Original Research Article

HIP HIP International

HIP International
2020, Vol. 30(1S) 54–58

DOI: 10.1177/1120700020938029
journals.sagepub.com/home/hpi
SAGE

Survival analysis after hip fracture: higher mortality than the general population and delayed surgery increases the risk at any time

Maximiliano Barahona[1], Cristian Barrientos[1], Gabriel Cavada[2], Julián Brañes[1], Álvaro Martinez[3] and Jaime Catalan[1]

Abstract

Purpose: To estimate survival curves in patients with hip fracture according to gender, age, type of fracture, and waiting time for surgery and to compare them with the life expectancy of the general population. The study hypothesis is that survival after hip fractures is significantly lower than in the general population, especially in cases that underwent delayed surgery, regardless of age and gender.

Methods: A survival analysis study was designed and approved by our institutional ethics review board. All patients who were coded with a diagnosis of hip fracture from 2002 to 2018 were included in the study. A total of 1176 patients were included, and the median age was 81 years (18–105 years). Kaplan-Meier curves and log-rank tests were performed to compare survival curves between those who underwent surgery on time and those with surgical delays. An exponential multivariate regression model was estimated, and a hazard ratio (HR) was reported for age, gender, and wait time for surgery. A significance of 5% was used, and a confidence interval level of 95% was reported.

Results: The Kaplan-Meier curves for delayed surgery (log-rank, $p = 0.00$) and the age group (log-rank, $p = 0.00$) were significantly different. Exponential regression estimated an HR 1.05 (1.05–1.07) for age, HR 1.80 (1.51–2.13) for men, and HR 1.93 (1.61–2.31) for each day of wait for surgery.

Conclusions: The 2 significant findings of this study are that hip fracture patients over 40 years old have a higher risk of dying at any time compared to the general population and that the waiting time for surgery (a modifiable factor) decreases survival rates at any time.

Keywords

Epidemiology, hip fracture, one-year mortality, survival Analysis

Date received: 29 October 2019; accepted: 14 April 2020

Introduction

The hip fracture is a frequent pathology, especially in patients over 50 years old. The incidence is estimated to increase due to the ageing of the population and the increase in life expectancy.[1]

Post-hip-fracture quality of life decreases, compromising patient independence.[2] Mortality at 1 year after hip fracture is reported to be between 15% and 32%.[3] Several factors influence mortality at one-year, including socioeconomic status and the wait time for surgery.[4] Ensuring access to the resolution of this pathology reduces health costs, increases survival, and improves the life quality of the patients.[5]

Despite the importance of this pathology and several studies reporting mortality at 1 year since hip fracture, no long-term survival analysis has been published; therefore, the impact on long-term survival compared to the general

[1]Orthopaedic Department, University of Chile Clinical Hospital, Santiago, Chile
[2]Epidemiology Department, University of Chile, Santiago, Chile
[3]Orthopaedic Department, San José Hospital, Santiago, Chile

Corresponding author:
Maximiliano Barahona, Orthopaedic Department, University of Chile Clinical Hospital, 999 Santos Dumont Street, 3rd Floor, Office 351, Independencia, Santiago, Región Metropolitana 8380456, Chile.
Email: maxbarahonavasquez@gmail.com

Table 1. Summary of patients.

	<40 years	40–60 years	60–80 years	>80 years
n	43	75	448	610
Median age	31 (18–39)	54 (41–59)	74 (60–80)	87 (81–105)
IQR age	24–31	49–57	69–77	84–91
Women	13 (30.23%)	40 (53.33%)	345 (77.01%)	504 (82.62%)
Intracapsular hip fracture	4 (11.43%)	20 (31.25%)	206 (51.63%)	227 (41.50%)
Time at risk	341	490	2488	2254
Incidence of death	0.003	0.055	0.102	0.22
n deaths	1	27	255	497
Median time at risk	8	6	4	3
Median survival	–	–	7	4

Table shows the number of patients (*n*), median and range of age, interquartile range (IQR) of age, frequency of women, frequency of intracapsular hip fracture, time at risk in years, incidence of death, number (*n*) of deaths, median time at risk in years, and median survival time for each group of age. As the number of deaths is <50% of the sample, no median survival is reported for <40 years and 40–60 years group. In the 40–60 group, the 25th percentile survival time was 5 years.

population and the long-term effect of wait time for surgery are unknown.

The purpose of this study is to estimate survival curves in patients with hip fracture according to gender, age, type of fracture, and waiting time for surgery, and compare it with the life expectancy of the general population. The study hypothesis is that survival after hip fractures is significantly lower than in the general population, especially in those cases that underwent delayed surgery regardless of age and gender.

Methods

A Survival analysis study was designed and approved by our institutional ethics review board. Our hospital codifies diseases according to the 10th International Classification of Diseases (ICD-10), a search was conducted for codes S72.0 (head and a neck fracture of the femur), S72.1 (pertrochanteric fracture) and S72.2 (subtrochanteric fracture of the femur). All patients who were coded with a diagnosis of hip fracture from 2002 to 2018 were included in this study. The patient's full name, national identificatory number, birth date, date of admission, date of discharge, surgery code, and surgery date were recorded. Patients with incomplete information were excluded. Then, per the National Portal of Transparency, we requested the National Civil Registry of Chile to inform whether the patients were alive by 30 July 2019; if not, they were asked to report the date of death.

A total of 1176 patients were included; 902 of them were women (76.70%). The median age was 81 years (range 18–105 years; interquartile range 72–87), and the number of patients by groups is summarised in Table 1. Intracapsular fractures were 457 (43.73%), and extracapsular fractures were 588 (55.15%); in 131 cases, it was impossible to determine the type of fracture. The median time for surgery was 3 days (range 1–42 days; interquartile range 2–5). Delayed surgery was defined as ⩾5 days, according to the 75th percentile of this sample.

The 2017 publication of the Statistics National Institute of Chile was used to compare this estimation to the life expectancy of the general national population (GP).[6] The comparison was made using the life expectancy of the quinquennial of GP, according to the median age of the subgroup. For example, the median age of the group 60–80 was 74, so to compare to the GP, the life expectancy of the quinquennial 70–74 was selected and compared to the study sample through an exponential regression model.

Kaplan-Meier curves and log-rank tests were performed to compare survival curves between those who underwent surgery on time and those who did so with delay. Exponential distribution was tested, fitting the logarithm of the Kaplan-Meier product-limit estimate of the survivor function to the studied time; this was accepted, as it achieved a correlation of 0.99. An exponential multivariate regression model was estimated, and hazard ratio (HR) was reported for age, gender, and wait time for surgery. A significance of 5% was used, and the confidence interval level of 95% was reported. The data was processed using Stata version 15 (StataCorp LP, College Station, Texas, USA).

Results

The total time at risk was 5574 years, the incidence rate of death was 0.14, the individual median time at risk was 4 years, and the median survival time was 5 years. The median survival time and time at risk by each age group are summarised in Table 1.

The Kaplan-Meier estimate curve for gender (log-rank, $p = 0.43$) and type of fracture (log-rank, $p = 0.34$) did not reach statistical difference. The type of fracture was only

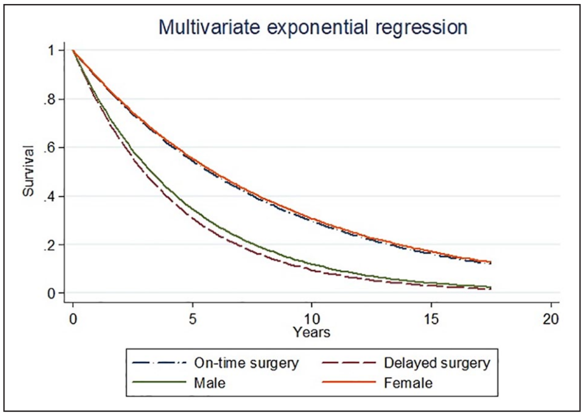

Figure 1. Survival curves adjusted by age of the on-time surgery (blue/dash line), delayed surgery (red/dash line), male gender (green/solid line), and female gender (red/solid line). Male and delayed surgery are at greater risk at any time, adjusted for age, according to the multivariate exponential regression estimated.

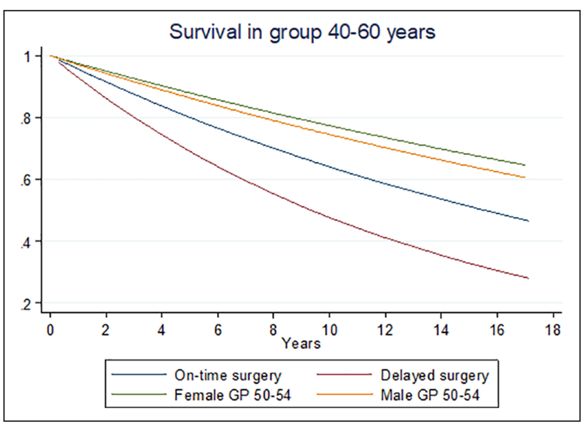

Figure 2. Survival estimation for the male and female general population (GP) at 50–54 years[6] is compared with the survival estimation of the exponential regression model by the wait time for surgery in the 40–60 years group. The hazard ratio was 1.19 (0.41–3.45), not reaching a statistical difference.

statically significant when the wait time for surgery was >5 days in the group between 60–80 years, extracapsular hip fractures being at higher risk (log-rank, $p=0.03$). The Kaplan-Meir curves for delayed surgery (log-rank, $p=0.00$) and a group of age (log-rank, $p=0.00$) were significantly different.

Exponential regression estimates an HR 1.05 (1.05–1.07) for each year older that the patient is, HR 1.80 (1.51–2.13) for men, HR 1.93 (1.61–2.31) for every day of wait for surgery. The survival curve estimated by the exponential regression model is shown in Figure 1.

Kaplan-Meier curves after hip fracture compared to life expectancy after 40 years of age has a significant difference, the risk being greater in the delayed group (Figures 2–4). Life expectancy is summarised in Table 2.

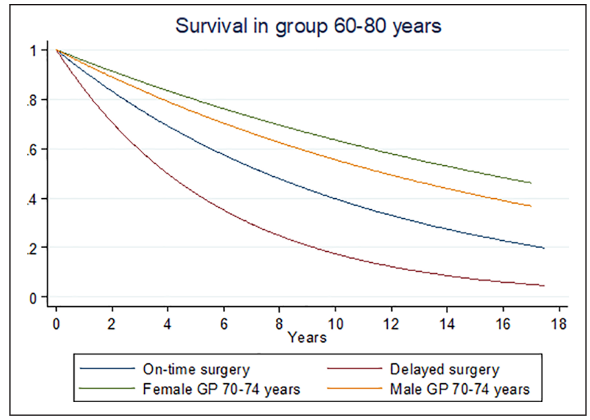

Figure 3. Survival estimation for the male and female general population (GP) at 70–74 years[6] is compared with the survival estimation of the exponential regression model by the wait time for surgery in the 60–80 years group. The hazard ratio was 1.89 (1.39–2.54), reaching a statistical difference.

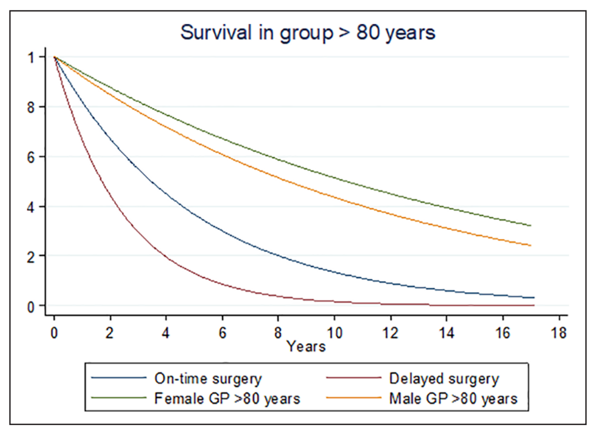

Figure 4. Survival estimation for the male and female general population (GP) at >80 years[6] are compared with the survival estimation of the exponential regression model by the wait time for surgery in the >80 years group. The hazard ratio was 2.03 (1.61–2.55), reaching a statistical difference.

Discussion

The 2 major findings of this study are that patients >40 years of age who had a hip fracture are at a greater risk of dying at any time compared to the general population and that the waiting time for surgery, clearly a modifiable factor, decreases survival rates at any time.

The incidence of hip fracture is growing, and the expectative is that this trend will continue. Tucker et al.[7] estimate a rise in hip fractures up to 128 per 100,000 by 2030 compared to the 86 per 100,000 that they found in 2015. This will only challenge healthcare systems around the world. Accordingly, the cost of treatment will increase, so cost-effective solutions must be implemented.[8]

A recent study performed in Denmark shows that a high risk of dying after a fragility fracture persists even after ten

Table 2. Life expectancy.

Expectancy of life	Female GP	Male GP	Delayed surgery	On-time surgery
<40	59,36	53,50	–	–
40–60	39,56	34,34	10,79	12,89
60–80	21,59	17,47	3,98	7,51
>80	15,01	12,02	1,70	3,45

Table shows expectancy of life for the male and female general population (GP) and the expectancy of life estimated by the exponential regression model for the 40–60, 60–80, and >80 years group by the wait time for surgery. The delayed group was defined by ⩾5 days, and on-time surgery was defined by <5 days.

years, especially in the proximal lower limb. This excess of mortality was higher than the expectancy of life of the general population ⩾50 years.[9] This finding confirms the persistent difference in mortality rate compared to the general population found in this study.

As incidence growth and mortality are higher than the general population at any time, efforts must be directed to prevention. Pierrie et al.[10] show that 45.5% had a preadmission before hip fracture, and a fall accounted for 27.5%; they concluded that community-based fall prevention programmes are a viable option for prevention. Also, both sarcopenia and osteoporosis are the main contributors to the risk of hip fracture, and both should be addressed by familiar physicians and geriatricians.[11]

Once the fracture has occurred, 1 of the best known modifiable factors for 1-year mortality is the waiting time for surgery.[12] Which came first: the egg or the chicken; the delayed surgery, or the comorbidities that sometimes delay surgery? The major reasons for delaying surgery in these patients are the anaesthetic risk and perioperative mortality. However, the report by Johansen et al.[13] shows survival rates in ASA 4 patients of 98.8% and 99.2% for 24 and 48 hours after surgery respectively. The individual risk is difficult to assess, but taking into account the absolute risk reported by Johansen et al.[13] (0.8–1.2%), in the most challenging scenario (ASA 4), comparing the risk of short- and long-term surgery delay, we believe that the surgery must be performed as soon as possible within a period of no longer than 5 days, and certain risks must be assumed to treat the hip fracture and improve long-term outcomes. The 5-day threshold was chosen for statically analysis only, as 5 days was the 75th percentile of the time patients waiting for surgery, so the take-home message should be to perform the surgery as soon as possible, also taking into account that the current recommendation of the Scottish guidelines for hip-fracture treatment is that the patient should undergo surgery in <3 days.[14]

The need for left ventricular evaluation before surgery is a matter of debate. In our hospital, an echocardiogram is a relatively easy access test, but it is not so in many places, which leads to surgery delay. The 2014 ACC/AHA guideline does not recommend the echocardiogram as a routine except for patients with a new or worsening heart condition.[15]

Metcalfe et al.[16] compared a pay-per-performance system for hip-fracture treatment and determined that it has a positive outcome in terms of 30-day and 1-year mortality. According to our results, this could be extrapolated to any time.

Other factors that are related to 1-year mortality after a hip fracture are serum albuminaemia, socioeconomic status, and the type of fracture.[17–19] Given the constant high risk of mortality after one year found in this study, these factors may also affect the long-term outcome.

Socioeconomic status is linked to postoperative care after hospital discharge. Farrow et al.[20] reported that patients that have a higher adherence to postoperative care have a higher survival at 30 and 120 days.

The type of fracture was only found to be significant in this study in a specific subgroup (60–80 years and delayed surgery); extracapsular hip fractures had a higher risk. The higher mortality in extracapsular hip fractures has been inconsistently reported.[18] This is similar to our results, where the type of fracture did not reach statistical significance in the multivariate exponential regression.

A limitation of this study is that the specific cause of mortality is unknown, so for example, a patient could have had a hip fracture but died because of lung cancer. Nevertheless, the number of patients studied minimises this bias. Another limitation is that the hospital data from before 2012 was manually registered; from 2012 onwards, an electronic file system was implemented in our health centre. Another limitation of this study is that the overall data is from 1 hospital and might vary in different regions, countries, and continents.

Also, our health centre does not have a high volume of hip fractures by year. However, morbidity and mortality in hip fractures have not been related to the volume of the institution or the surgeon.[21] We report a 1-year mortality rate of 0.16 (0.13–0.18), through the 17 years included in the study, which is within the lower limit of mortality at 1-year reported in the international literature.[7,18,22,23]

Conclusion

Mortality after a hip fracture is significantly lower compared to the life expectancy of the general population at any time. The survival curve after a hip fracture follows an exponential distribution, so the high risk of dying remains constant. The waiting time for surgery significantly determines an even greater increase in mortality at any time after the hip fracture.

Acknowledgements

The first author acknowledges the support of Leonel Barahona in the elaboration of this paper. Also, the authors acknowledge the contribution of Paulina Barahona and Erin Dillinger to the English edition of this article.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship and/or publication of this article.

ORCID iD

Maximiliano Barahona https://orcid.org/0000-0001-7878-8625

References

1. Sullivan KJ, Husak LE, Altebarmakian M, et al. Demographic factors in hip fracture incidence and mortality rates in California, 2000–2011. *J Orthop Surg Res* 2016; 11: 4.
2. Alexiou KI, Roushias A, Varitimidis SE, et al. Quality of life and psychological consequences in elderly patients after a hip fracture: a review. *Clin Interv Aging*. 2018; 13: 143.
3. Silva DMW, Lazaretti-Castro M, de Freitas Zerbini CA, et al. Incidence and excess mortality of hip fractures in a predominantly Caucasian population in the South of Brazil. *Arch Osteoporos* 2019; 14: 47.
4. Beaupre L, Khong H, Smith C, et al. The impact of time to surgery after hip fracture on mortality at 30- and 90-days: does a single benchmark apply to all? *Injury* 2019; 50: 950–955.
5. Shenouda M, Silk Z, Radha S, et al. The introduction of a multidisciplinary hip fracture pathway to optimise patient care and reduce mortality: a prospective audit of 161 patients. *Open Orthop J* 2017; 11: 309.
6. Villalon GC, Schneider SV and Ortega FC. *Chile, tabla de vida por método de mortalidad óptima*. Instituto Nacional de Estadistica de Chile. Santiago, 2016.
7. Tucker A, Donnelly K, McDonald S, et al. The changing face of fractures of the hip in Northern Ireland: a 15-year review. *Bone Joint J* 2017; 99–B: 1223–1231.
8. Sáez-López P, Brañas F, Sánchez-Hernández N, et al. Hip fracture registries: utility, description, and comparison. *Osteoporos Int* 2017; 28: 1157–1166.
9. Tran T, Bliuc D, Hansen L, et al. Persistence of excess mortality following individual nonhip fractures: a relative survival analysis. *J Clin Endocrinol Metab* 2018; 103: 3205–3214.
10. Pierrie SN, Wally MK, Churchill C, et al. Pre-hip fracture falls: a missed opportunity for intervention. *Geriatr Orthop Surg Rehabil* 2019; 10: 2151459319856230.
11. Oliveira A and Vaz C. The role of sarcopenia in the risk of osteoporotic hip fracture. *Clin Rheumatol* 2015; 34: 1673–1680.
12. Klestil T, Röder C, Stotter C, et al. Impact of timing of surgery in elderly hip fracture patients: a systematic review and meta-analysis. *Sci Rep* 2018; 8: 13933.
13. Johansen A, Tsang C, Boulton C, et al. Understanding mortality rates after hip fracture repair using ASA physical status in the National Hip Fracture Database. *Anaesthesia* 2017; 72: 961–966.
14. Sahota O and Currie C. Hip fracture care: all change. *Age Ageing* 2008; 37; 128–129.
15. Vrahas MS and Sax HC. Timing of operations and outcomes for patients with hip fracture—it's probably not worth the wait. *JAMA* 2017; 318: 1981–1982.
16. Metcalfe D, Zogg C, Judge A, et al. Pay for performance and hip fracture outcomes: an interrupted time series and difference-in-differences analysis in England and Scotland. *Bone Joint J* 2019; 101–B: 1015–1023.
17. Bohl DD, Shen MR, Hannon CP, et al. Serum albumin predicts survival and postoperative course following surgery for geriatric hip fracture. *J Bone Joint Surg Am* 2017; 99: 2110–2118.
18. Cui Z, Feng H, Meng X, et al. Age-specific 1-year mortality rates after hip fracture based on the populations in mainland China between the years 2000 and 2018: a systematic analysis. *Arch Osteoporos* 2019; 14: 55.
19. Sheehan KJ, Sobolev B and Guy P. Mortality by timing of hip fracture surgery: factors and relationships at play. *J Bone Joint Surg Am* 2017; 99: e106.
20. Farrow L, Hall A, Wood AD, et al. Quality of care in hip fracture patients: the relationship between adherence to national standards and improved outcomes. *J Bone Joint Surg Am* 2018; 100: 751–757.
21. Okike K, Chan PH and Paxton EW. Effect of surgeon and hospital volume on morbidity and mortality after hip fracture. *J Bone Joint Surg Am* 2017; 99: 1547–1553.
22. van de Ree CL, Gosens T, van der Veen AH, et al. Development and validation of the Brabant Hip Fracture Score for 30-day and 1-year mortality. *Hip Int* 2020; 30: 354–362.
23. Dinamarca-Montecinos JL, Améstica-Lazcano G, Rubio-Herrera R, et al. Hip Fracture. Experience in 647 Chilean patients aged 60 years or more. *Rev Med Chil* 2015; 143: 1552–1559.