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RESEARCH

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Risk factors associated with mortality in elderly patients receiving hemiarthroplasty for femoral neck fractures

Zhi Zeng[1†], Hao Li[1†], Chong Luo[1†], Mu-dan Huang[1], Hai-peng Li[2], Xiang Peng[1], De-en Wan[1], Jiang-jun Zhou[1], Ming Chen[3*] and Feng Shuang[1*]

Abstract

Background To investigate the risk factors for mortality in elderly patients who underwent hemiarthroplasty for femoral neck fractures over a five-year follow-up period.

Methods A retrospective analysis of clinical data from 80 elderly patients treated with hemiarthroplasty between January 2015 and December 2018. Kaplan–Meier survival analysis was conducted, and both univariate and multivariate logistic regression analyses identified independent mortality risk factors, including age, preoperative mobility, BMI, cardiovascular comorbidities, and fracture type.

Results Of the 80 patients, 38 (47.5%) died within the follow-up period. Kaplan–Meier analysis showed significantly reduced survival in patients with cardiovascular comorbidities, unstable fractures (Garden III and IV), and limited pre-fracture mobility ($p < 0.05$). Univariate analysis identified age, pre-fracture mobility, BMI, cardiovascular comorbidities, and fracture type as significant factors associated with mortality ($p < 0.05$). Multivariate analysis confirmed age, pre-fracture mobility, cardiovascular comorbidities, and unstable fractures as independent mortality predictors ($p < 0.05$).

Conclusions Advanced age, limited mobility before fracture, cardiovascular comorbidities, and unstable fractures significantly increase mortality risk in elderly patients undergoing hemiarthroplasty. Tailored fracture management and optimized cardiovascular care could improve survival.

Keywords Hemiarthroplasty, Elderly patients, Risk factors, Retrospective analysis

Background

Femoral neck fractures are common among the elderly and pose significant threats to their health and quality of life, often termed the "last fracture of life" [1]. Due to poor physical condition and severe osteoporosis in most elderly patients, hemiarthroplasty has become the primary surgical treatment [2, 3]. Compared to total hip arthroplasty, hemiarthroplasty offers advantages such as shorter operative time, less blood loss, faster recovery, and reduced bed rest duration, making it increasingly popular for treating femoral neck fractures in the elderly [4, 5]. However, high surgical risks and mortality rates in elderly patients with comorbid conditions and functional decline pose significant burdens on families and society

†Zhi Zeng, Hao Li and Chong Luo contributed equally to this work.

*Correspondence:
Ming Chen
ndyfy01837@ncu.edu.cn
Feng Shuang
shuangfeng_2000@163.com
[1] Department of Orthopedics, The 908th Hospital of Chinese People's Liberation Army Joint Logistics Support Force, No.1028 Jinggangshan Street, Qingyunpu District, Nanchang, Jiangxi Province 330002, China
[2] Department of Orthopedics, The Fourth Medical Center of Chinese People's Liberation Army General Hospital, Beijing 330006, China
[3] Department of Orthopedics, The First Affiliated Hospital of Nanchang University, No. 17 Yongwaizheng Street, Donghu District, Nanchang, Jiangxi Province 330006, China

[6, 7]. Identifying the risk factors for mortality following hemiarthroplasty is crucial for improving postoperative survival rates. This study retrospectively analyzes the clinical data of 80 elderly patients who underwent hemiarthroplasty over a five-year period to determine the risk factors affecting postoperative survival and provide clinical guidance for reducing surgical risks and improving survival rates.

Methods

Clinical data

Following approval from the Ethics Committee of the 908th Hospital of Chinese People's Liberation Army Joint Logistics Support Force (2020LL007), clinical and imaging data of elderly patients who underwent hemiarthroplasty between January 2015 and December 2018 were retrospectively analyzed. Informed consent was obtained from all participants. The study was conducted according to the guidelines of the Declaration of Helsinki.

Inclusion Criteria: 1) Age ≥ 65 years; 2) Unilateral femoral neck fractures; 3) Indication for surgery, no surgical or anesthetic contraindications, and underwent hemiarthroplasty with a follow-up period of over five years; 4) Complete clinical data and postoperative follow-up.

Exclusion Criteria: 1) Congenital lower limb developmental deformities; 2) History of acute or chronic systemic infections, joint infections, or severe vascular diseases of the lower limbs; 3) Severe trauma during the follow-up period.

Surgical approaches

All patients underwent hemiarthroplasty with cemented bipolar prostheses. Implant selection was based on patient characteristics and surgeon preference. The procedure included standard preparations, disinfection, and draping. Patients were positioned laterally and received spinal-epidural anesthesia combined with nerve block. A curved incision was made on the posterior side of the hip, and tissues were dissected to expose the hip joint. The femoral head was removed, and the acetabulum was prepared. A prosthesis stem and femoral head were implanted, followed by checking the stability and function of the hip joint. Postoperative infection prevention and standard wound care were administered.

Evaluation indicators

Clinical data were collected and analyzed. A total of 84 questionnaires were distributed, with 80 valid responses. Factors analyzed included age, sex, pre-fracture mobility, BMI, cardiovascular comorbidities, operative time, fracture type, anesthesia method, fracture side, intraoperative blood loss, and hospital stay. Fracture types were classified according to the Garden classification system. Unstable fractures (Garden III and IV) were significantly associated with higher mortality rates. Preoperative and postoperative X-ray images were used to assess implant positioning and stability. Representative images are shown in Fig. 1.

Statistical analysis

Data were analyzed using SPSS 29.0 software. Categorical data were expressed as [n(%)] and analyzed using χ^2 tests, while continuous data were expressed as (mean ± SD)

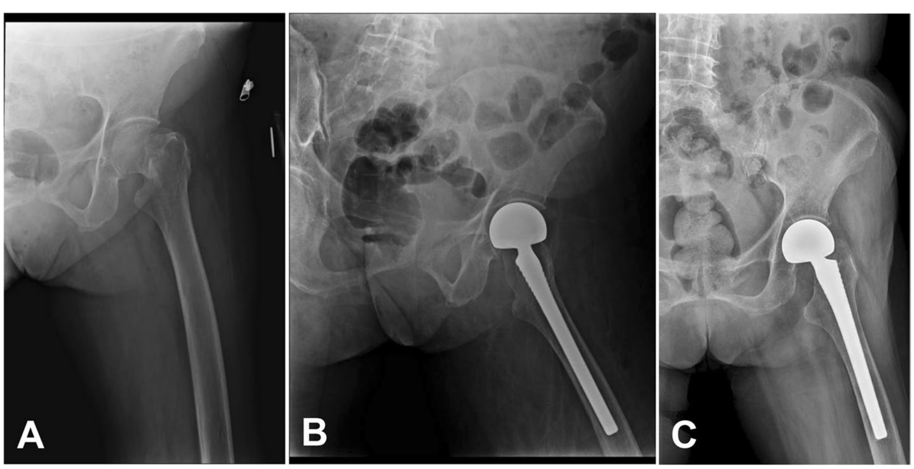

Fig. 1 Preoperative and postoperative X-ray images of an elderly femoral neck fracture patient undergoing hemiarthroplasty. **A** Preoperative image showing the femoral neck fracture. **B** Immediate postoperative image confirming implant placement. **C** Five-year postoperative image demonstrating implant stability and integration. The implant used was manufactured by Beijing Weigao Yahua Artificial Joint Development Co., Ltd., provided by Wisdom Co

and analyzed using t-tests. Kaplan–Meier survival curves were generated to evaluate cumulative survival rates (Fig. 2), and the log-rank test was used for group comparisons based on key factors, including age, pre-fracture mobility, cardiovascular comorbidities, and fracture type (Fig. 3). Variables with $P < 0.05$ in univariate analysis were entered into a multivariate logistic regression model to identify independent risk factors for mortality, controlling for potential confounders.

Results

Five-year mortality and survival curve

A total of 80 elderly patients who underwent hemiarthroplasty were included in this study, with a follow-up period of over five years. By the end of the follow-up, 38 patients (47.5%) had passed away. The results of the study showed that 8 cases died in the first year, accounting for 21%; The number of deaths in the second year was 9, accounting for 24%; In the third year, the number of deaths was 7, accounting for 18%; In the fourth year, the number of deaths was 9, accounting for 24%; In the fifth year, the number of deaths was 5, or 13%. The Kaplan–Meier method was used to analyze the data, revealing a five-year postoperative survival rate of 52.5%. The overall survival curve is shown in Fig. 2.

Comparison of survival curves by key factors

Kaplan–Meier analysis showed that patients aged ≥ 75, those bedridden before fracture, those with cardiovascular comorbidities, and those with unstable fractures (Garden III and IV) had significantly lower survival rates ($p < 0.05$ for all) (Fig. 3). These factors are associated with reduced survival in elderly patients after hemiarthroplasty.

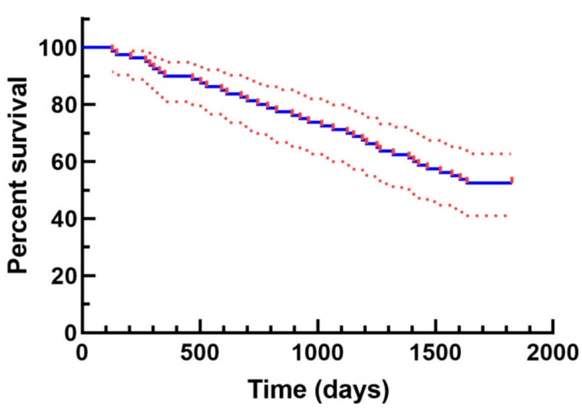

Fig. 2 Kaplan–Meier survival curves for elderly patients undergoing hemiarthroplasty. The solid blue line represents the cumulative survival rate over time (in days), with dotted red lines indicating the 95% confidence intervals

Clinical characteristics

Eighty patients were followed up, including 36 males and 44 females, aged 65–92 years (mean age: 77.04 ± 6.95 years). BMI ranged from 16.6 to 25.6 kg/m^2 (mean BMI: 19.55 ± 2.25 kg/m^2). The follow-up period ranged from 5.17 to 8.91 years (mean: 6.74 ± 1.06 years). Of these, 38 patients (47.5%) had died. Most deaths occurred within the first two years post-surgery, with the primary causes being cardiovascular complications and infections.

Univariate analysis of mortality risk factors

Univariate analysis showed that age, sex, pre-fracture mobility, BMI, cardiovascular disease, intraoperative operation time, fracture type, anesthesia method, fracture side, intraoperative blood loss and length of hospital stay of the 80 patients were compared. The results showed that there were significant differences in age, pre-fracture mobility, BMI, whether cardiovascular disease was associated, and fracture type ($P < 0.05$), while there were no significant differences in gender, intraoperative operation time, anesthesia method, fracture side, intraoperative blood loss, and length of hospital stay ($P > 0.05$), as shown in Table 1.

Multivariate logistic regression analysis

Age, pre-fracture mobility, cardiovascular comorbidities, and fracture type were identified as independent risk factors for mortality ($P < 0.05$). See Table 2.

Discussion

As age increases, the functionality of organs and bodily systems gradually declines. Elderly patients often exhibit poor physical condition and a weakened immune system, making them more susceptible to infections and malnutrition. This diminished capacity to handle the stress of fractures and surgical procedures results in higher surgical risks and increased postoperative complications [8]. Additionally, the prevalence of cardiovascular diseases, such as hypertension and coronary artery disease, is higher among the elderly. Surgical interventions following fractures can exacerbate these pre-existing conditions and even lead to new health issues in some patients [9–11]. These factors significantly impact the prognosis of hemiarthroplasty and threaten postoperative survival rates in elderly patients. Therefore, it is crucial to identify the risk factors associated with mortality in these patients and develop targeted preventive strategies to improve outcomes.

This study analyzed clinical data from 80 elderly patients who underwent hemiarthroplasty for femoral neck fractures and were followed up for over five years. We examined the correlation between patient characteristics (such as age, sex, pre-fracture mobility, BMI, cardiovascular

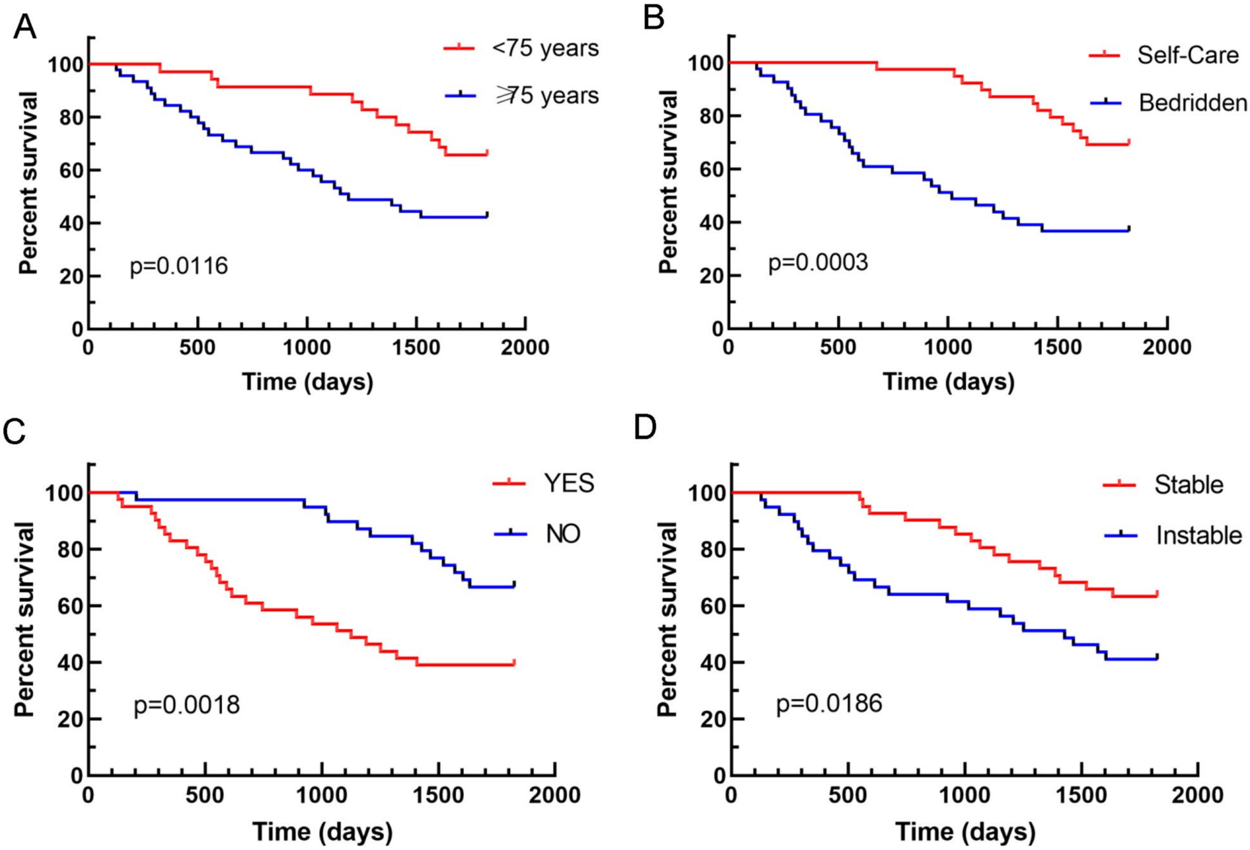

Fig. 3 Kaplan–Meier survival curves for elderly patients undergoing hemiarthroplasty, stratified by key factors. **A** Age: patients < 75 years versus ≥ 75 years ($p = 0.0116$). **B** Pre-fracture mobility: ambulatory versus bedridden patients ($p = 0.0003$). **C** Presence of cardiovascular comorbidities ($p = 0.0018$). **D** Fracture stability: stable versus unstable fractures (Garden III and IV) ($p = 0.0186$). The curves show significant differences in survival rates based on these factors

comorbidities, operative time, fracture type, anesthesia method, fracture side, intraoperative blood loss, and hospital stay) and mortality. Univariate analysis indicated that age, pre-fracture mobility, BMI, cardiovascular comorbidities, and fracture type were significant risk factors for mortality over five years post-surgery. Logistic regression analysis confirmed that age, pre-fracture mobility, cardiovascular comorbidities, and fracture type were independent risk factors for mortality, with statistically significant differences. Preoperative cardiovascular optimization strategies can effectively mitigate this risk, and we recommend that each patient's specific situation be evaluated and addressed, such as drug therapy to improve cardiovascular function, adjust water and electrolyte imbalances, and adopt a long-term and standardized strategy for cardiovascular disease treatment.

The Kaplan–Meier survival analysis highlights that advanced age, limited pre-fracture mobility, cardiovascular comorbidities, and unstable fractures (Garden III and IV) are significant predictors of lower survival in elderly patients undergoing hemiarthroplasty. These findings suggest that proactive management strategies tailored to high-risk groups, such as early cardiovascular optimization and encouraging postoperative mobility, may be crucial for improving long-term survival outcomes.

The influence of age on postoperative mortality following hemiarthroplasty is considerable. With advancing age, organ functions decline, leading to decreased compensatory abilities. The stress of prolonged bed rest and surgical interventions can worsen the health of elderly patients, adversely affecting surgical outcomes and increasing postoperative mortality. Nevertheless, it is essential to note that despite these challenges, elderly patients should not be considered contraindicated for surgery. On the contrary, healthcare providers should adopt proactive approaches to manage and treat complications in elderly patients, especially focusing on osteoporosis treatment to improve postoperative survival rates [12–14]. Our findings can be generalized to other patient populations, such as total hip replacement patients.

Table 1 Analysis of risk factors for death more than five years after hip arthroplasty [n(%)]

Influence factor		Deaths (38 cases)	Survival (42 cases)	x^2/t	P
Age (years)	< 75	12(31.58)	23(54.76)	4.357	0.037
	≥ 75	26(68.42)	19(45.24)		
Gender	Male	18(47.37)	18(42.86)	0.164	0.685
	Female	20(52.63)	24(57.14)		
Pre-fracture level	Self-care	12(31.58)	27(64.29)	8.542	0.003
	can not take care of oneself	26(68.42)	15(35.71)		
BMI(kg/m^2)	< 18.5	24(63.16)	17(40.48)	4.108	0.043
	≥ 18.5	14(36.84)	25(59.52)		
Whether there is cardiovascular disease	Yes	25(65.79)	16(38.10)	6.124	0.013
	No	13(34.21)	26(61.90)		
Intraoperative time (h)	< 2	28(73.68)	27(64.29)	0.820	0.365
	≥ 2	10(26.32)	15(35.71)		
Fracture type	stabilization	15(39.47)	27(64.29)	4.925	0.026
	instability	23(60.53)	15(35.71)		
Anesthesia method	intraspinal anesthesia	32(84.21)	33(78.57)	0.416	0.519
	general anesthesia	6(15.79)	9(21.43)		
Fracture side	Left	16(39.47)	23(54.76)	1.279	0.258
	Right	22(60.53)	19(45.24)		
Peroperative bleeding	< 200	19(50.00)	24(57.14)	0.409	0.522
	≥ 200	19(50.00)	18(52.86)		
Length of stay (days)	< 14	14(36.84)	15(35.71)	0.011	0.917
	> 14	24(63.16)	27(64.29)		

Note: Pre fracture activity level: Refers to the patient's ability to move before the fracture, whether they can walk normally or be confined to bed; Fracture type: According to the Garden classification, femoral neck fractures were divided into two types according to whether the fracture end was displaced, among which Garden I and II were stable, Garden III and IV were unstable; The anesthesia method: Refer to the frontal anesthesia of patients undergoing semi-hip replacement surgery, which can be divided into general anesthesia or intraspinal anesthesia;Fracture side refers specifically to the side of the patient with a femoral neck fracture, left femoral neck fracture or right femoral neck fracture

Advanced age, low mobility before fracture, preoperative cardiovascular disease, and unstable fractures also reduce survival in this group.

Pre-fracture mobility significantly affects survival rates after hemiarthroplasty. Patients with better pre-fracture mobility generally have better preoperative health, making them more resilient to surgical stress. This resilience allows for earlier postoperative rehabilitation, reducing bed rest duration and lowering the incidence of complications such as pulmonary infections, deep vein thrombosis, and pressure ulcers, thereby decreasing mortality risk [15, 16]. Future studies should explore early mobilization protocols tailored for patients with unstable fractures, as this could reduce the duration of bed rest, lower complication rates, and ultimately improve survival outcomes. Given the complex relationship between BMI and prefracture mobility, BMI management should be highly valued in clinical practice. For people with low BMI, such as malnutrition or chronic wasting diseases, weight should be increased to the appropriate range through reasonable nutritional intervention, thereby improving muscle strength and bone strength, and improving the level of activity before fracture. For individuals with high BMI, it is important to develop a scientific weight loss plan. Weight loss not only helps to reduce weight, reduce bone and muscle burden, but also reduces the risk of obesity-related diseases, improves overall body function, and thus improves pre-fracture mobility.

Table 2 Logistic analysis of multiple factors

Variables	*β*	SE	Wald x^2	p	OR	95%CI
Age (≥ 75 years)	1.376	0.559	6.051	0.014	3.957	1.323–11.841
Prefracture mobility (bed rest)	1.148	0.574	4.003	0.045	3.152	1.024–9.703
BMI (< 18.5 kg/m^2)	-0.278	0.600	0.215	0.643	0.757	0.234–2.453
Cardiovascular disease (Yes)	1.263	0.583	4.687	0.030	3.535	1.127–11.088
Fracture type (unstable type)	1.231	0.569	4.681	0.031	3.426	1.123–10.455

Cardiovascular comorbidities, such as hypertension and coronary artery disease, were identified as high-risk factors for mortality post-hemiarthroplasty. Patients with cardiovascular comorbidities were managed postoperatively by cardiologists. Optimizing cardiovascular function pre- and postoperatively may reduce the risk of complications and improve survival rates. Specific postoperative management included regular blood pressure monitoring, adjustment of anticoagulant therapies as needed, and vigilant observation for signs of thromboembolic events. Implementing these individualized interventions may help reduce cardiovascular-related complications and improve survival outcomes in this high-risk group. These conditions weaken the immune system, lead to malnutrition, and impair stress response regulation, making patients more prone to severe complications and worsening pre-existing conditions, thereby increasing mortality rates [17]. It is essential to evaluate and manage each patient's specific condition, such as enhancing cardiovascular function through pharmacotherapy and addressing electrolyte imbalances, to ensure effective control of complications. Long-term, standardized treatment strategies for cardiovascular diseases should be implemented [18].

Univariate and multivariate analyses revealed that unstable fractures might contribute to increased mortality risk in elderly patients undergoing hemiarthroplasty. Patients with unstable fractures, such as Garden III and IV, had a significantly higher risk of mortality, suggesting the need for tailored fracture management strategies to improve survival outcomes. [19]. In addition to fracture instability, univariate analysis indicated that BMI < 18.5 kg/m^2 is also a significant risk factor for mortality post-hemiarthroplasty in elderly patients. However, multivariate analysis did not reveal significant differences for BMI, possibly due to the limited sample size. Furthermore, the relatively small sample size may have limited the power to detect significant effects for BMI and other variables. Future research should increase sample sizes, particularly focusing on underweight patients, to refine our findings. Therefore, comprehensive preoperative assessments and accurate fracture type evaluations are crucial for reducing postoperative mortality rates in elderly patients with femoral neck fractures.

Numerous studies have demonstrated that BMI is a risk factor for postoperative complications, particularly when BMI is below 18.5 kg/m^2 [20–22]. To prevent such outcomes, healthcare providers typically offer nutritional support to underweight patients before surgery to better equip them for postoperative recovery. In this study, univariate analysis indicated that BMI < 18.5 kg/m^2 is an independent risk factor for mortality post-hemiarthroplasty in elderly patients. However, multivariate analysis did not reveal significant differences, possibly due to the limited sample size. Future research should increase sample sizes, particularly focusing on underweight patients, to refine our findings.

This study has some limitations. Given the retrospective nature of this study, there is a possibility of missing or inaccurate data. Although every effort was made to ensure data completeness, future prospective studies could provide more reliable and comprehensive evidence. Additionally, the inclusion of only patients aged 65 years or older may limit the generalizability of the results. This study focused on hemiarthroplasty, preferred in elderly patients for its shorter operative time and faster recovery. BMI was significant in univariate but not in multivariate analysis. We did not conduct a post-hoc power calculation to ensure adequate sample size for this variable. Future research should include comparisons with total hip arthroplasty (THA) to better evaluate outcomes and risks between the procedures. Prospective, multicenter studies with both hemiarthroplasty and THA groups would allow direct comparisons and provide insights for optimized treatment strategies in diverse patient populations.

Conclusions

In conclusion, aged, poor pre-fracture mobility, cardiovascular comorbidities, and unstable fracture types are significant risk factors for mortality in elderly patients undergoing hemiarthroplasty. Recognizing these factors allows for the development of targeted preventive strategies and perioperative improvements to enhance long-term survival rates in these patients.

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Authors' contributions
Conceptualization: ZZ, HL, CL, MC, FS; Data curation: MDH, HPL, XP, DEW; Formal Analysis: JJZ, MC, FS; Writing – original draft: ZZ, HL, CL; Writing – review & editing: all authors.

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Data availability
All data generated or analysed during this study are included in this published article.

Declarations

Ethics approval and consent to participate
Following approval from the Ethics Committee of the 908th Hospital of Chinese People's Liberation Army Joint Logistics Support Force (2020LL007), clinical and imaging data of elderly patients who underwent hemiarthroplasty between January 2015 and December 2018 were retrospectively analyzed. Informed consent was obtained from all participants.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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