASA[‡]	
I	1 (0.79%)
II	26 (28.3%)
III	85 (66.9%)
IV	5 (3.9%)
CCI [§]	
< 3	89 (70.1%)
≥ 3	38 (29.9%)
Number of comorbidities	
≥ 2	106 (83.5%)
≥ 3	26 (20.5%)
≥ 4	8 (6.3%)
Dementia	22 (17.3%)
Type of fracture	
Subcapital	19 (15%)
Transcervical	9 (7.1%)
Basicervical	15 (11.8%)
Intertrochanteric	68 (53.5%)
Pertrochanteric	8 (6.3%)
Subtrochanteric	8 (6.3%)
Type of anesthesia	
General	41 (32.3%)
Spinal	86 (67.7%)
Type of surgery	
Osteosynthesis	102 (80.3%)
Hip replacement	24 (18.9%)
No surgery	1 (0.8%)

[†]BMI: Body mass index

[‡]ASA: American Society of Anesthesiologists

[§]CCI: Charlson Comorbidity Index

Table 2 Univariate analysis for demographic and other variables associated with mortality in nonagenarians

Variable	Chi-square	*p* value
Gender	6.080	0.014
Type of anesthesia	5.131	0.024
Transfusion	3.062	0.080
Cerebrovascular disease	4.590	0.032
Decompensated heart failure	3.958	0.047
Postoperative requirement of vasopressor support	4.516	0.034

Table 3 Multivariate analysis for demographic and medical variables associated with mortality in nonagenarians

Variable	Wald	*p*value
Gender	1.859	0.173
Type of anesthesia	1.862	0.172
Transfusion	1.783	0.182
Cerebrovascular disease	0.170	0.680
Decompensated heart failure	1.091	0.296
Postoperative requirement of vasopressor support	0.997	0.318

outcome might be explained by the long period of time that had elapsed between fracture and surgery and the fact that patients with uncontrolled chronic diseases might arrive at our center in worse-than-expected conditions [7, 10].

According to the bivariate analysis, it was found that decompensated heart failure, requirement of postoperative vasopressor support, transfusion and general anesthesia might be related to an increased risk of death. Although some of these measures are necessary due to the patient's condition or the patient's perioperative evolution and are difficult to avoid once they are required, additional efforts should be implemented in order to enhance preoperative preparation and postoperative resuscitation and care, according to descriptions in the literature. Recently published studies have identified the need to implement multidisciplinary programs to improve the comprehensive care of older patients, with the purpose of improving their outcomes [22–26]. In general, the evidence on the use of general versus spinal anesthesia in patients with hip fracture is controversial, but a systematic review of the literature and meta-analysis by Chen et al. in 2019, and that included 11 retrospective observational studies and 2 randomized clinical trials with a total of 196,646 patients found that general anesthesia is associated with increased risk of in-hospital mortality, acute respiratory failure, longer hospital stays and higher readmission. Other findings include evidence to suggest that regional anesthesia is associated with improved perioperative outcomes, but recognize that more randomized clinical trials are necessary to reach final conclusions [27].

The multivariate analysis shows that these variables do not seem to impact fatal outcomes of nonagenarians with fragility fractures around the hip, probably due to the number of patients studied and the limitation to control for confounders that influence mortality [21, 22].

Despite the strong association between CCI and mortality, as described by Jiang et al. [28] compared to previous reports, BMI, cognitive impartment, the ASA and CCI as sole indicators of health status were not identified as risk factors for mortality after hip fractures in our population group [2, 10, 11, 28–30]. Interestingly, Groff and colleagues

identified that in addition to previously described risk factors, pulmonary complications are predictors for in-hospital mortality that should be considered in elderly patients with hip fractures [29]. Other studies have shown increased mortality due to greater physical frailty resulting from older age [9, 20], the lack of adequate control of comorbidities [4, 7, 8] and the limitation to control for postoperative complications related to hypovolemic shock, blood transfusion and congestive heart failure [4, 31] just as we found in our population.

Conversely, the high mortality rate in our patients might be explained by the long time that elapses between the fracture and the surgery, a time that is conditioned by several factors typical of our region and country. Although our hospital is located in Bogotá, it does not treat patients from the city but rather is focused on patients from the rural and peripheral area of our state, Cundinamarca. This state is located in the heart of the Andean area, which is very mountainous, filled with challenging backroads. Likewise, the local customs of the population are that many elderly people live on their own farms, alone and away from their families, who live in nearby towns. Sometimes, after several days have passed, these patients are transferred to peripheral hospitals for first care. These are low complexity hospitals with insufficient human or technological resources for high complex care, and few have intensive care units and adequate geriatric care. Therefore, patients must be referred to higher-level institutions, such as ours, but the referral system is also slow due to administrative procedures of each of the patients' insurers. This is undoubtedly a weakness in our study, since it is difficult to control and reduce the time of pre-hospital consultation, although in the vast majority of cases, after admission to our institution, surgery takes place within the first 72 h. A previous study published in our hospital in 2018 and carried out with 478 patients with hip fracture with a mean age of 80.2 ± 9 years and which did not include any patient aged 90 years or older showed a mortality of 31.4% with time between fracture and surgery of 8.8 ± 4.6 days. This showed a notable difference in mortality in patients older than 90 years and patients younger than 90 years with hip fractures, 53.5% versus 31.4% [32].

The main strength of this study was its ability to characterize the population of patients over 90 years of age who may be at higher risk of dying from hip fractures and the possible implications of this on health policies [5–7]. On the other hands, the limitations of this study are the inability to identify causal associations of cross-sectional studies and the small number of patients included in the analysis, as most studies that identify strong associations between variables such as age, gender, ASA, ICC, among others, analyze a large number of individuals, some not necessarily limited to patients over ninety years old [4, 24, 25, 30, 31].

To our knowledge, this is the first work that highlights the association between postoperative mortality of nonagenarians after hip fractures and the requirement of vasopressor support, blood transfusions and decompensation of heart failure. However, we acknowledge that additional prospective studies with sufficient samples should be conducted to definitively conclude this association.

In conclusion, patients older than 90 years with hip fractures have higher mortality rates than younger patients. Some conditions such as the presence of congestive heart failure, the need for postoperative vasopressor support, the need for transfusion and general anesthesia could be associated and indicate a higher mortality per year, but studies with a greater number of patients are required to be able to conclude these associations. This could help strengthen perioperative strategies and identify the patients, at admission, that are at greater risk of mortality.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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