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Original Article

Comprehensive Geriatric Assessment for Identifying Mortality Risk in Older Patients after Hip Fracture Surgery

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SUMMARY

Introduction: Our objective was to analyze the mortality risk factors in older patients after hip surgery using comprehensive geriatric assessment (CGA).
Methods: In this prospective cohort study, old adults (≥ 60 years) who had undergone hip fracture surgery were enrolled in a single medical center from January 2020 to December 2021. The comprehensive geriatric assessment, as well as clinical information of each patient was recorded during the hospital stay. A Cox regression model was used to determine associations with survival.
Results: A total of 164 old patients (66 males and 98 females) with a mean age of 81.09 ± 8.84 years were included. Twenty-seven patients died within one year (mortality rate 16.46%). In the Cox regression model, univariate analysis revealed male gender, older age, high American Society of Anesthesiologists grade (ASA = 4), length of hospital stay (≥ 10 days), activities of daily living (ADL) score at day of discharge, comorbidity with chronic obstructive pulmonary disease (COPD)/asthma or cancer, and postoperative infection (pneumonia or urinary tract infection) were associated with mortality. Female gender (hazard ratio [HR] = 0.40; 95% confidence interval [CI]: 0.17, 0.93; p = 0.033), higher discharge ADL score (HR = 0.97; 95% CI: 0.95, 1.00; p = 0.045), and postoperative infection (HR: 3.65; 95% CI: 1.25, 10.69; p = 0.018) remained significant predictors of one-year mortality after adjustment for confounding factors.
Conclusions: Integrating clinical data with CGA effectively identifies older hip fracture patients at high mortality risk. Early identification of these patients and implementation of multidisciplinary co-managed care strategies are recommended to potentially reduce one-year mortality.

1. Introduction

Hip fracture is a debilitating condition that places an economic burden on healthcare systems.[1] An analysis of previous research utilizing databases spanning regions across Oceania, Asia, Western and Northern Europe, and America found that 40% occur in people aged ≥ 85 years.[2] Morri et al. showed that there was a 9.4% increase in risk of dying within 12 months after hip fracture surgery for each one-year increase in age.[3]

Older patients with fractures usually have pre-existing functional deficits, frailty, and several comorbidities.[4,5] In a previous study, comprehensive geriatric care with a multidisciplinary approach for geriatric hip fractures showed better functional recovery achievement, prevented potential complications, and reduced mortality rates.[5–7] However, a gap remains in the literature regarding the widespread use and impact of multidisciplinary interventions combined with comprehensive geriatric assessment (CGA) in this high-risk population.

The CGA is a multidimensional assessment that evaluates the bio-psycho-social needs of the elderly. Ibitoye et al. demonstrated that geriatrician assessment was associated with reduced mortality in older adults with trauma.[8] Moreover, the assessment also helped to identify geriatric patients who had an increased risk of hip fracture in the emergency department.[9]

We aimed to evaluate whether CGA implementation can help care providers identify mortality risk among geriatric patients. By identifying vulnerable individuals, healthcare systems can prioritize resources and implement strategies to mitigate the impact of such events on this fragile population. Furthermore, it integrates CGA to identify major prognostic factors, addressing the clinical need for better risk stratification and highlighting the importance of multidisciplinary care emphasized in recent literature.

2. Material & methods

2.1. Study design and study participants

This research was conducted in Taichung Veterans General Hospital (TCVGH, Taichung, Taiwan) between January 1, 2020, and De-

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cember 31, 2021, using a prospective cohort design. A total of 168 patients with a hip fracture that was diagnosed in the emergency department and surgically treated in our hospital were reviewed. The inclusion criteria for the study were: (a) patients aged 60 years or older, (b) diagnosis of hip fracture, including femoral neck fracture and intertrochanteric fracture, (c) fracture treated within 3 days from time of injury. We excluded patients who were diagnosed with multiple traumas, pathologic fractures, periprosthetic fractures, or old fractures (defined as those treated $\geq$ 3 days after the time of injury), as well as those who did not undergo fracture surgery or had missing data. A total of four patients were excluded based on these criteria. Therefore, 164 patients were included in the final analysis. This study was approved by the Institutional Review Board of Taichung Veterans General Hospital (IRB number: CF18067B-5).

2.2. Hip fracture evaluation and comprehensive geriatric assessment

Hip fracture events were defined using the International Classification of Diseases, Ninth/Tenth Revision codes for hip fractures. Baseline characteristics, including sex, age, and body mass index (BMI) were collected. Detailed preoperative data, such as comorbidities, American Society of Anesthesiologists (ASA) grade, and time to surgery were retrieved from the anesthesiology evaluation charts and electronic medical records of the patients. Comorbidities in the study included chronic obstructive pulmonary disease (COPD)/asthma, cancer, heart failure and diabetes mellitus (DM). The ASA scores were grouped as 2, 3, or 4, in accordance with previous studies. Time-to-surgery was defined as the time from emergency department admission to the start of surgery, and was grouped into four categories. The CGA, including physical health, functional status, psychological health, and nutrition, as well as clinical information of each patient was recorded during the hospital stay. Activities of daily living (ADL) was used as an indicator of a person's functional status. Psychological health was evaluated with the Geriatric Depression Scale-5 (GDS-5) score. Malnutrition was analyzed using the mini nutritional assessment (MNA). Calf circumference and handgrip strength were measured as they have been adopted as diagnostic tools for sarcopenia.[10,11]

2.3. Hip fracture postoperative follow-up

All patients included in the study underwent an operation. The Harris Hip Score (HHS) is used for the assessment of the results of hip surgery, which is scored out of a total of 100 points. A greater score indicates better hip function and greater satisfaction. HHS encompasses several domains, including pain, function, absence of deformity, and range of motion.[12] "Fell down during past 12 months" and "sleep disturbance" were also considered as factors in predicting mortality. Postoperative complications were classified as adverse outcome infection (urinary tract infection and pneumonia). All-cause mortality was defined as any death occurring within one year after hip fracture surgery, as determined through follow-up telephone interviews. All patients included in this study were successfully contacted by telephone.

2.4. Statistical analysis

The collected data were analyzed using IBM SPSS version 22.0 (International Business Machine Corp., New York, USA). Chi-Square test, Fisher's exact test, and Mann-Whitney U test were used for the data analysis as appropriate. To determine which factors were independently associated with one-year mortality after hip fracture surgery, a multivariable Cox proportional hazards model was used. The multivariable analysis was adjusted for sex, age, ASA grade, length of hospital stay, discharge ADL, comorbidity with COPD/asthma or cancer, and adverse outcome infection (urinary tract infection and pneumonia). $p < 0.05$ was considered significant for all tests.

3. Results

3.1. Characteristics of the study subjects

Overall, between January 1, 2020, and December 31, 2021, 164 individuals (66 males and 98 females) were included, with a mean (standard deviation) age of 81.09 ($\pm$8.84) years. As shown in Table 1, mortality within one year occurred in 27 of 164 patients (16.46%). Sex, age, ASA classification, length of hospital stay, discharge ADL, comorbidity with cancer, and adverse outcome infection with pneumonia or UTI were associated with 1-year all-cause mortality. However, no difference was observed in patients' fracture type, type of hip surgery, time-to-surgery, bone mineral density (BMD) T-score, Harris Hip Score, BMI, number of drugs, handgrip strength, calf circumference, MNA, fell down during past 12 months, comorbidity with COPD/asthma, heart failure, DM, sleep disturbance, and GDS-5 score.

3.2. Independent risk factors associated with 1-year mortality following surgical hip fracture management

Table 2 shows the risk of death for the included variables calculated using Cox proportional hazards model. The univariable analysis showed that sex, age, higher ASA grade (ASA = 4), length of hospital stay, discharge ADL, comorbidity with COPD/asthma or cancer, and postoperative infection (pneumonia or urinary tract infection) were all associated with one-year mortality risk. Multivariable risk analysis found that female gender (HR = 0.40; 95% CI: 0.17, 0.93; $p = 0.033$), higher discharge ADL score (HR = 0.97; 95% CI: 0.95, 1.00; $p = 0.045$), and postoperative infection (HR: 3.65; 95% CI: 1.25, 10.69; $p = 0.018$) were independent predictors of mortality after adjustment for the confounding factors.

4. Discussion

This cohort study investigated the predictive factors associated with all-cause mortality by CGA in older hip fracture patients. Of the 164 patients enrolled in this study, the mortality rate was 16.46% within 1 year after hip surgery. Sex, discharge ADL score, and postoperative infection status independently predicted mortality. The all-cause mortality observed in our study was lower when compared with most previous studies.[13,14] Adoption of a multidisciplinary approach was recommended in the previous literature to optimally manage hip fractures.[15] Our hospital has adopted a multidisciplinary co-managed care protocol for geriatric patient fractures, involving various specialties such as emergency units, orthopedic surgeons, geriatricians, anesthetists, cardiologists, rehabilitation physicians, neurologists, osteoporosis treatment centers, post-acute care referral teams, and nursing teams. This patient-centered approach aims to reduce mortality and comorbidity, improve functional outcomes and quality of life, and lower overall medical costs.

Several studies have reported that mortality rate after hip fracture was associated with age, sex, anesthesiologist's classification of physical status, timing of surgery, and comorbidities.[16–19] However, in these studies, there are relatively few data on the long-term mor-

Table 1
Baseline demographic, clinical and comprehensive geriatric assessment characteristics of elderly hip-fracture patients stratified by 1-year survival status (Survivors vs. Non-survivors), 2020–2021.

	Total (n = 164) n (%)	Survivors (n = 137) n (%)	Non-survivors (n = 27) n (%)	*p* value
Sex[c]				0.008**
Male	66 (40.24%)	49 (35.77%)	17 (62.96%)	
Female	98 (59.76%)	88 (64.23%)	10 (37.04%)	
Age (mean ± SD)[m]	81.09 ± 8.84	80.23 ± 8.76	85.48 ± 8.05	0.004**
Type of hip fracture[c]				0.156
Femoral neck fracture	129 (78.66%)	105 (76.64%)	24 (88.89%)	
Intertrochanteric fracture	35 (21.34%)	32 (23.36%)	3 (11.11%)	
Type of hip surgery[c]				0.127
Arthroplasty	64 (39.02%)	57 (41.61%)	7 (25.93%)	
Open Reduction and Internal Fixation (ORIF)	100 (60.98%)	80 (58.39%)	20 (74.07%)	
American Society of Anesthesiologists (ASA)[f]				0.011*
ASA-2	39 (23.78%)	37 (27.01%)	2 (7.41%)	
ASA-3	122 (74.39%)	99 (72.26%)	23 (85.19%)	
ASA-4	3 (1.83%)	1 (0.73%)	2 (7.41%)	
Time to surgery (hour)[f]				0.502
< 24 hours	86 (52.44%)	75 (54.74%)	11 (40.74%)	
24–36 hours	31 (18.90%)	24 (17.52%)	7 (25.93%)	
36–48 hours	18 (10.98%)	15 (10.95%)	3 (11.11%)	
> 48 hours	29 (17.68%)	23 (16.79%)	6 (22.22%)	
Bone mineral density T-score (mean ± SD)[m]	-3.13 ± 1.03	-3.09 ± 1.04	-3.39 ± 0.91	0.222
Length of hospital stay (mean ± SD)[m]	8.89 ± 4.45	8.58 ± 4.02	10.44 ± 6.04	0.085
Length of hospital stay[c]				0.036*
< 10 days	113 (68.90%)	99 (72.26%)	14 (51.85%)	
≥ 10 days	51 (31.10%)	38 (27.74%)	13 (48.15%)	
Harris Hip Score (mean ± SD)[m]	37.23 ± 19.32	38.06 ± 18.57	33.07 ± 22.65	0.275
BMI (mean ± SD)[m]	23.14 ± 4.44	23.35 ± 4.48	22.07 ± 4.14	0.222
Body mass index (BMI)[c]				0.777
BMI < 24	106 (64.63%)	87 (63.50%)	19 (70.37%)	
24 ≤ BMI < 27	31 (18.90%)	27 (19.71%)	4 (14.81%)	
BMI ≥ 27	27 (16.46%)	23 (16.79%)	4 (14.81%)	
Number of drugs[c]				0.964
< 4	48 (29.27%)	40 (29.20%)	8 (29.63%)	
≥ 4	116 (70.73%)	97 (70.80%)	19 (70.37%)	
Handgrip strength (kg) (mean ± SD)[m]	15.19 ± 7.12	15.27 ± 7.37	14.60 ± 5.22	0.829
Calf circumference (cm) (mean ± SD)[m]	27.26 ± 4.74	27.33 ± 4.97	26.90 ± 3.44	0.979
Mini nutritional assessment (MNA)[c]				0.279
MNA ≥ 24	27 (16.46%)	24 (17.52%)	3 (11.11%)	
17 ≤ MNA < 24	85 (51.83%)	73 (53.28%)	12 (44.44%)	
MNA < 17	52 (31.71%)	40 (29.20%)	12 (44.44%)	
Discharge activities of daily living[m]	39.91 ± 19.09	41.92 ± 18.88	29.62 ± 17.02	0.007**
Fell down last 12 months[c]	134 (86.45%)	112 (86.15%)	22 (88.00%)	1.000
Comorbidity[c]				
COPD/asthma	18 (10.98%)	12 (8.76%)	6 (22.22%)	0.083
Cancer	27 (16.46%)	18 (13.14%)	9 (33.33%)	0.019*
Heart failure (HF)	21 (12.96%)	16 (11.85%)	5 (18.52%)	0.352
Diabetes mellitus	58 (35.37%)	51 (37.23%)	7 (25.93%)	0.262
Adverse outcome infection (Aoi, pneumonia + UTI)[c]	10 (6.10%)	5 (3.65%)	5 (18.52%)	0.012*
Sleep disturbance[c]	63 (38.41%)	51 (37.23%)	12 (44.44%)	0.481
Geriatric Depression Scale[c]				0.082
< 2	90 (59.60%)	79 (62.70%)	11 (44.00%)	
≥ 2	61 (40.40%)	47 (37.30%)	14 (56.00%)	

[c] Chi-square test, [f] Fisher's Exact test, [m] Mann-Whitney U test. COPD: chronic obstructive pulmonary disease, UTI: urinary tract infection. * $p < 0.05$, ** $p < 0.01$.

tality risk factors related to hip fracture under a multidisciplinary co-management model.[20] In our study, it was found that female gender, higher ADL score, and postoperative infection were significant predictors of one-year mortality after hip surgery. Men were less likely to survive than women in our study and the findings were consistent with the previous literature.[21,22] Possible explanations for the gender difference in mortality after hip fracture were examined in previous cohorts.[21,22] Mortality after hip fracture was usually associated with infections, including urinary tract infection, pneumonia or septicemia, in a prior study that reported mortality rates for men and women were similar if deaths caused by infection were excluded.[21] Moreover, in our study, postoperative infection (UTI and pneumonia) was independently associated with mortality. It has been shown that biological inflammatory markers (neutrophil-to-lymphocyte ratio) can predict mortality in hip fracture patients.[23] It has been hypothesized that complication–associated inflammation results in organ damage, which subsequently shortens long-term survival. According to previous research, risk factors of postoperative UTI in hip fracture surgery include older age, chronic steroid use, blood transfusion, time to operation > 2 days from admission,[24] as

Table 2
Univariable and multivariable Cox proportional-hazards model analysis of baseline factors associated with 1-year all-cause mortality after hip-fracture surgery in older patients, 2020–2021 (n = 164).

	Univariable			Multivariable		
	HR	95% CI	*p* value	HR	95% CI	*p* value
Sex						
Male	1.00			1.00		
Female	0.36	(0.17–0.79)	0.010*	0.40	(0.17–0.93)	0.033*
Age	1.07	(1.02–1.12)	0.007**	1.04	(0.98–1.10)	0.155
Type of hip fracture						
Femoral neck fracture	1.00					
Intertrochanteric fracture	0.45	(0.13–1.48)	0.188			
Type of hip surgery						
Arthroplasty	1.00					
Open Reduction and Internal Fixation (ORIF)	1.95	(0.83–4.62)	0.128			
American Society of Anesthesiologists (ASA)						
ASA-2	1.00					
ASA-3	4.00	(0.94–16.97)	0.060			
ASA-4	17.56	(2.47–125.04)	0.004**			
Time to surgery (hour)						
< 24 hours	1.00					
24–36 hours	1.89	(0.73–4.88)	0.188			
36–48 hours	1.36	(0.38–4.86)	0.640			
> 48 hours	1.76	(0.65–4.77)	0.263			
Bone mineral density T-score	0.76	(0.49–1.18)	0.214			
Length of hospital stay						
< 10 days	1.00			1.00		
≥ 10 days	2.18	(1.03–4.65)	0.043*	1.22	(0.52–2.86)	0.655
Harris Hip Score	0.99	(0.97–1.01)	0.206			
Body mass index (BMI)						
BMI < 24	1.00					
24 ≤ BMI < 27	0.70	(0.24–2.07)	0.523			
BMI ≥ 27	0.84	(0.29–2.47)	0.753			
Number of drugs						
< 4	1.00					
≥ 4	0.98	(0.43–2.24)	0.963			
Handgrip strength (kg)	0.99	(0.92–1.06)	0.693			
Calf circumference (cm)	0.98	(0.89–1.08)	0.658			
Mini nutritional assessment (MNA)						
MNA ≥ 24	1.00					
17 ≤ MNA < 24	1.28	(0.36–4.53)	0.704			
MNA < 17	2.24	(0.63–7.93)	0.212			
Discharge activities of daily living	0.97	(0.94–0.99)	0.003**	0.97	(0.95–1.00)	0.045*
Fell down last 12 months	1.14	(0.34–3.82)	0.827			
Comorbidity						
COPD/asthma	2.68	(1.08–6.64)	0.033*	1.69	(0.58–4.89)	0.333
Cancer	2.80	(1.26–6.23)	0.012*	1.90	(0.78–4.68)	0.160
Heart failure	1.67	(0.63–4.40)	0.303			
Diabetes mellitus	0.61	(0.26–1.45)	0.265			
Adverse outcome infection (Aoi, pneumonia + UTI)	4.36	(1.65–11.55)	0.003**	3.65	(1.25–10.69)	0.018*
Sleep disturbance	1.39	(0.65–2.97)	0.397			
Geriatric Depression Scale						
< 2	1.00					
≥ 2	2.03	(0.92–4.47)	0.079			

Cox regression. COPD: chronic obstructive pulmonary disease, UTI: urinary tract infection. * $p < 0.05$, ** $p < 0.01$.

well as age, male sex, chronic respiratory disease, and liver disease in postoperative pneumonia.[25] As these risk factors are well known, early preventive strategies and early diagnosis of postoperative complications may minimize their influence and improve surgical safety. Our review of the data for these 164 patients revealed no documented cases of postoperative wound infection, with only pneumonia and urinary tract infection being recorded as complications.

In addition to the traditional known risk factors for postoperative mortality in hip fracture, several older age–associated geriatric disorders, such as pre-fracture function, cognitive impairment, and muscle strength have been shown to influence the prognosis of hip fracture.[26] In our study, impaired ADL scores were demonstrated to be an important predictor of postoperative mortality in older adults with hip fractures. A previous study proposed that the relationship between ADL and post-hip fracture surgery mortality may be due to medical comorbidities and medical conditions related to ADL impairment, including residence in long-term care, dementia, and Parkinson's disease.[27] Hence, the importance of postoperative rehabilitation in hip fracture improving ADL and outcomes after surgery cannot be understated.[28]

There were several limitations in the present study. First, the sample size was probably not large enough, resulting in a limited number of events per variable in our multivariate analysis, which might have prevented certain true risk factors from reaching statistical significance. We acknowledge this limitation and propose conducting larger, potentially multicenter studies in the future to increase statistical power. However, our investigation was comprehensive, as few studies have predicted mortality in older patients hospitalized with a hip fracture, evaluated by comprehensive geriatric assessment. A second limitation was that mortality assessment was based on telephone interviews with patients' families. Although follow-up was complete for all included patients, this method may still introduce information bias. Moreover, the reliance on patient records from a single medical center may have resulted in omission of data if a patient sought treatment at other hospitals. A third limitation was the presence of missing data in the ASA grade, a clinically relevant variable associated with perioperative risk and mortality. The absence of this information may have reduced the accuracy of the risk adjustment and outcome interpretation. Furthermore, no sensitivity analysis was conducted to assess the potential impact of these missing values. Future studies should aim to improve data completeness to mitigate bias introduced by missing data. Despite adjusting for multiple covariates, unmeasured confounding factors may still have influenced the one-year mortality outcome. For instance, nutritional indicators such as serum albumin levels, which are known to be associated with poor prognosis, were not included in the analysis.[29] These potential factors require further investigation in future research. Furthermore, while our CGA included various aspects of geriatric assessment, formal cognitive evaluation using tools like MMSE or mini-cog was not included in the final analysis due to significant missing data. Additionally, our assessment of sarcopenia was limited to handgrip strength and calf circumference, which can only indicate possible sarcopenia. The absence of formal cognitive evaluation and a detailed sarcopenia diagnosis, as well as the lack of reported assessment of vision and hearing abilities, represent limitations of this study. Future research should incorporate these aspects for a more comprehensive evaluation. Finally, due to the broad categorization of comorbidities in our CGA questionnaire, the Charlson Comorbidity Index was not available in this dataset. This lack of a standardized comorbidity index is a limitation, and future versions of our questionnaire will include the Charlson Comorbidity Index for a more comprehensive analysis of comorbidity burden.

5. Conclusions

In this prospective cohort study of 164 patients who underwent surgical treatment for hip fractures, we found the predictive factors for one-year mortality included gender, activity of daily living score, and postoperative infection. Future efforts aimed at improving outcomes should focus on strategies to develop daily living skills and maintain strict infection control.

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The authors declare that they have no conflict of interest.

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References

1. Dong Y, Zhang Y, Song K, Kang H, Ye D, Li F. What was the epidemiology and global burden of disease of hip fractures from 1990 to 2019? Results from and additional analysis of the Global Burden of Disease Study 2019. *Clin Orthop Relat Res.* 2023;481(6):1209–1220. doi:10.1097/CORR.0000000000002465
2. Sing CW, Lin TC, Bartholomew S, et al. Global epidemiology of hip fractures: Secular trends in incidence rate, post-fracture treatment, and all-cause mortality. *J Bone Miner Res*. 2023;38(8):1064–1075. doi:10.1002/jbmr.4821
3. 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
4. Boddaert J, Raux M, Khiami F, Riou B. Perioperative management of elderly patients with hip fracture. *Anesthesiology*. 2014;121(6):1336–1341. doi:10.1097/ALN.0000000000000478
5. Kavak M, Oğuz S, Akkoyun Z, İnan U. Predictive factors associated with thirty-day mortality in geriatric patients with hip fractures. *Acta Orthop Traumatol Turc*. 2022;56(4):240–244. doi:10.5152/j.aott.2022.21407
6. Wang H, Li C, Zhang Y, et al. The influence of inpatient comprehensive geriatric care on elderly patients with hip fractures: a meta-analysis of randomized controlled trials. *Int J Clin Exp Med*. 2015;8(11):19815–19830.
7. Li Y, Tung KK, Cho YC, Lin SY, Lee CH, Chen CH. Correction: Improved outcomes and reduced medical costs through multidisciplinary co-management protocol for geriatric proximal femur fractures: a one-year retrospective study. *BMC Geriatr*. 2022;22(1):504. doi:10.1186/s12877-022-03136-x
8. Ibitoye SE, Braude P, Carter B, et al. Geriatric assessment is associated with reduced mortality at 1 year for older adults admitted to a major trauma center: A prospective observational study. *Ann Surg*. 2023;277(2):343–349. doi:10.1097/SLA.0000000000005092
9. Lin PY, Huang HH, Yen DH. Comprehensive geriatric assessment in the emergency department for identifying elderly individuals at risk of hip fracture. *J Acute Med*. 2022;12(3):113–121. doi:10.6705/j.jacme.202209_12(3).0004
10. Kim CH, Han J, Kim JW. One-year change in handgrip strength in patients with hip fracture: a prospective comparison with hip disease. *BMC Geriatr*. 2023;23(1):65. doi:10.1186/s12877-023-03782-9
11. Borges K, Artacho R, Jodar-Graus R, Molina-Montes E, Ruiz-López MD. Calf circumference, a valuable tool to predict sarcopenia in older people hospitalized with hip fracture. *Nutrients*. 2022;14(20):4255. doi:10.3390/nu14204255
12. Nilsdotter A, Bremander A. Measures of hip function and symptoms: Harris Hip Score (HHS), Hip Disability and Osteoarthritis Outcome Score (HOOS), Oxford Hip Score (OHS), Lequesne Index of Severity for Osteoarthritis of the Hip (LISOH), and American Academy of Orthopedic Surgeons (AAOS) Hip and Knee Questionnaire. *Arthritis Care Res (Hoboken)*. 2011;63 Suppl 11:S200–S207. doi:10.1002/acr.20549
13. Huette P, Abou-Arab O, Djebara AE, et al. Risk factors and mortality of patients undergoing hip fracture surgery: a one-year follow-up study. *Sci Rep*. 2020;10(1):9607. doi:10.1038/s41598-020-66614-5
14. Novoa-Parra CD, Hurtado-Cerezo J, Morales-Rodríguez J, Sanjuan-Cerveró R, Rodrigo-Pérez JL, Lizaur-Utrilla A. Factors predicting one-year mortality of patients over 80 years operated after femoral neck fracture. Factores predictivos de la mortalidad al año en pacientes mayores de 80 años intervenidos de fractura del cuello femoral. *Rev Esp Cir Ortop Traumatol (Engl Ed)*. 2019;63(3):202–208. doi:10.1016/j.recot.2018.10.007
15. De C, Harbham PK, Postoyalko C, Bhavanasi B, Paringe V, Theivendran K. Mortality following hip fracture surgery during COVID-19 pandemic compared to pre-COVID-19 period: A case matched cohort series. *Malays Orthop J*. 2021;15(2):107–114. doi:10.5704/MOJ.2107.016
16. Cher EWL, Allen JC, Howe TS, Koh JSB. Comorbidity as the dominant predictor of mortality after hip fracture surgeries. *Osteoporos Int*. 2019;30(12):2477–2483. doi:10.1007/s00198-019-05139-8
17. Åhman R, Siverhall PF, Snygg J, et al. Determinants of mortality after hip fracture surgery in Sweden: a registry-based retrospective cohort study. *Sci Rep*. 2018;8(1):15695. doi:10.1038/s41598-018-33940-8
18. 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(1):13933. doi:10.1038/s41598-018-32098-7
19. Smith T, Pelpola K, Ball M, Ong A, Myint PK. Pre-operative indicators for

mortality following hip fracture surgery: a systematic review and meta-analysis. *Age Ageing.* 2014;43(4):464–471. doi:10.1093/ageing/afu065
20. Forni S, Pieralli F, Sergi A, Lorini C, Bonaccorsi G, Vannucci A. Mortality after hip fracture in the elderly: The role of a multidisciplinary approach and time to surgery in a retrospective observational study on 23,973 patients. *Arch Gerontol Geriatr.* 2016;66:13–17. doi:10.1016/j.archger.2016.04.014
21. Wehren LE, Hawkes WG, Orwig DL, Hebel JR, Zimmerman SI, Magaziner J. Gender differences in mortality after hip fracture: the role of infection. *J Bone Miner Res.* 2003;18(12):2231–2237. doi:10.1359/jbmr.2003.18.12.2231
22. Sharma H, Vashishtha P, Sharma R. Gender differences in patients with hip fracture: a greater risk of morbidity and mortality in men. *J Orthop Trauma*. 2005;19(5):365–366.
23. Forget P, Moreau N, Engel H, et al. The neutrophil-to-lymphocyte ratio (NLR) after surgery for hip fracture (HF). *Arch Gerontol Geriatr.* 2015;60(2):366–371. doi:10.1016/j.archger.2014.11.008
24. Saadat GH, Alsoof D, Ahmad B, Butler BA, Messer TA, Bokhari F. Incidence, risk factors and clinical implications of postoperative urinary tract infection in geriatric hip fractures. *Injury*. 2022;53(6):2158–2162. doi:10.1016/j.injury.2022.03.012
25. Zhao K, Zhang J, Li J, et al. In-hospital postoperative pneumonia following geriatric intertrochanteric fracture surgery: Incidence and risk factors. *Clin Interv Aging*. 2020;15:1599–1609. doi:10.2147/CIA.S268118
26. Ishidou Y, Koriyama C, Kakoi H, et al. Predictive factors of mortality and deterioration in performance of activities of daily living after hip fracture surgery in Kagoshima, Japan. *Geriatr Gerontol Int*. 2017;17(3):391–401. doi:10.1111/ggi.12718
27. Seitz DP, Anderson GM, Austin PC, et al. Effects of impairment in activities of daily living on predicting mortality following hip fracture surgery in studies using administrative healthcare databases. *BMC Geriatr*. 2014;14:9. doi:10.1186/1471-2318-14-9
28. Chen M, Du Y, Tang W, et al. Risk factors of mortality and second fracture after elderly hip fracture surgery in Shanghai, China. *J Bone Miner Metab*. 2022;40(6):951–959. doi:10.1007/s00774-022-01358-y
29. Sim SD, Sim YE, Tay K, et al. Preoperative hypoalbuminemia: Poor functional outcomes and quality of life after hip fracture surgery. *Bone*. 2021;143:115567. doi:10.1016/j.bone.2020.115567