General

Extracapsular femoral neck fractures treated with total hip arthroplasty: identification of a population with better outcomes

Giuseppe Toro[1], Enrico Pola[1], Roberta Miranda[1], Michele Conte[2], Adriano Braile[1] [a], Raffaele Pezzella[3], Annalisa De Cicco[1], Salvatore D'auria[4], Antonio Piscopo[4], Alfredo Schiavone Panni[1]

[1] Department of Medical and Surgical Specialties and Dentistry, University of Campania "Luigi Vanvitelli", [2] Department of Medical and Surgical Specialties and Dentistry, University of Campania "Luigi Vanvitelli"; Unit of Orthopaedics and Traumatology, Ospedale Sacro Cuore di Gesù Fatebenefratelli, [3] Unit of Orthopaedics and Traumatology, AORN San Giuseppe Moscati, [4] Unit of Orthopaedics and Traumatology, Ospedale Sacro Cuore di Gesù Fatebenefratelli

Keywords: femoral neck fractures, extracapsular fracture, intertrochanteric fractures, unstable fractures, total hip arthroplasty, outcomes

https://doi.org/10.52965/001c.38576

Orthopedic Reviews

Vol. 14, Issue 6, 2022

Background

Femoral neck fractures (FNF) are associated to patient's disability, reduced quality of life and mortality. None of the fixation devices commonly used for extracapsular (EC) FNF (i.e., dynamic hip screws (DHS) and intramedullary nails (IN)) is clearly superior to the other, especially in case of unstable fractures (31.A2 and 31.A3 according to AO/OTA classification). The aim of our study was to identify a sub-population of patients with EC fractures in which better outcomes could be obtainable using total hip arthroplasty (THA).

Methods

All patients with EC unstable fractures treated with THA were included in the present study. Demographic data, American Society of Anesthesiologists (ASA) score, hospitalization length, transfusion rate, implant-related complications and mortality rate were collected. Clinical outcomes were evaluated using the Oxford Hip Score (OHS), while patients' general health status through the 12 Item Short Form questionnaires (SF-12).

Results

30 patients (7 male; 23 female) with a mean age of 78.8 years were included. The 1-year mortality rate was 13.3%. The mean OHS was 27.5, while the mean SF-12 were 45.84 for the mental item and 41.6 for the physical one. Age was the only factor associated with the OHS and patients older than 75 years presented a 12- fold higher risk of developing bad outcomes.

Conclusions

THA seems to be a viable option for unstable EC fractures, with good clinical outcomes, especially in patients younger than 75 years of age. The mortality rate associated with THA in EC fractures is low and anyway comparable with IN.

BACKGROUND

Femoral neck fractures (FNF) are the most common fragility fractures , involving around 1.5 million people worldwide every year.[1,2] These fractures are a relevant public health issue because of a high risk of patients' disability, reduced quality of life and mortality. The expected rise of the incidence of hip fractures will be up to 6.25 million in 2050,[3] so a great effort has been made to improve their management and reduce both the morbidity and mortality rates.[4,5]

a **Corresponding author:**
Adriano Braile, MD
Department of Medical and Surgical Specialties and Dentistry, University of Campania "Luigi Vanvitelli"
Via L. De Crecchio, 4. 80138 Naples, Italy
E-Mail: adriano.braile@hotmail.it

FNF are generally classified in 'intracapsular' (IC) and 'extracapsular' (EC), depending on the anatomical localization. These two types widely differ in terms of etiopathology, treatment and outcomes.[6] In fact, while IC fragility fractures are treated using hip replacement, the EC through osteosynthesis. However, none of the fixation devices commonly used [i.e., dynamic hip screws (DHS) and intramedullary nails (IN)] are clearly superior to the others, and the choice between them is generally based on the classification of EC fractures. According to the AO/OTA, EC fractures could be divided into stable (31A1.1 - 31A2.1) and unstable (31A2.2 - 31A3.3).[7] The American Academy of Orthopedic Surgeons (AAOS) recommends the use of both DHS and IN for stable EC fractures, while only IN for the unstable ones.[8] However, in this latter, both types of fixation devices were associated to a high risk of failure with the need of a subsequent hip replacement.[1,9] Total hip arthroplasty (THA) after a failed osteosynthesis was associated to worse outcomes,[10] and therefore a proper patient selection should be desirable, considering that this frailty population very often could not afford a secondary procedure. Therefore, the use of THA as a primary treatment for EC fractures had been proposed by several authors with viable outcomes.[11,12] However, THA in EC fractures are not complication free, and a high risk of both mechanical (i.e. dislocation) and local complications (i.e. wound infection) had been reported.[13] In order to better clarify the possible indication of THA in EC fractures we conducted a retrospective study to identify a sub-population in which better outcomes could be achievable.

METHODS

We conducted a retrospective study including all patients with unstable EC fractures (AO/OTA classification type 31A2 and 31A3) treated with THA between January 2019 and December 2019. All patients with less than 1 year of follow-up and who were unable to walk prior the fracture, were excluded. Demographic data, American Society of Anesthesiologists (ASA) score, hospitalization length, transfusion rate, implant-related complications and mortality rate were collected. All patients were treated using an uncemented, cylindrical, modular stem (Restoration modular, Stryker, Kalamazoo, MI) and an uncemented hemispherical acetabulum (Pinnacle, Johnson&Johnson, Warsaw, IN) with a constrained liner. In all patients the prosthesis was implanted through a direct lateral approach in supine position, and the greater trochanter was fixed with a metal cerclage, if needed.

Heparin and antibiotics prophylaxis were administered in all patients and assisted weight-bearing was allowed since the second day after surgery. After the discharge, all patients were seen once a week during the first month, then once a month until the 6 months, and finally every 3 months until the 12 months after the surgery. X-ray evaluations were routinely performed at 3,6 and 12 months.

Clinical outcomes were evaluated using the Oxford Hip Score (OHS), while patients' general health status through the 12 Item Short Form questionnaire (SF-12). Using the OHS value of '30' as a threshold, patients were then classified in two groups: "good outcomes" (>= 30) and "bad outcomes" (<30).[14] To evaluate the bone quality, the Canal bone ratio (CBR) was evaluated on pre-operative x-rays as previously reported.[15,16]

To find any difference between groups we evaluated the t-student test for continuous, and the Fisher's exact-test for categorical data. Finally, for those preoperative variables founded to be significatively different, the odds-ratio was calculated in order to give an evaluation of the risk for developing negative outcomes.

As routinely performed, all patients signed a written consent agreeing to undergo to the procedure and allowing to use their data for audit and scientific purposes. According to the Italian law, because the present study includes routinely performed clinical and radiological evaluations, a formal ethical approval was not required.

RESULTS

A total of 30 patients (7 male; 23 female) were included in the present study. The entire cohort data was summarized in Table 1. Twenty patients presented a fracture type 31.A2, while 10 a type 31.A3. Two patients (6.6%) died in the 30 days after the surgery, 2 others (13.3%) in the following 11 months. Therefore, the overall 1-year mortality rate was 13%. A total of 20 patients (66%) received a mean of 0.86 blood unit of transfusion, and the mean length of stay was 7.3 days. (Table 1). No implant-related complications were observed during the study period. The mean CBR was 0.5 (range 0.32-0.64). At the final follow-up the mean OHS was 27.52, the mean SF-12 was 45.84 (range 30.8-54.76) for the Mental Score (MCS) and 41.61 for the Physical Score (PCS) (see Table 1 for further details). The two investigated groups differed for age, PCS and MCS, but did not in terms of CBR, length of stay, ASA score, sex, type of fracture and blood transfusion (see table 2). The Odds-Ratio between OHS (<30) and age (> 75) was 12.00.

DISCUSSION

The main purpose of this study was to investigate on the factors that may affect clinical outcomes of patients with unstable EC fractures (AO/OTA 31.A2 – 31.A3) treated with uncemented THA, in order to identify a population that could benefit more from this procedure. In fact, generally EC fractures are treated with internal fixation devices such as IN and DHS. However, none of these absolutely ensure a fracture stability and a viable consolidation in unstable EC fractures, with unpredictable outcomes especially in patients with severe osteoporosis and concomitant hip osteoarthritis (HO).[12,17,18] Moreover, these factors and the intrinsic fracture instability were reported to be associated to the unsatisfactory results reported with internal fixation.[19–21] Considering also the high failure and the complications rates reported with both IN and DHS, hip replacement has been recommended by some authors as a primary treatment for unstable EC fractures.[22–24] Good outcomes were reported using cemented hemiarthroplasty.[25–27] Par-

Table 1. Patients' demographics.

N° of patients	*30*
Age, Mean (Range)	*78.8 (66-92)*
Sex	
Male	*7*
Female	*23*
LOS, Days (range)	*7.3 (6-8)*
Trasfusion	
Yes	*20*
No	*10*
Mean (range)	*0.9 (0-2)*
Type of fracture	
31-A2	*20*
31-A3	*10*
OHS, mean (range)	*27.52 (13-34)*
SF-12 Mental Score, mean (range)	*45.84 (30.8-54.76)*
SF-12 Physical Score, mean (range)	*41.61 (20.95-50.91)*
CBR score, mean (range)	*0.5 (0.64-0.32)*

OHS: Oxford hip score. **SF-12:** 12-Item Short Form Survey. **CBR:** Cortical bone ratio. **LOS:** Length of stay

ticularly, Stappaerts et al. in a randomized prospective study, comparing cemented endoprosthesis with DHS, observed that the former were associated to better results in terms of reoperation rate, and proposed them for the treatment of older patients.[27] Similar results were also reported by, Blomfeldt et al.[28] comparing THA with internal fixation after a minimum of 4 years of follow up. The earlier rehabilitation of patients with unstable EC fractures was reported by Parvjeet et al. in their case-control study comparing THA with IN.[25] According to the authors, THA was associated to immediate weight-bearing and early lower limbs mobilization and strengthening exercises, reducing thus the bedtime and the relative complications rate.[25] In fact, as reported by Haentjens et al., the incidence of bedsores, lung infections and atelectasis was lower in patients with EC fractures treated with THA compared to internal fixation.[29] These observations might promote the use of THA in elderly patients with severe osteoporosis.[25] All patients in the present study were encouraged to mobilize the joints and strength the muscles of the affected limb since the first day after the surgery, while the weight-bearing was allowed since the second. The possibility of an early rehabilitation in FNF is essential to reduce immobilization-related complications, like the impairment in daily activities and the high mortality.[30]

While the 30-day mortality rate of surgically treated FNF was reported to be approximatively 5%,[31,32] the one-year vary between 16.6% and 26.4%, depending on the studied population.[30,31] In fact, patients with EC fractures may have a shorter survival time.[33] Mattison et al. in a register-based study on over 10,548 patients with EC fractures, reported a at 30-day mortality of 7.7% and a one year mortality of 26% , with most of patients treated with internal fixation devices (10,416/10,548).[1]

In our study the 30-day mortality rate was 6.6%, while the 1-year was 13.3%. These results were approximatively in line with those reported by of other authors who investigated on THA in FNF. Particularly, Parvizi et al. demonstrated a 30-days mortality of 4.8%, observing that females over 70 years of age were at higher risk.[34] Similarly, in our cohort the deaths were observed among the most elderly females (mean age 83.5 years), with an ASA score of at least 3.

Although these observations might promote the use of THA also in EC features, the mortality rate was similar to that reported with the use of IN. In fact, Bonnevialle et al.[35] in a study on 247 patients with unstable EC fracture, observed a comparable mortality rate at 6 months of follow-up in both THA and IN (21% vs 21,2% respectively). These results were lately confirmed in the meta-analysis conducted by Ju et al.[13] Interestingly, these authors underlined that although the use of THA was associated to a shorter bedtime and a reduced implant-related complications rate compared to IN, there were no advantages in terms of hip function.[13] In our opinion, these observations further underline the need of better identify those patients with EC fracturs that benefits more from a THA. With this perspective, we compared patients with "good outcomes" and those with "bad outcomes", based on the results of the OHS. The mean OHS reported in our population was 27.52, representing with a better result to that reported in a similar population,[36] but extremely worse to that achievable in elderly patients treated with uncemented THA for primary HO.[15] Some authors correlated the "Activities of Daily Living Skills" to the osteoporosis, showing that the former became worse as the osteoporosis severity increased.[37,38] In our study, "good outcomes" and "bad outcomes" groups did not differ in terms of both ASA score and severity of osteoporosis, and the only variable associated with "bad outcomes" was patients' age. Particularly, patients over 75 years of age presented a 12-fold-higher risk of developing a low OHS (namely a worse hip function). These results contrasted with those reported by Toro et al., on 411 patients who underwent to TH A for primary HO. In their series, the authors reported that both the ASA and the CBR,not the age were associated with the OHS, while the age did not.[15] The difference is not surprising. In fact, FNF patients and those with primary HO are very different. For example, patients with FNF (as well as those with periprosthetic ones), are more fragile than those with primary HO, presenting more comorbidities and a more severe osteoporosis.[15,39] The reason why in our study patient's age has a such impact on hip function is unclear. It could be assumed that patients with less than 75 years of age presented both a better mobility, and general health status prior the FNF; and these factors might improve their recoverability. In fact, in the study conducted by Diurez et al., the functional results of EC fractures were related to the patients' health condition prior the surgery.[40]

Interestingly, in our study fracture type had no rule in determining the outcomes of EC fractures treated with

Table 2. Main differences between groups.

	OHS >=30	*OHS<30*	*P-value*
Number	*12*	*14*	
Age (mean)	*74.33*	*81.07*	*0.0061*
Sex			
M	*2*	*3*	*1*
F	*10*	*11*	
SF-12 mental score (mean)	*49.63*	*42.59*	*0.0009*
SF-12 physical score (mean)	*48.08*	*36.07*	*0.0138*
CBR (mean)	*0.52*	*0.52*	*1*
LOS (mean)	*7.42*	*7.21*	*0.48*
ASA (mean)	*2.83*	*2.79*	*0.8*
Type of fracture			
31 A.2	*8*	*9*	*1*
31 A.3	*4*	*5*	
Blood Transfusion			
Yes	*8*	*8*	*0.75*
No	*4*	*6*	

OHS: Oxford hip score. **SF-12:** 12-Item Short Form Survey. **CBR:** Cortical bone ratio. **LOS:** Length of stay. **ASA:** American Society of Anesthesiologists score.

THA. However, according to Fichman et al., 31.A3 fractures might be those who most benefit from THA, because of the lower major complication and reoperation rates compared to IN.[36]

Finally, the patient's quality of life in the "good outcomes" group was better for both the mental and physical status, and the mean results were better to that previously reported.[36] This is not surprising, considering that a linear association between the OHS and the SF-12 items could be observed. In our opinion, these results further underline the need for a proper patient's selection in order to improve their outcomes.

Our study has some limitations, related to its retrospective nature, that could lead to selection bias, and to the small sample size, that might underpowered the statistics. However, our findings might aid in better understanding the outcomes and indications of THA in unstable EC fractures. Moreover, this could help in the design of a randomized controlled trial for the treatment of these fractures. Another limitation could be the short follow-up, that might underestimate the implant-related complication rate (i.e., periprosthetic fractures or implant loosening). However, considering the high 1-year mortality rate of FNF and the subsequent high risk of drop-off, our study was specifically designed to assess the viability of THA in a short-term follow-up.

CONCLUSIONS

THA seems to be a viable option for unstable EC fractures, with good clinical outcomes, especially in patients younger than 75 years of age. The mortality rate associated with THA in EC fractures is low and anyway comparable with IN. These latter were reported to be associated to both a higher reoperation and complication rate, especially in case of 31.A3 fractures. Therefore, these fractures might be more appropriately treated with THA. The results included in the present study might be useful to design larger randomized controlled trials with longer follow-up to confirm the viability of THA in EC fracturs.

ABBREVIATIONS

FNF: Femoral neck fractures; IC: intracapsular; EC: extracapsular; DHS: dynamic hip screws; IN: intramedullary nails; AO/OTA: Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association; THA: Total hip arthroplasty; AAOS: American Academy of Orthopedic Surgeons; ASA: American Society of Anesthesiologists; OHS: Oxford Hip Score; SF-12: 12-Item Short Form questionnaires; CBR: Canal bone ratio; MCS: SF-12 Mental Score; PCS: SF-12 Physical Score; HO: hip osteoarthritis.

ACKNOWLEDGMENTS

None.

AUTHORS' CONTRIBUTION

GT, MC, AB, and ASP conceived the study. MC, RM,ADC, and RP collected data. RP, AB, and GT performed the statistical analysis. EP, SD, AP, and GT analyzed and interpreted the collected data. AB, ADC and MC wrote the first draft of the manuscript. ASP supervised the entire study. All authors red and approved the final version of the paper before submission.

CONFLICT OF INTERESTS

The authors declare no potential conflict of interest.

FUNDING

The authors received no financial support for the research and/or authorship of this article.

ETHICAL APPROVAL

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

INFORMED CONSENT

Informed consent was obtained from all individual participants included in the study.

REFERENCES

1. Mattisson L, Bojan A, Enocson A. Epidemiology, treatment and mortality of trochanteric and subtrochanteric hip fractures: data from the Swedish fracture register. *BMC Musculoskelet Disord*. 2018;19(1):369. doi:10.1186/s12891-018-2276-3

2. Cooper C, Cole ZA, Holroyd CR, et al. Secular trends in the incidence of hip and other osteoporotic fractures. *Osteoporos Int*. 2011;22(5):1277-1288. doi:10.1007/s00198-011-1601-6

3. Gullberg B, Johnell O, Kanis JA. World-wide Projections for Hip Fracture. *Osteoporos Int*. 1997;7(5):407-413. doi:10.1007/pl00004148

4. Matsuo M, Yamagami T, Higuchi A. Impact of age on postoperative complication rates among elderly patients with hip fracture: a retrospective matched study. *J Anesth*. 2018;32(3):452-456. doi:10.1007/s00540-018-2494-8

5. Tarantino U, Iolascon G, Cianferotti L, et al. Clinical guidelines for the prevention and treatment of osteoporosis: summary statements and recommendations from the Italian Society for Orthopaedics and Traumatology. *J Orthop Traumatol*. 2017;18(S1):3-36. doi:10.1007/s10195-017-0474-7

6. Toro G, Lepore F, Cicala SD, Concilio P, Calabrò G, Toro A, et al. ABO system is not associated with proximal femoral fracture pattern in Southern Italy. *Hip Int*. 2018;282(suppl):84-88.

7. Müller ME, Koch P, Nazarian S, Schatzker J. *The Comprehensive Classification of Fractures of Long Bones*. Springer Berlin Heidelberg; 1990. doi:10.1007/978-3-642-61261-9

8. Socci AR, Casemyr NE, Leslie MP, Baumgaertner MR. Implant options for the treatment of intertrochanteric fractures of the hip: rationale, evidence, and recommendations. *The Bone & Joint Journal*. 2017;99-B:128-133.

9. Toro G, Moretti A, Ambrosio D, et al. Fractures around Trochanteric Nails: The "Vergilius Classification System." *Adv Orthop*. 2021;2021:7532583. doi:10.1155/2021/7532583

10. Yang Z, Liu H, Xie X, Tan Z, Qin T, Kang P. Total Hip Arthroplasty for Failed Internal Fixation After Femoral Neck Fracture Versus That for Acute Displaced Femoral Neck Fracture: A Comparative Study. *J Arthroplasty*. 2015;30(8):1378-1383. doi:10.1016/j.arth.2015.02.037

11. Cho SH, Cho HL, Cho H. Primary Cementless Hip Arthroplasty in Unstable Intertrochanteric Femur Fracture in Elderlys: Short-term Results. *Hip Pelvis*. 2014;26(3):157. doi:10.5371/hp.2014.26.3.157

12. Fusini F, Massè A, Risitano S, et al. Should we operate on all patients with COVID-19 and proximal femoral fractures? An analysis of thirty, sixty, and ninety day mortality rates based on patients' clinical presentation and comorbidity: a multicentric study in Northern Italy. *Int Orthop*. 2021;45(10):2499-2505. doi:10.1007/s00264-021-05166-3

13. Ju J bao, Zhang P xun, Jiang B guo. Hip Replacement as Alternative to Intramedullary Nail in Elderly Patients with Unstable Intertrochanteric Fracture: A Systematic Review and Meta-Analysis. *Orthop Surg*. 2019;11(5):745-754. doi:10.1111/os.12532

14. Rothwell AG, Hooper GJ, Hobbs A, Frampton CM. An analysis of the Oxford hip and knee scores and their relationship to early joint revision in the New Zealand Joint Registry. *The Journal of Bone and Joint Surgery British volume*. 2010;92-B:413-418.

15. Toro G, Bothorel H, Saffarini M, Jacquot L, Chouteau J, Rollier JC. Uncemented total hip arthroplasty in octogenarian and nonagenarian patients. *Eur J Orthop Surg Traumatol*. 2019;29(1):103-110. doi:10.1007/s00590-018-2242-7

16. Yeung Y, Chiu KY, Yau WP, Tang WM, Cheung WY, Ng TP. Assessment of the proximal femoral morphology using plain radiograph-can it predict the bone quality? *J Arthroplasty*. 2006;21(4):508-513. doi:10.1016/j.arth.2005.04.037

17. Piscopo A, Pola E, Fusini F, et al. Revision arthroplasty with megaprosthesis after Girdlestone procedure for periprosthetic joint infection as an option in massive acetabular and femoral bone defects. *Acta Biomed*. 2021;92(Supplement 3):e2021531. doi:10.23750/abm.v92iS3.12160

18. Papasimos S, Koutsojannis CM, Panagopoulos A, Megas P, Lambiris E. A randomised comparison of AMBI, TGN and PFN for treatment of unstable trochanteric fractures. *Arch Orthop Trauma Surg*. 2005;125(7):462-468. doi:10.1007/s00402-005-0021-5

19. Kim WY, Han CH, Park JI, Kim JY. Failure of intertrochanteric fracture fixation with a dynamic hip screw in relation to pre-operative fracture stability and osteoporosis. *International Orthopaedics (SICOT)*. 2001;25(6):360-362. doi:10.1007/s002640100287

20. Mariani EM, Rand JA. Nonunion of intertrochanteric fractures of the femur following open reduction and internal fixation. Results of second attempts to gain union. *Clin Orthop Relat Res*. 1987;:81-89.

21. Davis T, Sher J, Horsman A, Simpson M, Porter B, Checketts R. Intertrochanteric femoral fractures. Mechanical failure after internal fixation. *The Journal of Bone and Joint Surgery British volume*. 1990;72-B:26-31. doi:10.1302/0301-620x.72b1.2298790

22. Harwin SF, Stern RE, Kulick RG. Primary Bateman-Leinbach bipolar prosthetic replacement of the hip in the treatment of unstable intertrochanteric fractures in the elderly. *Orthopedics*. 1990;13(10):1131-1136. doi:10.3928/0147-7447-19901001-09

23. Rodop O, Kiral A, Kaplan H, Akmaz I. Primary bipolar hemiprosthesis for unstable intertrochanteric fractures. *International Orthopaedics (SICOT)*. 2002;26(4):233-237. doi:10.1007/s00264-002-0358-0

24. Sidhu AS, Singh AP, Singh AP, Singh S. Total hip replacement as primary treatment of unstable intertrochanteric fractures in elderly patients. *International Orthopaedics (SICOT)*. 2010;34(6):789-792. doi:10.1007/s00264-009-0826-x

25. Perticarini L, Rossi SMP, Fioruzzi A, Jannelli E, Mosconi M, Benazzo F. Modular tapered conical revision stem in hip revision surgery: mid- term results. *BMC Musculoskelet Disord*. 2021;22(1):29. doi:10.1186/s12891-020-03886-y26

26. Faldini C, Grandi G, Romagnoli M, et al. Surgical treatment of unstable intertrochanteric fractures by bipolar hip replacement or total hip replacement in elderly osteoporotic patients. *J Orthopaed Traumatol*. 2006;7(3):117-121. doi:10.1007/s10195-006-0133-x

27. Stappaerts KH, Deldycke J, Broos PLO, Staes FFGM, Rommens PM, Claes P. Treatment of Unstable Peritrochanteric Fractures in Elderly Patients with a Compression Hip Screw or with the Vandeputte (VDP) Endoprosthesis: A Prospective Randomized Study. *Journal of Orthopaedic Trauma*. 1995;9(4):292-297. doi:10.1097/00005131-199509040-00004

28. Blomfeldt R. Comparison of Internal Fixation with Total Hip Replacement for Displaced Femoral Neck Fractures Randomized, Controlled Trial Performed at Four Years. *J Bone Joint Surg Am*. 2005;87(8):1680. doi:10.2106/jbjs.d.02655

29. Haentjens P, Casteleyn PP, De Boeck H, Handelberg F, Opdecam P. Treatment of unstable intertrochanteric and subtrochanteric fractures in elderly patients. Primary bipolar arthroplasty compared with internal fixation. *J Bone Joint Surg Am*. 1989;71(8):1214-1225. doi:10.2106/00004623-198971080-00015

30. Morri M, Ambrosi E, Chiari P, et al. One-year mortality after hip fracture surgery and prognostic factors: a prospective cohort study. *Sci Rep*. 2019;9(1):18718. doi:10.1038/s41598-019-55196-6

31. de Miguel Artal M, Roca Chacón O, Martínez-Alonso M, Serrano Godoy M, Mas Atance J, García Gutiérrez R. [Hip fracture in the elderly patient: Prognostic factors for mortality and functional recovery at one year]. *Rev Esp Geriatr Gerontol*. 2018;53(5):247-254. doi:10.1016/j.regg.2018.04.447

32. Kempenaers K, Van Calster B, Vandoren C, et al. Are the current guidelines for surgical delay in hip fractures too rigid? A single center assessment of mortality and economics. *Injury*. 2018;49(6):1169-1175. doi:10.1016/j.injury.2018.03.032

33. Kannegaard PN, van der Mark S, Eiken P, Abrahamsen B. Excess mortality in men compared with women following a hip fracture. National analysis of comedications, comorbidity and survival. *Age Ageing*. 2010;39(2):203-209. doi:10.1093/ageing/afp221

34. Parvizi J, Ereth MH, Lewallen DG. THIRTY-DAY MORTALITY FOLLOWING HIP ARTHROPLASTY FOR ACUTE FRACTURE. *The Journal of Bone and Joint Surgery-American Volume*. 2004;86(9):1983-1988. doi:10.2106/00004623-200409000-00017

35. Bonnevialle P, Saragaglia D, Ehlinger M, Tonetti J, Maisse N, Adam P, et al. Trochanteric locking nail versus arthroplasty in unstable intertrochanteric fracture in patients aged over 75 years. *Orthopaedics & Traumatology: Surgery & Research*. 2011;97:S95-100.

36. Fichman SG, Mäkinen TJ, Safir O, et al. Arthroplasty for unstable pertrochanteric hip fractures may offer a lower re-operation rate as compared to cephalomedullary nailing. *International Orthopaedics (SICOT)*. 2016;40(1):15-20. doi:10.1007/s00264-015-2794-7

37. Huffman FG, Vaccaro JA, Zarini GG, Vieira ER. Osteoporosis, Activities of Daily Living Skills, Quality of Life, and Dietary Adequacy of Congregate Meal Participants. *Geriatrics (Basel)*. 2018;3.

38. Berkemeyer S, Schumacher J, Thiem U, Pientka L. Bone T-scores and functional status: a cross-sectional study on German elderly. *PLoS One*. 2009;4:e8216.

39. Toro G, Di Fino C, De Cicco A, et al. Atypical periprosthetic femoral fractures of the hip: characterisation of three cases. *HIP International*. 2020;30(2_suppl):77-85. doi:10.1177/1120700020971726

40. Duriez P, Devaux T, Chantelot C, Baudrier N, Hery JY, Mainard D, et al. Is arthroplasty preferable to internal fixation for the treatment of extracapsular fracture of the upper femur in the elderly? *Orthopaedics & Traumatology: Surgery & Research*. 2016;102:689-694.