

Association Between Non-Operative versus Operative Management and Mortality in Elderly Patients with Hip Fracture: A Retrospective Cohort Study

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Objective: To compare outcomes between non-operative and operative management of hip fractures in elderly patients.

Methods: In this single-center retrospective cohort study (January 2018–December 2022), we enrolled 298 elderly patients with hip fractures after excluding 704 from an initial 1,002 consecutive cases. This study excluded patients with old fractures, other types of fractures, lack of data on injury reason, and absence of follow-up data. Multivariable logistic regression was used to explore the association between different treatment and mortality, adjusting for age, gender, injury reason, fracture type, hypertension, and diabetes. Subgroup analyses were employed to assess the association between the different treatments and mortality.

Results: Among the 298 elderly patients with hip fractures, 59 were managed non-operatively and 239 underwent surgery. The overall 1-year mortality rate was 14.43% (43/298). Mortality was 25.42% (15/59) in the non-operative group and 11.72% (28/239) in the operative group. After adjustment, surgical management reduced mortality risk by 61% (OR =0.39, 95% CI:0.19–0.82, P = 0.013). Subgroup analysis demonstrated significant benefit in patients < 80 years (87% risk reduction; OR = 0.13, 95% CI: 0.04–0.42), whereas no significant association was observed in ≥ 80-year-olds (OR = 0.85, 95% CI:0.32–2.80, P for interaction = 0.023).

Conclusion: Our analysis indicates an association between operative management and reduced mortality risk in elderly hip fracture patients. This benefit was observed to be more marked in individuals aged under 80 years. While consistent with existing observational studies, these findings merit confirmation through randomised controlled trials, particularly to determine optimal management strategies for the oldest old (≥80 years).

Keywords: hip fracture, operation, mortality, cohort study, elderly

Introduction

Hip fractures represent the most severe consequence of osteoporosis.¹ As the global population ages, they pose a significant and growing public health burden. Worldwide, over 1.5 million adults suffer a hip fracture annually,² including approximately 325,000 in the United States.³ These injuries are particularly common among older adults due to osteoporosis, often resulting from minor falls or even low-impact activities. Hip fractures lead to functional decline, disability, and increased mortality, creating a substantial burden for patients, their families, and society.

Studies consistently demonstrate a link between hip fractures and elevated mortality, with non-operative management associated with particularly high long-term risks. For example, Frenkel et al reported comparable in-hospital mortality between operative and non-operative groups (14.9% vs. 18.1%, P=0.575), but a significantly higher one-year mortality



rate in non-surgically treated patients (67.0% vs. 48.2%, $P=0.005$).⁴ The economic impact is also profound, with annual direct medical costs in the U.S. reaching \$5.96 billion.⁵

While surgery is widely proposed as an effective treatment to reduce mortality,⁶ many elderly patients have significant comorbidities (eg., hypertension, diabetes, heart disease) that may make non-operative management a necessary alternative for the frailest individuals,⁷ particularly indicated for those exhibiting extreme frailty, declining surgical intervention, or presenting with delayed hip fractures.⁴ Clinical guidelines, such as those from the American Academy of Orthopaedic Surgeons (AAOS), acknowledge multiple treatment options for patients over 55, including hemiarthroplasty, internal fixation, or non-operative care for stable femoral neck fractures.⁸ Paradoxically, contemporary evidence reveals substantial heterogeneity: certain investigations demonstrate no statistically significant disparities in functional outcomes or mortality between surgical and non-surgical cohorts,⁴ while others document elevated mortality in non-operatively managed groups.⁹ Crucially, a paucity of high-quality evidence persists regarding surgical mortality risk reduction in patients aged ≥ 65 years. Consequently, we implemented this retrospective cohort study to quantitatively delineate the mortality impact associated with operative versus non-operative management in geriatric hip fracture patients, employing multivariate analysis to elucidate causality.

Methods

Study Population

We conducted a retrospective cohort study using medical records from the Department of Trauma and Orthopedics at Huangshan City People's Hospital in Anhui Province. The study included patients admitted with hip fractures between January 2018 and December 2021. The detailed patient selection process is illustrated in [Figure 1](#). Briefly, the inclusion criteria were: (1) age >65 years; (2) acute hip fracture; and (3) admission to the trauma orthopedic ward within the study period. Exclusion criteria were: (1) Old fracture. (2) Other fracture types; (3) Missing data of injury reason, (4) Incomplete follow-up data. Full documentation is provided in [Figure 1](#) (Patient Selection Flowchart). The study was reported following the STROBE guidelines.¹⁰

Non-surgical management was adopted for hip fracture patients in this cohort due to severe comorbidities, patient/family refusal,⁴ and financial considerations. The non-operative treatment protocol comprised: bed rest, analgesic management, prophylaxis against pressure ulcers and deep vein thrombosis (DVT), prophylaxis against hypostatic pneumonia, comorbidity-directed therapy, traction, and rehabilitation.

Primary interventions for hip fractures encompassed hip arthroplasty or open reduction internal fixation.⁴ Surgical approaches utilized anterior or posterolateral access, with implant options including biological prosthesis, cemented prostheses, and othertype. Internal fixation devices encompass plate systems and intramedullary nails. Perioperative care protocols featured: continuous vital sign monitoring, multimodal therapeutic interventions, VTE prophylaxis, pressure ulcer prevention strategies, nutritional supplementation, delirium screening and management, surgical incision/drain care, guided postoperative rehabilitation protocols, pain management, prevention of constipation, and fall prevention measures.⁸

Ethical Considerations

The study protocol and the use of the anonymized database were approved by the Ethics Committee of Huangshan People's Hospital (No. 2022-C-017). Due to the retrospective nature of the study and the use of anonymized data, the requirement for informed consent was waived. All procedures were conducted in accordance with the ethical principles of the Declaration of Helsinki.

Definitions

Hip fractures were identified using ICD-10 codes S72.0–S72.2, encompassing femoral neck, pertrochanteric, and subtrochanteric fractures.

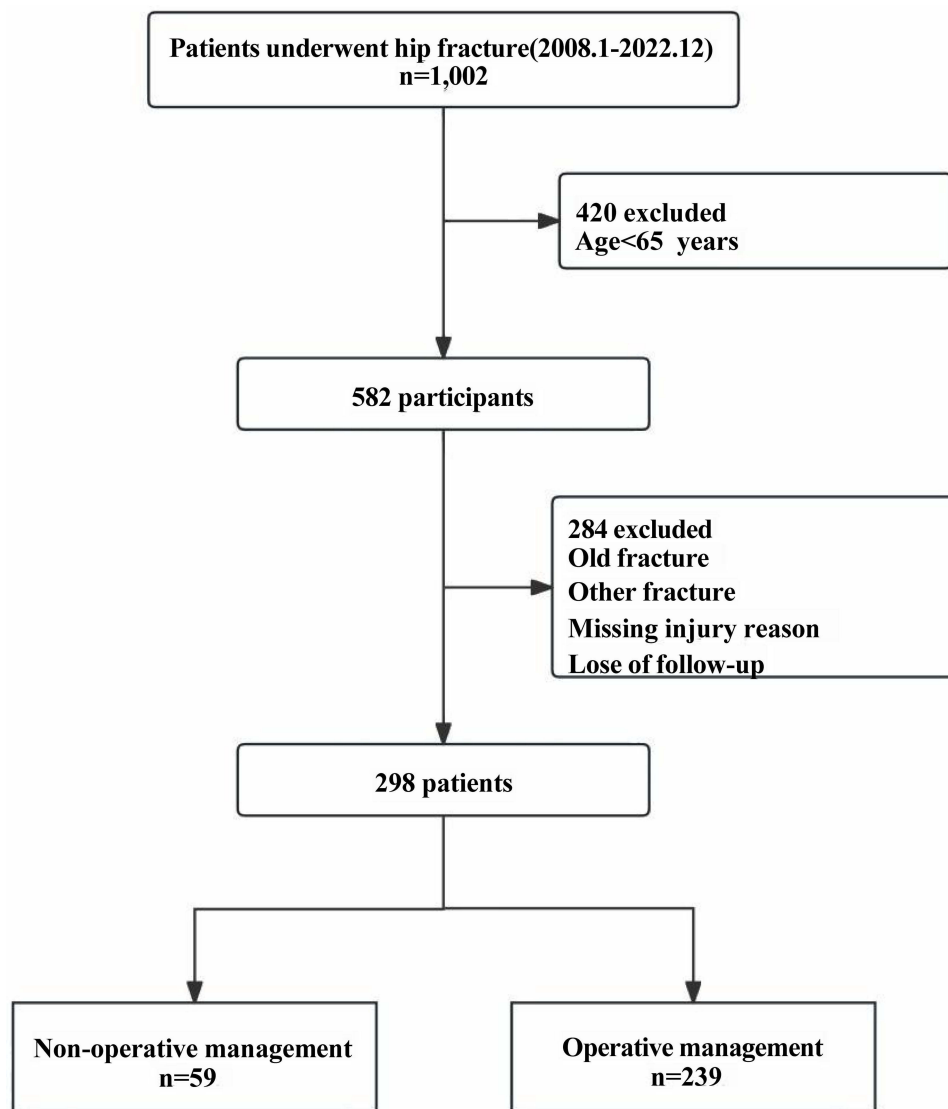


Figure 1 Flow diagram of the patient selection process.

Covariates

Collected covariates included demographic characteristics, cause of injury, fracture type, and comorbidities (hypertension, diabetes¹¹ mellitus, heart disease, cerebrovascular disease, liver disease, pulmonary disease, and chronic kidney disease). These variables were selected as potential confounders representing the patients' baseline health status.

Outcomes

The primary outcome was all-cause mortality following hip fracture diagnosis. Mortality follow-up was conducted until December 31, 2022. Causes of death encompassed a range of conditions, including but not limited to respiratory failure, heart failure, and cerebrovascular events. Mortality data were ascertained through systematic interrogation of the hospital's electronic health records (EHR) system with source verification in original medical documentation, supplemented by structured telephone follow-ups at 3-month intervals to confirm vital status until censoring or mortality occurrence.

Statistical Analysis

Continuous variables are summarized as mean \pm standard deviation or median with interquartile range, while categorical variables are presented as frequencies and percentages. Group comparisons were made using Student's *t*-test, ANOVA, Chi-square test, or Fisher's exact test, as appropriate.

The association between treatment (surgery vs. non-surgery) and mortality was assessed using univariate and multivariate logistic regression, yielding odds ratios (ORs) with 95% confidence intervals (CIs). We constructed four sequential models: Model 1 (unadjusted); Model 2 (adjusted for age and sex); Model 3 (further adjusted for cause of injury and fracture type); and Model 4 (further adjusted for hypertension and diabetes). We consequently employed multiple statistical models to evaluate the robustness of the findings. Subsequently, covariates in the final model were adjusted based on two criteria: (1) Variables underwent statistical correction if their inclusion altered the matching odds ratio by $\geq 10\%$; (2) Multivariate variable selection was guided by established prior evidence and clinical constraints. Model 4 consequently exhibited superior stability and reduced methodological invasiveness relative to other models. Interaction and stratified analyses were performed by age group (<80 vs. ≥ 80 years).

Sensitivity analyses: First, univariate analyses were initially conducted. Second, validation through sensitivity analyses incorporating both variables (Medical insurance, and pulmonary disease) confirmed the robustness of primary findings. Third, building upon Model 4, we incorporated additional adjustments for heart disease and pulmonary disease to reassess the association between therapeutic interventions and mortality. Finally, E values were reported in the sensitivity analysis, which is related to the potential subject to unmeasured confounding.³⁴

All analyses were performed using R version 3.3.2 and Free Statistics software version 1.7.1. A two-sided *p*-value < 0.05 was considered statistically significant.

Results

Baseline Characteristics of Study Participants

A total of 1,002 patients underwent surgery for femoral fracture at the trauma orthopedic center of Huangshan City People's Hospital between January 2018 and December 2022. After applying the exclusion criteria, 298 eligible patients (185 females and 113 males) were included in the final analysis. The baseline characteristics of the non-operative and operative management groups are presented in [Table 1](#). Of the total cohort, 59 patients (19.8%) were managed non-operatively, while 239 (80.2%) underwent surgery. The median length of stay (LOS) was 14.5 days (interquartile range [IQR]: 10.2–18.8). A statistically significant difference in fracture type distribution was observed between the two management groups (*P* < 0.05, [Table 1](#)).

Risk Factors and Mortality

Multivariate logistic regression analysis was performed to identify factors affecting mortality. After adjusting for covariates, surgical management was associated with a significantly lower risk of mortality compared to non-operative management (OR: 0.39, 95% CI: 0.19–0.82, *P* = 0.013) ([Table 2](#)).

Subgroup analysis by age revealed a significant interaction. The reduction in mortality associated with surgery was more pronounced in patients aged <80 years (OR: 0.13, 95% CI: 0.04–0.42, *P* = 0.001) than in those aged ≥ 80 years (OR: 0.85, 95% CI: 0.52–2.28, *P* = 0.075) ([Table 3](#)). This indicates that the protective effect of surgery was particularly strong in the younger elderly population.

Consistent with this finding, the overall analysis confirmed that non-operative management was associated with higher mortality. Regarding specific causes of death within one year of follow-up, the most frequent were heart failure, lung cancer, and COVID-19 ([Table 4](#)).

Sensitivity Analysis

Univariate analysis demonstrated statistical significance for age, cardiac comorbidity, and operative management in relation to mortality (*P* < 0.05; [Supplementary Table 1](#)). Model robustness persisted when sequentially adjusting for: (1) insurance status and pulmonary disease; and (2) cardiac and pulmonary comorbidities ([Supplementary Tables 2 and 3](#),

Table 1 Baseline Characteristics of Participants

Variables	Total (n = 298)	No Surgery (n = 59)	Surgery (n = 239)	P value
Age, (years)	78.5 ± 7.5	80.0 ± 7.7	78.1 ± 7.5	0.081
Gender, n (%)				0.681
Female	185 (62.1)	38 (64.4)	147 (61.5)	
Medical insurance, n (%)				0.015
Yes	133 (44.6)	18 (30.5)	115 (48.1)	
Career, n (%)				0.354
Farmer	164 (55.0)	34 (57.6)	130 (54.4)	
Worker	6 (2.0)	0 (0)	6 (2.5)	
Freelancer	60 (20.1)	15 (25.4)	45 (18.8)	
Retirement	68 (22.8)	10 (16.9)	58 (24.3)	
Injury reason, n (%)				0.787
Fall	275 (92.3)	54 (91.5)	221 (92.5)	
Accidence	23 (7.7)	5 (8.5)	18 (7.5)	
Hip fracture, n (%)				< 0.001
Femoral neck fracture	103 (34.6)	13 (22)	90 (37.7)	
Per trochanteric fracture	190 (63.8)	42 (71.2)	148 (61.9)	
Subtrochanteric fracture	5 (1.7)	4 (6.8)	1 (0.4)	
Hypertension, n (%)				0.773
Yes	116 (38.9)	22 (37.3)	94 (39.3)	
DM, n (%)				
Yes	32 (10.7)	5 (8.5)	27 (11.3)	
Heart disease, n (%)				0.030
Yes	40 (13.4)	13 (22)	27 (11.3)	
Chronic kidney disease, n (%)				1.000
Yes	9 (3.0)	2 (3.4)	7 (2.9)	
Cerebral disease, n (%)				0.402
Yes	27 (9.1)	7 (11.9)	20 (8.4)	
Pulmonary disease, n (%)				0.007
Yes	20 (6.7)	9 (15.3)	11 (4.6)	
Liver disease, n (%)				0.485
Yes	3 (1.0)	1 (1.7)	2 (0.8)	
Hospital costs (¥)	21,360.0 (15,770.0, 26,600.0)	4747.0 (3301.0, 7544.0)	23,000.0 (19,100.0, 27,820.0)	< 0.001
LOS (days)	14.5 (10.2, 18.8)	7.0 (4.0, 12.0)	16.0 (12.0, 19.0)	< 0.001

Abbreviations: LOS, length of stay; DM, diabetes mellifluous; (¥), yuan.

Table 2 Multivariate Logistical Regression of Surgery for Mortalit

Variable	Model 1		Model 2		Model 3		Model 4	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
Surgery								
No	Reference		Reference		Reference		Reference	
Yes	0.39 (0.19~0.79)	0.009	0.42 (0.2~0.86)	0.018	0.39 (0.19~0.82)	0.012	0.39 (0.19~0.82)	0.013

Notes: Model 1: did not adjust any confounders. Model 2: adjusted for age and gender. Model 3: additionally adjusted for injury reason and fracture type. Model 4: additionally adjusted for hypertension, and DM.

respectively). The E-value for this cohort ranged from 4.19 to 4.57 ([Supplementary Figure 1](#)). In sensitivity analyses, all computed E-values exceeded the observed odds ratio (OR). Most E-values >4 indicate that substantial unmeasured confounding would be required to explain the current association, suggesting a more robust relationship.

Table 3 Subgroup Analyses of the Association Between Surgery and Mortality

Subgroup	Total	Event (%)	Crude. OR 95% CI	Crud. P value	Adj. OR 95% CI	Adj. P value	P for interaction
Age (Years)							0.023
Age < 80	136	8 (5.9)	0.15 (0.05~0.47)	0.001	0.13 (0.04~0.42)	0.001	0.090
Age ≥ 80	103	20 (19.4)	0.81 (0.32~2.06)	0.662	0.85 (0.32~2.28)	0.746	
Gender							
Male	92	11 (12.0)	0.22 (0.07~0.65)	0.006	0.15 (0.05~0.51)	0.002	
Female	147	17 (11.6)	0.58 (0.22~1.52)	0.266	0.79 (0.28~2.22)	0.652	

Note: adj: Adjusted. Crude: did not adjust any confounders. Adj: additionally adjusted for age, gender, injury reason, fracture type, hypertension, and DM.

Table 4 The Reason of Mortality of Hip Fracture in the Elderly During the Follow-Up

The Reason of Mortality	N	Percentage (%)
Respiratory failure	7	16.28
Heart failure	4	9.30
Chronic renal failure	4	9.30
Multiple organ failure	3	6.98
Myocardial infarct	1	2.33
Cerebral infarction	4	9.30
Cerebral hemorrhage	1	2.33
Pulmonary embolism	1	2.33
Lung cancer	5	11.63
Cardiac arrest	1	2.33
Corona virus disease	5	11.63
Other	7	16.28

Discussion

This study demonstrated that operative management of hip fractures in elderly patients was associated with a significantly reduced mortality risk.

The benefits of surgical intervention for elderly hip fracture patients are increasingly recognized globally. In our cohort, the one-year mortality rate was substantially higher in the non-operative group (25.42%) compared to the surgical group (11.72%). This finding aligns with existing literature: Frenkel et al reported significantly elevated one-year mortality in non-operatively managed patients (67.0% vs. 48.2%).⁴ Similarly, Yang et al found that arthroplasty improved long-term survival in femoral neck fracture patients over 90 compared to conservative treatment.¹² Multiple other studies support this pattern—Nike et al documented higher one-year mortality with nonoperative management (16.4% vs. 9.3%),¹³ while Karen et al observed reduced five-year mortality with surgical management of unstable spine fractures in the elderly.¹⁴ Additional evidence from Ashton et al,¹⁵ a matched cohort study,¹⁶ and a multicenter investigation consistently showed significantly higher mortality rates in non-operatively managed patients. Even in frail, institutionalized older patients with limited life expectancy, Sverre et al demonstrated that operative management resulted in lower six-month mortality.⁷ A systematic review further concluded that nonoperative management of frail elderly hip fracture patients predicts poor prognosis.¹⁷

Our analysis specifically revealed that surgery substantially reduced mortality in patients under 80 years old, consistent with previous research.^{18,19} This age-dependent effect may be explained by several factors: patients aged ≥80 typically present with more numerous and severe comorbidities. Additionally, the requirement for administrative approval from the medical section before surgery can cause delays. Even when surgery is pursued, octogenarians often

have diminished physiological reserve, reduced organ functional capacity, and poorer tolerance to the acute stress of fracture and surgery, collectively increasing perioperative risks and compounding postoperative complications. While statistical significance was not reached in the oldest old (≥ 80 years old), the point estimate directionally aligns with benefit. Surgical decisions should incorporate frailty assessments and geriatric comanagement to mitigate competing risks. Interestingly, our study found similar excess all-cause mortality patterns after hip fractures in both men and women, contrasting with some previous studies.^{19,20} Although men demonstrated lower hip fracture incidence and mortality than women, this trend was not statistically significant in our cohort. These discrepancies may stem from the unique characteristics of our Chinese patient population or from our comprehensive analytical approach incorporating not only subgroup but also interaction and stratified analyses.

This study has several notable strengths. First, our inclusion of all consecutive elderly hip fracture patients minimized selection bias. Second, we thoroughly evaluated the surgery-mortality relationship using multiple multivariate logistic regression models with sequential adjustment for potential confounders.

Several limitations warrant consideration. First, Despite potential residual confounding, subgroup analyses, E-values were done. Non-surgical patients were presumably frailer in unmeasured domains (eg., pre-fracture functional status, cognitive impairment, ASA-classified comorbidity burden). The substantial effect size (OR=0.39) likely overestimates the true causal relationship, highlighting the need for future multicentre randomised controlled trials. Second, our findings are based on patients aged ≥ 65 years with specific hip fracture types (femoral neck, pertrochanteric, and subtrochanteric), which may limit generalizability to younger patients or those with other fracture patterns. Third, while existing evidence suggests different surgical techniques (eg., arthroplasty vs. internal fixation) may significantly impact outcomes,²¹ we did not perform subgroup analyses based on surgical approach. Fourth, post hoc power analysis indicated 72.9% power ($\alpha=0.05$, two-sided) to detect an odds ratio (OR) of 0.39, assuming baseline mortality rates of 11.7% (group 1) and 25.4% (group 2), with a required sample size of 298. As this falls below the conventional 80% threshold. We recognise that the study's statistical power constraint requires larger patient cohorts in future research. This expansion will enable more robust conclusions regarding the observed associations. Finally, The primary significance of this study resides in delineating critical research priorities. Specifically, future investigations should address: Which quantifiable frailty metrics best predict favourable surgical outcomes? How preoperative optimisation pathways for octogenarian/nonagenarian patients may confer survival gains. Which non-operative or palliative strategies maximise quality of life for the frailest patients who derive no survival benefit from surgery, prioritising comfort-oriented care.

Conclusions

This study confirms that surgery significantly reduces mortality in elderly hip fracture patients, with the greatest benefit in those under 80. These findings strongly support operative management as the standard of care for this population. Non-operative management may be indicated for patients with absolute contraindications, including prohibitive comorbidities causing functional decline, intrinsically stable fractures, or patient/family refusal. For those with clear surgical indications who express reservations, clinicians should communicate the substantial survival benefits evidenced in current literature and actively optimise modifiable parameters to enable surgical intervention. In cases where comorbidities or frailty preclude operative candidacy, comprehensive geriatric assessment via multidisciplinary co-management is essential. This approach necessitates intensifying management of underlying pathologies, implementing non-surgical protocols to reduce complications, and prioritising quality-of-life optimisation.

Data Sharing Statement

The original contributions of this study are included in the article/[supplementary material section](#). Further inquiries can be directed to the corresponding author.

Ethics Approval and Consent to Participate

The establishment of this database and the study were approved by the Ethical Committee of the Huangshan City People's Hospital, Huangshan, China, The data are anonymous, and the requirement for informed consent was therefore

waived. The study adhered to the Declaration of Helsinki. This study was performed in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.

Acknowledgments

We gratefully thank Jie Liu of the Department of Vascular and Endovascular Surgery, Chinese PLA General Hospital and Jian Ling of the Department of Trauma and Orthopedic Surgery, Huangshan City People's Hospital for their contributions to the statistical support, study design consultations, and comments regarding the manuscript. We thank all the patients who took part in the study.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

This study did not receive any specific grants from any funding agencies in the public, commercial, or not-for-profit sectors.

Disclosure

The authors report no conflicts of interest in this work.

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