Epidemiology of Hip Fractures in Argentina. Anemia, Prolonged Hospitalization, and ASA Score as Predictive Factors of Morbidity and Mortality in the Analysis of 1000 Patients

Germán Garabano, Harold Simesen de Bielke, Adriana Cubecino, Nicolás A. Robador, Javier Olivetto, Débora Gamarra, Mónica N. Sierto, María Laura Beltramino

Morbidity and Mortality Committee, Asociación Argentina de Ortopedia y Traumatología, Autonomous City of Buenos Aires, Argentina

ABSTRACT

Background: Hip fractures are associated with a significant impact on morbidity and mortality. The aim of this report was to identify the variables related to the development of complications and mortality after a hip fracture. **Materials and Methods:** We carried out a data analysis from the first 1000 hip fracture surveys from the Morbidity and Mortality Committee of the *Asociación Argentina de Ortopedia y Traumatología*. Through a bivariate analysis and a multivariate regression, the independent variables related to the presentation of complications or death were identified.

Results: Complications were related to pre-operative anemia, delay in surgery, hospital stay, and red blood cell transfusions. In addition, mortality was related to pre-operative anemia, red blood cell transfusions, hospital stay, ASA score, and postoperative complications. Multiple regression analysis revealed anemia and prolonged hospitalization to be significant predictors of complications, while anemia and ASA score were recognized as predictors of mortality.

Conclusion: This study highlights the predictive value of anemia, an ASA III-IV score, and hospital stay in relation to the morbidity and mortality of patients with hip fracture. Various efforts should be made to optimize the condition of these patients and the health system in order to reduce this impact on morbidity and mortality.

Key words: hip fracture, anemia, ASA, hospital stay, morbidity, mortality.

Level of Evidence: IV

Epidemiología de la fractura de cadera en la Argentina. Anemia, internación prolongada y puntaje de la ASA como factores predictivos de morbimortalidad en el análisis de 1000 pacientes

RESUMEN

Introducción: Las fracturas de cadera se asocian con un importante impacto en la morbimortalidad. El objetivo de este estudio fue identificar las variables relacionadas con el desarrollo de complicaciones y la muerte luego de una fractura de cadera. **Materiales y Métodos:** Se realizó un análisis de los datos provenientes de las primeras 1000 encuestas de fracturas de cadera del Comité de Morbimortalidad de la Asociación Argentina de Ortopedia y Traumatología. Mediante un análisis bivariado y una regresión multivariada se identificaron las variables independientes relacionadas con la aparición de complicaciones o la muerte. **Resultados**: Las complicaciones se relacionaron con anemia preoperatoria, demora en el tratamiento, aumento de los días de internación y transfusiones de glóbulos rojos. La muerte se asoció con la anemia preoperatoria, las transfusiones de glóbulos rojos, el total de días de internación, el puntaje de la ASA y la presencia de complicaciones posoperatorias. La anemia y la internación prolongada fueron los factores predictivos independientes de complicaciones identificados, mientras que la anemia y el puntaje de la ASA fueron los factores predictivos de muerte. **Conclusiones:** Este estudio destaca el valor predictivo de la anemia, un puntaje III y IV de la ASA, y la estancia hospitalaria en relación con la morbimortalidad de pacientes con fractura de cadera. Se deberán destinar esfuerzos para optimizar la condición de estos pacientes y el sistema de salud en pos de disminuir este impacto en la morbimortalidad.

Palabras clave: Fractura de cadera; anemia; ASA; estancia hospitalaria; morbilidad; mortalidad.

Nivel de Evidencia: IV

Received on April 1st, 2021. Accepted after evaluation on August 3rd, 2021 • Dr. GERMÁN GARABANO • ggarabano@gmail.com https://orcid.org/0000-0001-5936-0607

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INTRODUCTION

Hip fractures are associated with a considerable increase in morbidity, mortality, and financial burdens for both patients and health systems.[1,2] In multiple studies, different variables associated with this impact have been identified, among them, preoperative (age, sex, comorbidities, functional status, etc.), intraoperative (duration of surgery, type of treatment, etc.) and postoperative (hospital stay, transfusions, restoration of gait, etc.) variables.[1,3-5]

In the first part of the report prepared by this Committee, a descriptive analysis of the results of 1000 surveys on hip fractures was presented.[6] As distinctive data of that report, it was observed that fractures predominated markedly in the female sex (2.7:1) and that 80% were >70 years old. On the other hand, there was no predominance between medial and lateral fractures. Regarding comorbidities, about 50% had anemia (Hb <11 mg/dl) and more than 42%, a high-risk ASA (*American Society of Anaesthesiologists*) score (III-IV). 45% of patients underwent surgery within five days after admission and less than 21% had a hospital stay of less than six days. The rate of complications recorded was close to 12%, the mortality rate was 4%, and the minimum follow-up was 4 months.[6]

The objective of this study was to identify those variables that were significantly related to the appearance of complications and death after treatment of a hip fracture.

MATERIALS AND METHODS

The data analyzed in this study emerged from the survey on hip fractures, available in the section of the Morbidity and Mortality Committee of the *Asociación Argentina de Ortopedia y Traumatología* (https://aaot.org.ar/certificacion/comite-de-morbi-mortalidad/). The survey was jointly designed by the *Asociación Argentina de Ortopedia y Traumatología*, the *Asociación Argentina de Trauma Ortopédico* and the *Asociación Argentina para el Estudio de la Cadera y la Rodilla.*

To analyze morbidity and mortality related to hip fractures, the survey evaluates preoperative variables (age; sex; type of gait: with or without aid, intradomiciliary or extradomiciliary; whether the patient lives alone or not; whether the patient lives at home or in an institution; hemoglobin and hematocrit values), surgical variables (waiting time for surgery, type of fracture, type of treatment: internal fixation or arthroplasty, antibiotic and antithrombotic prophylaxis, total days of hospitalization) and postoperative variables (hemoglobin and hematocrit values, red blood cell transfusions, use of drainage, rehabilitation). Complication and mortality rates were also analyzed.

The analysis was performed after the recording of the first 1000 responses, which comprised a period between January 2015 and December 2019. 59.7% of the responses came from the public health system and 40.3% from the private sector, 34 institutions in different regions of the country.

Statistical analysis

Continuous variables were summarized as mean and standard deviation, and categorical variables as frequency and percentage. We used Student's t-test to compare continuous variables between groups of patients with or without complications, and who died or not, and the chi-squared test to analyze the association between categorical variables; where the assumptions for applying that test were not met, Fisher's test was used.

To analyze whether any of the variables analyzed influenced the possibility of suffering a complication or dying, a logistic regression model was applied. The results of logistic regression are presented in terms of odds ratios (OR) for significant variables.

For all statistical conclusions, a significance level of 5% was used. The analysis was performed with the statistical program R.

RESULTS

Complications

The overall complication rate recorded was 12.2%, but, when excluding cases that had incomplete records of any of the variables analyzed, the resulting percentage was 16.45% (103/626). The types of complications are detailed in Table 1.

Table 1. Detail of the type and incidence of complications

Complication	Incidence (%)
Infection	7.3
Superficial	3.5
Deep	3.8
Dislocation	3.8
Intraoperative fracture	0.8
DVT/PTE	2

DVT = deep vein thrombosis, PTE = pulmonary thromboembolism.

Regarding the variables that were related to the development of postoperative complications, in general, we could observe a significant relationship with preoperative hemoglobin values (Figure 1), anemia, delay in treatment (days elapsed from diagnosis to treatment), increased days of hospitalization and red blood cell transfusions (Table 2).

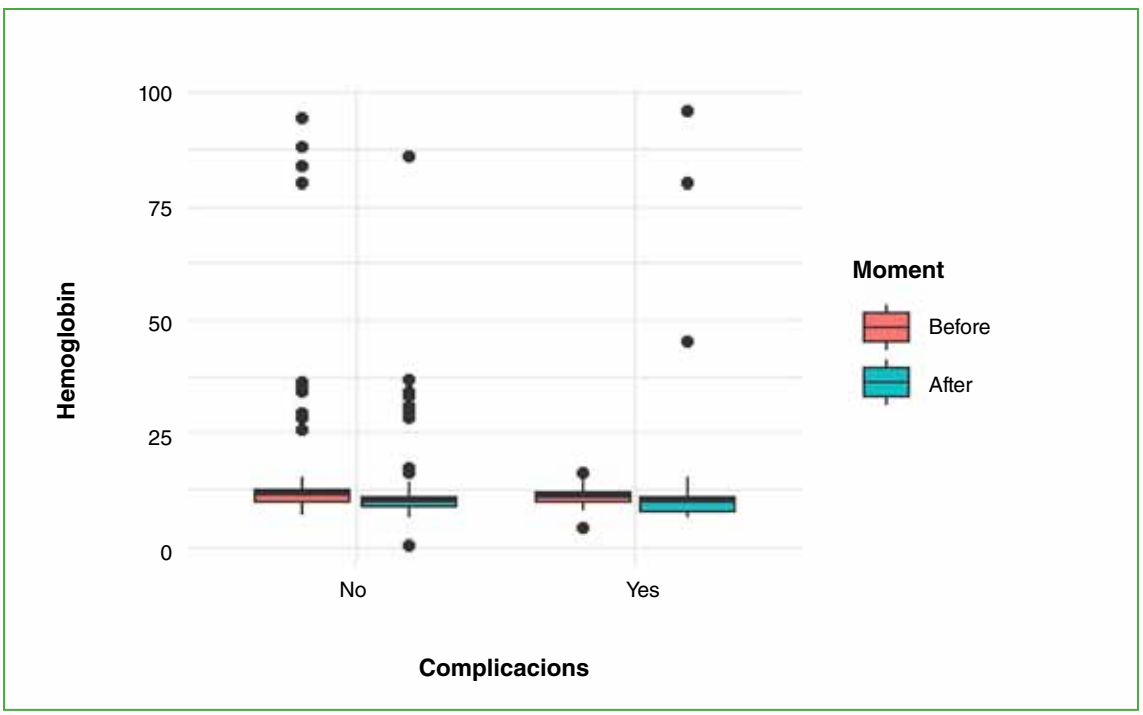

Figure 1. Distribution of preoperative and postoperative hemoglobin values according to complications.

Table 2. Characteristics of patients according to complication

	Without complications (n = 523)	With complications (n = 103)	p	Total (n = 827)
Sex				
Female	396 (75.7%)	77 (74.8%)	0.935	620 (75.0%)
Male	127 (24.3%)	26 (25.2%)		207 (25.0%)
Age group (years)				
<40	12 (2.3%)	1 (1.0%)	0.358	23 (2.8%)
41-60	25 (4.8%)	7 (6.8%)		48 (5.8%)
61-70	67 (12.8%)	9 (8.7%)		94 (11.4%)
71-80	157 (30.0%)	26 (25.2%)		235 (28.4%)
>80	262 (50.1%)	60 (58.3%)		427 (51.6%)
Fracture				
Lateral	276 (52.8%)	51 (49.5%)	0.6191	436 (52.7%)
Medial	247 (47.2%)	52 (50.5%)		391 (47.3%)
Preoperative hematocrit level				
Mean (SD)	33.0 (6.01)	32.4 (4.77)	0.101	33.3 (5.89)
Median [C1, C3]	33.0 [30.0; 36.4]	32.0 [29.0; 35.0]		33.0 [30.0; 37.0]
Preoperative hemoglobin level				
Mean (SD)	11.8 (5.09)	10.9 (1.85)	0.0119	11.7 (5.21)
Median [C1, C3]	11.5 [10.1; 12.5]	11.0 [9.65; 12.0]		11.3 [10.0; 12.5]
NR	30 (5.7%)	15 (14.6%)		82 (9.9%)
Preoperative anemia				
Yes	222 (45%)	50 (56.8%)	0.0452	372 (47.8%)
NR	30 (5.7%)	15 (14.6%)		45 (7.2%)
Time from diagnosis to treatment				
0-6 days	190 (36.3%)	29 (28.2%)	0.0225	250 (30.2%)
6-11 days	137 (26.2%)	35 (34.0%)		245 (29.6%)
11-21 days	124 (23.7%)	17 (16.5%)		187 (22.6%)
21-31 days	41 (7.8%)	12 (11.7%)		71 (8.6%)
More than 31 days	11 (2.1%)	6 (5.8%)		24 (2.9%)
NR	20 (3.8%)	4 (3.9%)		50 (6.0%)
Total hospitalization time				
0-6 days	157 (30.0%)	17 (16.5%)	0.0123	193 (23.3%)
6-11 days	156 (29.8%)	32 (31.1%)		253 (30.6%)
11-21 days	148 (28.3%)	33 (32.0%)		237 (28.7%)
21-31 days	31 (5.9%)	8 (7.8%)		60 (7.3%)
More than 31 days	9 (1.7%)	6 (5.8%)		23 (2.8%)
NR	22 (4.2%)	7 (6.8%)		61 (7.4%)
Osteosynthesis				
National	246 (47.0%)	54 (52.4%)	0.196	431 (52.1%)
Imported	47 (9.0%)	5 (4.9%)		62 (7.5%)
NR	230 (44.0%)	44 (42.7%)		334 (40.4%)
Drainage				
No	359 (68.6%)	62 (60.2%)	0.134	543 (65.7%)
Yes	148 (28.3%)	37 (35.9%)		257 (31.1%)
NR	16 (3.1%)	4 (3.9%)		27 (3.3%)
Red blood cell transfusions				
No	341 (65.2%)	51 (49.5%)	<0.001	525 (63.5%)
Yes	141 (27.0%)	46 (44.7%)		221 (26.7%)
NR	41 (7.8%)	6 (5.8%)		81 (9.8%)
ASA Score				
I and II	305 (58.3%)	54 (52.4%)	0.255	431 (52.1%)
III and IV	188 (35.9%)	44 (42.7%)		328 (39.7%)
NR	30 (5.7%)	5 (4.9%)		68 (8.2%)

SD = standard deviation, NR = not recorded.

When analyzing the complications with the treatment received, no significant differences were observed between the different types of osteosynthesis, nor between the different types of arthroplasties. Although complications were greater in patients treated with arthroplasty, the difference compared to those undergoing osteosynthesis was also not significant (Table 3).

Table 3. Type of treatment and its relationship to complications

Treatment	Without complications	With complications	p
Osteosynthesis (n = 307)	**260**	**47**	0.44
Cannulated screws	37 (12.0)	4 (1.3)	
Cephalomedullary nail	154 (50.2)	32 (10.4)	
Sliding screw plate	69 (22.5)	11 (3.6)	
Arthroplasty (n = 319)	**263**	**56**	0.58
Unipolar	39 (12.2)	9 (2.8)	
Bipolar	101 (31.7)	25 (7.8)	
Total replacement	123 (38.5)	22 (6.9)	
Osteosynthesis vs. arthroplasty (n = 626)	**523**	**103**	0.45
Osteosynthesis	260 (41.5)	47 (7.5)	
Arthroplasty	263 (42.0)	56 (8.9)	

When each of the complications was specifically evaluated, we observed a significant association between infection and intraoperative fracture and age. Infections were significantly more frequent in patients >80 years (p 0.021) and intraoperative fractures in those >71 years (p 0.015). These fractures occurred in the arthroplasty group.

The multivariate regression analysis recognized preoperative anemia and total days of hospitalization as independent variables for the development of complications after a hip fracture (Table 4).

Table 4. Independent risk variables related to complications

	OR	CI95%
Preoperative hemoglobin level	0.8799	0.76-0.99
Preoperative anemia (Yes vs. No)	1.61	1.02-2.55
Total days of hospitalization (>15 vs. <11 days)	4.623	1.22-16.20
Time from diagnosis to treatment	1.09	0.39-2.75
Total hospitalization time	1.81	0.70-5.52
Red blood cell transfusions	1.04	0.98-3.58

OR = odds ratio, 95%CI = 95% confidence interval.

The risk of suffering a complication almost quintuples with the increase in hospitalization days and is 61% higher if the patient is anemic. In this sense, the risk decreased by 12% when hemoglobin increased in a single unit, configuring a protective effect.

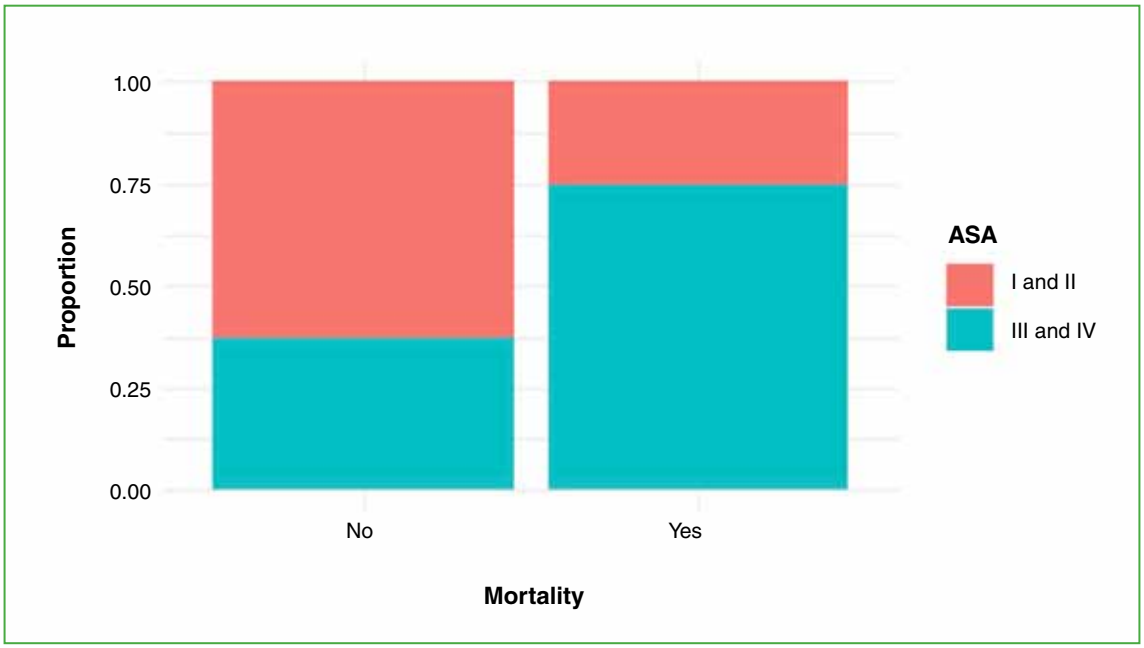

Figure 2. Proportions of patients with a low-risk (I and II) and high-risk (III and IV) ASA score, according to mortality.

Mortality

The recorded mortality rate was 1.2% at 30 days, while the overall rate was 3.92% (estimated at least 4 months after surgery). Death was found to be related to preoperative anemia, red blood cell transfusions, total days of hospitalization, and ASA score (Figure 2, Table 5).

On the other hand, the presence of complications was another variable that significantly affected the mortality rate (p 0.003). 0.8% of patients without complications and 19% of those who suffered complications died.

When the different treatments were analyzed, there were no differences between the different types of osteosynthesis. Differences were found between the different types of arthroplasties (p 0.005). Unipolar and bipolar replacements showed a significant difference compared to total replacements (Table 6.) When comparing osteosynthesis treatment and prosthetic treatment, there were no significant differences between the two.

The multivariate analysis revealed that the variables that significantly influenced death were preoperative anemia and ASA score. The chance of dying triples when the patient is anemic before surgery and is about 3.5 times higher with an ASA score III or IV than with an I or II score. Preoperative hemoglobin values had a protective effect on death (38% lower when hemoglobin increased 1 unit) (Table 7).

Table 5. Patient characteristics (deceased vs. alive)

	Alive (n = 612)	Deceased (n = 25)	p	Total (n = 637)
Sex				
Female	467 (76.3%)	17 (68.0%)	0.475	484 (76.0%)
Male	145 (23.7%)	8 (32.0%)		153 (24.0%)
Age group				
<40	12 (2.0%)	0 (0%)	0.3858	12 (1.9%)
41-60	32 (5.2%)	2 (8.0%)		34 (5.3%)
61-70	73 (11.9%)	2 (8.0%)		75 (11.8%)
71-80	184 (30.1%)	4 (16.0%)		188 (29.5%)
>80	311 (50.8%)	17 (68.0%)		328 (51.5%)
Fracture				
Lateral	324 (52.9%)	12 (48.0%)	0.7789	336 (52.7%)
Medial	288 (47.1%)	13 (52.0%)		301 (47.3%)
Preoperative hematocrit level				
Mean (SD)	33.1 (4.95)	31.9 (4.93)	0.093	33.0 (4.95)
Median [IQR]	33.0 [29.9; 36.5]	32.0 [28.0; 34.0]		33.0 [29.8; 36.0]
Preoperative hemoglobin level				
Mean (SD)	11.7 (4.74)	9.96 (1.87)	<0.001	11.7 (4.61)
Median [IQR]	11.5 [10.1; 12.5]	10.0 [9.08; 11.2]		11.3 [10.0; 12.5]
NR	61 (10.0)	3 (12.0)		64 (9.9%)
Anemia				
Yes	247 (40.7%)	16 (64.0%)	0.0184	310 (48.7%)
NR	61 (10.0%)	3 (12.0%)		64 (10%)
Time from diagnosis to treatment				
0-6 days	216 (35.3%)	5 (20.0%)	0.2602	221 (34.7%)
6-11 days	152 (24.8%)	6 (24.0%)		158 (24.8%)
11-21 days	136 (22.2%)	9 (36.0%)		145 (22.8%)
21-31 days	50 (8.2%)	3 (12.0%)		53 (8.3%)
More than 31 days	17 (2.8%)	1 (4.0%)		18 (2.9%)
NR	41 (6.7%)	1 (4.0%)		42 (6.6%)
Total hospitalization time				
0-6 days	176 (28.8%)	1 (4.0%)	0.0009	177 (27.8%)
6-11 days	186 (30.4%)	8 (32.0%)		194 (30.6%)
11-21 days	158 (25.8%)	6 (24.0%)		164 (25.7%)
21-31 days	36 (5.9%)	4 (16.0%)		40 (6.3%)
More than 31 days	12 (2.0%)	3 (12.0%)		15 (2.4%)
NR	44 (7.2%)	3 (12.0%)		47 (7.4%)
Osteosynthesis				
National	287 (46.9%)	11 (44.0%)	0.465	431 (52.1%)
Imported	52 (8.5%)	3 (12.0%)		62 (7.5%)
NR	273 (44.6%)	11 (44.0%)		334 (40.4%)
ASA Score				
I and II	353 (57.7%)	7 (28.0%)	0.00177	360 (56.5%)
III and IV	207 (33.8%)	17 (68.0%)		224 (35.2%)
NR	52 (8.5%)	1 (4.0%)		52 (8.2%)
Drainage				
No	416 (68.0%)	13 (52.0%)	0.383	429 (67.3%)
Yes	177 (28.9%)	9 (36.0%)		186 (29.2%)
NR	19 (3.1%)	3 (12.0%)		22 (3.5%)
Red blood cell transfusion				
No	392 (64.1%)	7 (28.0%)	<0.001	399 (62.6%)
Yes	177 (28.9%)	16 (64.0%)		193 (30.3%)
NR	43 (7.0%)	2 (8.0%)		45 (7.1%)

SD = standard deviation, IQR = interquartile range, NR = not recorded.

Table 6. Death by type of treatment

Treatment	Alive	Deceased	p
Osteosynthesis (n = 310)	**298**	**12**	0.17
Cannulated screw	43 (13.8)	0	
Cephalomedullary nail	185 (59.7)	6 (1.9)	
Sliding screw plate	70 (22.6)	6 (1.9)	
Arthroplasty (n = 327)	**314**	**13**	0.005
Unipolar	41 (12.5)	5 (1.5)	
Bipolar	127 (38.8)	7 (2.1)	
Total replacement	146 (44.6)	1 (0.3)	
Osteosynthesis vs. arthroplasty (n = 637)	**612**	**25**	0.94
Osteosynthesis	310 (48.7)	12 (1.8)	
Arthroplasty	327 (51.3)	13 (2.0)	

Table 7. Independent variables related to death

	OR	CI95%
Preoperative hemoglobin level	0.62	0.48-0.80
Preoperative anemia	3.07	1.23-8.70
Total hospitalization time	2.20	0.30-5.96
ASA Score (III and IV vs. I and II)	3.49	1.42-9.43
Red blood cell transfusions	1.51	0.87-2.64

OR = odds ratio, 95%CI = 95% confidence interval.

DISCUSSION

The main findings of this analysis were that the development of postoperative complications following a hip fracture was associated with preoperative anemia, delay in treatment, increased days of hospitalization, red blood cell transfusions, and age (the latter only in the case of infections and intraoperative fractures). Anemia and prolonged hospitalization were the independent variables that had a greater association with complications.

An association was found between death and preoperative hemoglobin, preoperative anemia, total days of hospitalization, ASA score, red blood cell transfusions, type of arthroplasty, and complications. But the independent variables identified to be associated with death were preoperative anemia and ASA score III or IV.

Perioperative anemia is common in patients with hip fracture, especially older adults. The reported incidence varies between 24% and 44%, and up to 84% if only postoperative levels are considered.[7-9] As in this report, where this variable was associated with an increased risk of developing postoperative complications and death, other studies also link it to an increase in postoperative complications, days of hospitalization, and readmission and mortality rates.[7,8]

Ryan et al.[9] analyzed 34,805 patients with hip fracture and 65% had anemia upon admission, this was associated with an increased risk of death and readmission.

Arshi et al.[10] analyzed 8416 patients with hip fracture and also linked anemia and postoperative transfusions with an increase in days of hospitalization and mortality rate at 30 days.

In this analysis, the other independent variable that was associated with an increase in postoperative complications was prolonged hospitalization. This can be analyzed from several points of view. On the one hand, the delay in treatment which, although significant in the univariate analysis, was not identified as an independent risk variable. We understand that both variables are related and dependent on each other, especially if we observe that, in our analysis, only a third of the patients underwent surgery within six days of hospitalization.

While the impact of a delay in surgery has not been consistently demonstrated, several studies agree that fractures should be treated within 48 hours of admission to decrease morbidity and mortality.[11-15] This is an ideal that is difficult to achieve in most healthcare centers in our country for reasons beyond the analysis of this report.

In this study, the most frequent complication was postoperative infection (7.3%). In a systematic review of the literature, Noailles et al.[16] reported an incidence of surgical site infection following prosthetic treatment of a hip fracture of 1.7-7.3%. In addition, these authors concluded that this rate was related to preoperative comorbidities (obesity, liver disease, advanced age), intraoperative variables (surgery time, uncemented stems) and postoperative variables (prolonged hospitalization, hematoma at the surgical site, prolonged wound drainage, and more than one bladder catheterization).

Liu et al.[17] published a rate of superficial infections of 7.58% and a rate of deep infections of 1.45% in 1240 patients with hip fracture. In their study, the risk variables were: age >79 years, body mass index >26.6, prolonged surgery (>107 min) and hypoproteinemia. In another similar study of 692 patients, Ji et al.[18] reported a link between infections, anemia, and diabetes.

In our analysis, infection was directly associated with age, but we can also relate it to anemia, since this was one of the independent variables that increased the risk of complications. On the other hand, the difference in transfusion rates between patients with complications and without complications was significant. Multiple studies have linked transfusions to postoperative infections and prolonged hospitalization, and the results of our analysis match this.[8,10]

Regarding death after a hip fracture, after analyzing 14,932 patients, the Swedish registry obtained a mortality rate of 8.2% at 30 days and 23.6% at one year after surgery. In the aforementioned study, the predictive variables identified were age, male sex, and a >II ASA score.[11] Our analysis did not identify age or sex as variables affecting the mortality rate. However, there was a correlation with the ASA scores. Although this score was originally conceived as a predictive factor of perioperative anesthetic risk, different studies have shown its usefulness as a marker of postoperative morbidity and mortality in several conditions, for example, hip fractures.[1,5,11]

In another study with about 140,000 patients, it was reported that those with femoral neck fracture treated with arthroplasty, >80 years, and with a Charlson comorbidity index >2 had an increased risk of death at 90 days after surgery.[5]

In a study that evaluated exclusively intertrochanteric fractures, the mortality rate was 5.3% at 30 days after surgery and 14.4% after a year.[19]

The predictive factors of death found in this analysis coincided with those of the international literature. The mortality rate recorded in this study was relatively low. One possible explanation could be an underreporting of deaths, although as the data came from surveys, it is difficult to establish the cause.

To our knowledge, this is the first study to assess both complications and mortality rate in a significant number of patients in our field. As it covers a large number of sites and provinces of our country, it could be taken as a reference for future studies.

The limitations of this report are those of a study in which the data collected come from different centers and it is not possible to establish whether the information provided represents all patients treated or only a fraction of them. This could lead to a bias in the recording of both complications and deaths. Another limitation, a consequence of the design of the survey, is the impossibility of categorizing, in a reliable way, the complications according to the classifications designed for this purpose (Clavien-Dindo).

CONCLUSIONS

This report identified anemia as an independent variable of risk of developing complications and death after surgery, following a hip fracture. The other independent variable related to postoperative complications was prolonged hospitalization. ASA scores III and IV were the other variable associated with increased risk of death. This suggests the importance of improving, as far as possible, the clinical conditions of patients suffering from a hip fracture, perhaps with a multidisciplinary care team. On the other hand, it is fundamental to evaluate how to improve the conditions of the health system to facilitate the treatment of this condition and articulate the postoperative management in order to reduce prolonged hospitalizations that could be avoided.

Conflict of interests: The authors declare they do not have any conflict of interests.

H. Simesen de Bielke ORCID ID: https://orcid.org/0000-0003-2922-1440
A. Cubecino ORCID ID: https://orcid.org/0000-0002-8955-6595
N. A. Robador ORCID ID: https://orcid.org/0000-0002-2683-6725
J. Olivetto ORCID ID: https://orcid.org/0000-0001-9445-0704
D. Gamarra ORCID ID: https://orcid.org/0000-0001-7661-850X
M. N. Sierto ORCID ID: https://orcid.org/0000-0003-3330-0360
M. L. Beltramino ORCID ID: https://orcid.org/0000-0001-5061-1932

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