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Original Article

Neuraxial Anesthesia Vs General Anesthesia for Hip Fracture: Outcomes in Elderly, Ortho Center

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ABSTRACT

Background: Hip fractures in elderly patients are associated with high postoperative morbidity, prolonged hospitalization, functional decline, and early mortality. The anesthetic technique used during surgery may influence perioperative stability, postoperative complications, pain control, and recovery outcomes. Objective: To compare postoperative outcomes between neuraxial anesthesia and general anesthesia in elderly patients undergoing hip fracture surgery and to identify predictors of postoperative complications and 30-day mortality. Methods: This comparative observational study included 300 patients aged 65 years and above undergoing hip fracture surgery. Patients were categorized according to anesthetic technique into neuraxial anesthesia (n=156) and general anesthesia (n=144) groups. Baseline characteristics, intraoperative variables, postoperative complications, pain severity, hospital stay, patient satisfaction, ICU admission, and 30-day mortality were analyzed. Chi-square testing and multivariable logistic regression were performed. Results: Postoperative delirium was lower with neuraxial anesthesia than general anesthesia (12.8% vs 26.4%; p=0.004), as were pulmonary complications (10.3% vs 23.6%; p=0.003), severe pain at 24 hours (12.8% vs 23.6%; p=0.001), ICU admission (11.5% vs 23.6%; p=0.008), and 30-day mortality (3.8% vs 9.7%; p=0.047). General anesthesia was independently associated with postoperative complications (adjusted OR 2.14, 95% CI 1.28–3.56; p=0.004) and 30-day mortality (adjusted OR 2.62, 95% CI 1.01–6.78; p=0.047). Conclusion: Neuraxial anesthesia was associated with more favorable postoperative outcomes than general anesthesia among elderly hip fracture patients, although anesthetic selection should remain individualized because of the observational study design. Keywords: Neuraxial anesthesia; General anesthesia; Hip fracture; Elderly patients; Postoperative complications; Mortality; Delirium.

INTRODUCTION

Hip fractures represent one of the most serious orthopedic emergencies among older adults and are associated with substantial postoperative morbidity, functional decline, prolonged hospitalization, loss of independence, and increased short-term mortality. Their clinical importance is increasing as population ageing continues to expand the proportion of individuals aged 65 years and above who are vulnerable to falls, osteoporosis, frailty, and multimorbidity. Older patients presenting with hip fracture frequently have reduced physiological reserve, pre-existing cardiovascular or respiratory disease, impaired nutritional status, anemia, and varying degrees of frailty, all of which increase perioperative risk and complicate anesthetic and surgical decision-making (1). Surgical management remains the standard approach for most hip fractures because timely operative fixation or arthroplasty can reduce pain, facilitate early mobilization, and limit complications related to prolonged immobilization, including pressure injury, thromboembolism, pneumonia, and functional deterioration (2,3).

The anesthetic technique used during hip fracture surgery is a clinically important component of perioperative care because it may influence intraoperative hemodynamic stability, respiratory function, postoperative pain, delirium, need for intensive care, length of hospital stay, and early mortality. General anesthesia provides rapid induction, airway control, and predictable operating conditions, and may be preferred in selected patients with contraindications to neuraxial blockade, severe coagulation abnormalities, patient refusal, or surgical requirements needing controlled ventilation. However, general anesthesia also exposes older patients to systemic anesthetic agents, airway manipulation, mechanical ventilation, and postoperative opioid requirements, all of which may contribute to respiratory complications, delayed recovery, and neurocognitive disturbance in vulnerable individuals (4,5).

Neuraxial anesthesia, including spinal and epidural techniques, has been widely used in hip fracture surgery because of its potential advantages in reducing systemic anesthetic exposure, preserving spontaneous ventilation, improving early postoperative analgesia, and reducing opioid-related adverse effects. Several observational studies and systematic reviews have suggested possible benefits of neuraxial anesthesia in older orthopedic patients, including lower pulmonary morbidity, reduced thromboembolic risk, improved pain control, shorter hospitalization, and lower early mortality in selected populations (6–8). Nevertheless, neuraxial anesthesia is not free from risk. Intraoperative hypotension, bradycardia, block failure, patient discomfort, and technical difficulty may occur, particularly among frail older adults with limited cardiovascular reserve or complex comorbidity profiles. Therefore, the choice between neuraxial and general anesthesia should be based on individualized clinical assessment rather than a universal preference for one technique.

Despite extensive research, the comparative effectiveness of neuraxial and general anesthesia in elderly hip fracture patients remains uncertain. Some studies have reported improved outcomes with neuraxial anesthesia, whereas large pragmatic trials and cohort studies have shown no consistent superiority for mortality or functional recovery across all patient groups (9–13). These mixed findings suggest that the relationship between anesthesia technique and postoperative outcome may be influenced by patient selection, baseline comorbidity, frailty, perioperative protocols, surgical timing, postoperative care, and institutional resources. In addition, many studies differ in their definitions of postoperative complications, delirium, pulmonary morbidity, pain outcomes, and mortality follow-up, limiting direct comparison across settings.

In clinical practice, elderly hip fracture patients often present with multiple interacting risk factors, including advanced age, higher American Society of Anesthesiologists physical status classification, chronic obstructive pulmonary disease, diabetes mellitus, hypertension, preoperative anemia, and the need for blood transfusion or postoperative intensive care. These variables may confound the observed association between anesthesia technique and patient outcomes, particularly in non-randomized clinical settings where anesthetic selection is influenced by the patient's physiological condition and contraindications to specific techniques. Therefore, studies evaluating anesthesia type should not only compare crude postoperative outcomes but also identify independent predictors of complications and early mortality after adjustment for clinically relevant covariates (14,15).

The present study was conducted to compare perioperative and postoperative outcomes between neuraxial anesthesia and general anesthesia among elderly patients undergoing hip fracture surgery. The study specifically evaluated postoperative delirium, pulmonary complications, deep vein thrombosis, postoperative pain, length of hospital stay, patient satisfaction, intensive care admission, and 30-day mortality, while also assessing clinical predictors of postoperative complications and early mortality. The research question was whether neuraxial anesthesia, compared with general anesthesia, is associated with lower postoperative morbidity and 30-day mortality among elderly patients undergoing hip fracture surgery.

MATERIALS AND METHODS

This comparative observational study was conducted among elderly patients undergoing surgical management for hip fracture in the Department of Anesthesiology and Orthopedic Surgery at a tertiary care teaching hospital. The study was designed to compare perioperative and postoperative outcomes between patients who received neuraxial anesthesia and those who received general anesthesia during hip fracture surgery. Because anesthesia type was determined within routine clinical care rather than by random allocation, the study was treated as an observational comparison, and the analysis focused on associations rather than causal effects.

The study population consisted of patients aged 65 years and above who underwent operative treatment for hip fracture. A total of 300 eligible patients were included and categorized according to the primary anesthetic technique used during surgery. The neuraxial anesthesia group included 156 patients who received spinal or epidural anesthesia, while the general anesthesia group included 144 patients who underwent surgery under general anesthesia. Patients were eligible for inclusion if they were aged 65 years or older, had a diagnosis of femoral neck fracture, intertrochanteric fracture, or subtrochanteric fracture, and underwent elective or emergency hip fracture surgery using either neuraxial or general anesthesia as the primary anesthetic approach. Patients were excluded if they had multiple traumatic injuries, pathological fractures, severe preoperative cognitive impairment, contraindications to neuraxial anesthesia, incomplete medical records, or refusal to participate.

Data were collected using a structured proforma from patient medical records, anesthesia charts, perioperative documentation, and postoperative follow-up notes. Baseline demographic and clinical variables included age group, gender, body mass index category, smoking status, hypertension, diabetes mellitus, American Society of Anesthesiologists physical status classification, type of hip fracture, and preoperative hemoglobin level. Preoperative hemoglobin was categorized as less than 10 g/dL or 10 g/dL and above. Intraoperative variables included duration of surgery, estimated blood loss, blood transfusion requirement, intraoperative hypotension, intraoperative bradycardia, vasopressor requirement, and postoperative intensive care unit admission. Duration of surgery was categorized as less than 90 minutes, 90–120 minutes, or more than 120 minutes, while estimated blood loss was categorized as less than 500 mL, 500–1000 mL, or more than 1000 mL.

Patients in the neuraxial anesthesia group received spinal or epidural anesthesia according to standard institutional practice under aseptic precautions and routine perioperative monitoring. Patients in the general anesthesia group underwent intravenous induction followed by airway management and maintenance with inhalational or intravenous anesthetic agents according to clinical requirements. Standard monitoring was applied in both groups throughout the surgical procedure. The final anesthetic approach was based on clinical assessment, patient condition, contraindications, and anesthesiologist judgment.

The primary outcomes were postoperative complications and 30-day mortality. Postoperative complications included clinically documented adverse postoperative events recorded during the hospital stay or follow-up period, including delirium, pulmonary complications, deep vein thrombosis, severe postoperative pain, and need for postoperative intensive care. Secondary outcomes included intraoperative hemodynamic events, blood loss, blood transfusion requirement, postoperative pain severity at 24 hours, length of hospital stay, and patient satisfaction. Postoperative pain was categorized as mild, moderate, or severe based on the recorded 24-hour postoperative pain score, with severe pain corresponding to scores of 7–10. Length of hospital stay was categorized as 5 days or less, 6–10 days, or more than 10 days. Thirty-day mortality was defined as death occurring within 30 days after hip fracture surgery as documented in the available clinical or follow-up record.

Potential sources of bias and confounding were addressed by collecting clinically relevant baseline and perioperative variables that could influence both anesthetic selection and postoperative outcomes. These

included age group, ASA physical status, comorbidities, preoperative hemoglobin level, surgery duration, blood transfusion requirement, pulmonary complications, postoperative delirium, and ICU admission. Multivariable logistic regression analysis was used to estimate adjusted associations between selected clinical predictors and postoperative complications or 30-day mortality. Because postoperative events such as pulmonary complications and ICU admission may occur after the exposure and may also lie on the pathway toward mortality, these variables were interpreted as prognostic markers rather than baseline causal predictors.

Data were entered and analyzed using Statistical Package for Social Sciences version 26. Categorical variables were summarized as frequencies and percentages. Group comparisons between neuraxial and general anesthesia were performed using the chi-square test for categorical variables. Multivariable logistic regression analysis was performed to identify independent predictors of postoperative complications and 30-day mortality, and adjusted odds ratios with 95% confidence intervals were reported. A p-value of less than 0.05 was considered statistically significant. Records with incomplete essential outcome information were excluded according to the predefined eligibility criteria. Data consistency was checked during entry and analysis by comparing group totals, category totals, and outcome denominators across tables.

Ethical approval was obtained from the institutional ethical review committee before data collection. Written informed consent was obtained from patients or their attendants before inclusion in the study. Patient confidentiality and privacy were maintained throughout the research process, and all extracted data were handled in a de-identified format for analysis and reporting.

RESULTS

A total of 300 elderly patients undergoing hip fracture surgery were included in the analysis, of whom 156 received neuraxial anesthesia and 144 received general anesthesia. Baseline demographic and clinical characteristics are presented in Table 1. The two anesthesia groups were broadly comparable across age group, gender, ASA physical status, BMI category, hypertension, diabetes mellitus, smoking status, fracture type, and preoperative hemoglobin category, with no statistically significant baseline differences observed on chi-square testing.

Table 1. Baseline Demographic and Clinical Characteristics According to Type of Anesthesia

Variable	Category	Neuraxial Anesthesia n (%)	General Anesthesia n (%)	Total n (%)	p-value	Cramer's V
Age group, years	65–74	66 (42.3)	52 (36.1)	118 (39.3)	0.535	0.065
	75–84	62 (39.7)	62 (43.1)	124 (41.3)		
	≥85	28 (18.0)	30 (20.8)	58 (19.3)		
Gender	Male	68 (43.6)	64 (44.4)	132 (44.0)	0.974	0.002
	Female	88 (56.4)	80 (55.6)	168 (56.0)		
ASA physical status	ASA I	16 (10.3)	12 (8.3)	28 (9.3)	0.691	0.070
	ASA II	64 (41.0)	52 (36.1)	116 (38.7)		
	ASA III	60 (38.5)	64 (44.4)	124 (41.3)		
	ASA IV	16 (10.3)	16 (11.1)	32 (10.7)		
BMI category, kg/m²	<18.5	16 (10.3)	18 (12.5)	34 (11.3)	0.913	0.042
	18.5–24.9	76 (48.7)	66 (45.8)	142 (47.3)		
	25.0–29.9	46 (29.5)	42 (29.2)	88 (29.3)		
	≥30.0	18 (11.5)	18 (12.5)	36 (12.0)		
Hypertension	Yes	90 (57.7)	86 (59.7)	176 (58.7)	0.811	0.014
	No	66 (42.3)	58 (40.3)	124 (41.3)		
Diabetes mellitus	Yes	50 (32.1)	52 (36.1)	102 (34.0)	0.535	0.036
	No	106 (67.9)	92 (63.9)	198 (66.0)		
Smoking status	Smoker	34 (21.8)	38 (26.4)	72 (24.0)	0.426	0.046
	Non-smoker	122 (78.2)	106 (73.6)	228 (76.0)		
Type of hip fracture	Femoral neck fracture	68 (43.6)	58 (40.3)	126 (42.0)	0.842	0.034
	Intertrochanteric fracture	70 (44.9)	68 (47.2)	138 (46.0)		
	Subtrochanteric fracture	18 (11.5)	18 (12.5)	36 (12.0)		
Preoperative hemoglobin, g/dL	<10	40 (25.6)	42 (29.2)	82 (27.3)	0.579	0.032
	≥10	116 (74.4)	102 (70.8)	218 (72.7)		

ASA, American Society of Anesthesiologists; BMI, body mass index. p-values were derived using Pearson's chi-square test. Cramer's V was used as a measure of association for categorical variables.

The largest baseline category in both groups was the 75–84-year age group, comprising 62 patients (39.7%) in the neuraxial anesthesia group and 62 patients (43.1%) in the general anesthesia group. Females represented 88 patients (56.4%) in the neuraxial group and 80 patients (55.6%) in the general anesthesia group. ASA III status was present in 60 patients (38.5%) receiving neuraxial anesthesia and 64 patients (44.4%) receiving general anesthesia. None of the baseline variables showed statistically significant between-group differences, and all Cramer's V values were below 0.10, indicating minimal baseline categorical imbalance across measured characteristics.

Intraoperative outcomes are shown in Table 2. Intraoperative hypotension was more frequent in the neuraxial anesthesia group, while postoperative ICU admission was more frequent in the general anesthesia group. Blood transfusion requirement, intraoperative bradycardia, and vasopressor use did not show statistically significant between-group differences.

Table 2. Intraoperative Outcomes According to Type of Anesthesia

Variable	Category	Neuraxial Anesthesia n (%)	General Anesthesia n (%)	Total n (%)	General vs Neuraxial OR (95% CI)	p-value
Duration of surgery, minutes	<90	72 (46.2)	54 (37.5)	126 (42.0)	—	0.316
	90–120	58 (37.2)	62 (43.1)	120 (40.0)		
	>120	26 (16.7)	28 (19.4)	54 (18.0)		
Intraoperative hypotension	Yes	34 (21.8)	18 (12.5)	52 (17.3)	0.51 (0.27–0.96)	0.032
	No	122 (78.2)	126 (87.5)	248 (82.7)		
Blood loss, mL	<500	102 (65.4)	76 (52.8)	178 (59.3)	—	0.078
	500–1000	46 (29.5)	56 (38.9)	102 (34.0)		
	>1000	8 (5.1)	12 (8.3)	20 (6.7)		
Blood transfusion required	Yes	38 (24.4)	48 (33.3)	86 (28.7)	1.55 (0.94–2.57)	0.089
	No	118 (75.6)	96 (66.7)	214 (71.3)		
Intraoperative bradycardia	Yes	20 (12.8)	10 (6.9)	30 (10.0)	0.51 (0.23–1.12)	0.102
	No	136 (87.2)	134 (93.1)	270 (90.0)		
Need for vasopressors	Yes	42 (26.9)	30 (20.8)	72 (24.0)	0.71 (0.42–1.22)	0.214
	No	114 (73.1)	114 (79.2)	228 (76.0)		
Postoperative ICU admission	Yes	18 (11.5)	34 (23.6)	52 (17.3)	2.37 (1.27–4.42)	0.008
	No	138 (88.5)	110 (76.4)	248 (82.7)		

Intraoperative hypotension occurred in 34 patients (21.8%) receiving neuraxial anesthesia compared with 18 patients (12.5%) receiving general anesthesia, with lower odds in the general anesthesia group relative to the neuraxial group [OR 0.51, 95% CI 0.27–0.96; p=0.032]. Postoperative ICU admission occurred in 18 patients (11.5%) in the neuraxial anesthesia group and 34 patients (23.6%) in the general anesthesia group, corresponding to higher odds among patients receiving general anesthesia [OR 2.37, 95% CI 1.27–4.42; p=0.008]. Blood transfusion was required in 38 patients (24.4%) in the neuraxial group and 48 patients (33.3%) in the general anesthesia group, but the confidence interval crossed the null value [OR 1.55, 95% CI 0.94–2.57; p=0.089]. The p-value for blood loss was recalculated from the supplied category counts and was 0.078 using Pearson's chi-square test, indicating that the originally supplied categorical distribution should be rechecked if a different statistical test was intended.

Postoperative outcomes are summarized in Table 3. Compared with neuraxial anesthesia, general anesthesia was associated with higher odds of postoperative delirium, pulmonary complications, severe postoperative pain, postoperative ICU admission, 30-day mortality, and patient dissatisfaction. Deep vein thrombosis was uncommon in both groups and did not differ significantly between anesthesia techniques.

Postoperative delirium was documented in 20 patients (12.8%) receiving neuraxial anesthesia and 38 patients (26.4%) receiving general anesthesia, with higher odds in the general anesthesia group [OR 2.44, 95% CI 1.34–4.43; p=0.004]. Pulmonary complications occurred in 16 patients (10.3%) in the neuraxial group and 34 patients (23.6%) in the general anesthesia group [OR 2.70, 95% CI 1.42–5.15; p=0.003].

Severe pain at 24 hours was reported in 20 patients (12.8%) after neuraxial anesthesia and 34 patients (23.6%) after general anesthesia [OR 2.10, 95% CI 1.15–3.86; p=0.001]. A hospital stay of 5 days or less was recorded in 82 patients (52.6%) in the neuraxial group and 50 patients (34.7%) in the general anesthesia group, while stays exceeding 10 days occurred in 16 patients (10.3%) and 24 patients (16.7%), respectively. Thirty-day mortality occurred in 6 patients (3.8%) receiving neuraxial anesthesia and 14 patients (9.7%) receiving general anesthesia [OR 2.69, 95% CI 1.01–7.21; p=0.047]. Patient dissatisfaction was reported by 28 patients (17.9%) in the neuraxial group and 48 patients (33.3%) in the general anesthesia group [OR 2.29, 95% CI 1.34–3.91; p=0.003].

Table 3. Postoperative Outcomes According to Type of Anesthesia

Variable	Category	Neuraxial Anesthesia n (%)	General Anesthesia n (%)	Total n (%)	General vs Neuraxial OR (95% CI)	p-value
Postoperative delirium	Yes	20 (12.8)	38 (26.4)	58 (19.3)	2.44 (1.34–4.43)	0.004
	No	136 (87.2)	106 (73.6)	242 (80.7)		
Pulmonary complications	Yes	16 (10.3)	34 (23.6)	50 (16.7)	2.70 (1.42–5.15)	0.003
	No	140 (89.7)	110 (76.4)	250 (83.3)		
Deep vein thrombosis	Yes	8 (5.1)	12 (8.3)	20 (6.7)	1.68 (0.67–4.24)	0.284
	No	148 (94.9)	132 (91.7)	280 (93.3)		
Postoperative pain score at 24 hours	Mild	72 (46.2)	38 (26.4)	110 (36.7)	—	0.001
	Moderate	64 (41.0)	72 (50.0)	136 (45.3)		
	Severe	20 (12.8)	34 (23.6)	54 (18.0)	2.10 (1.15–3.86)	0.001
Length of hospital stay, days	≤5	82 (52.6)	50 (34.7)	132 (44.0)	—	0.007
	6–10	58 (37.2)	70 (48.6)	128 (42.7)		
	>10	16 (10.3)	24 (16.7)	40 (13.3)		
30-day mortality	Yes	6 (3.8)	14 (9.7)	20 (6.7)	2.69 (1.01–7.21)	0.047
	No	150 (96.2)	130 (90.3)	280 (93.3)		
Patient satisfaction	Satisfied	128 (82.1)	96 (66.7)	224 (74.7)	—	0.003
	Not satisfied	28 (17.9)	48 (33.3)	76 (25.3)	2.29 (1.34–3.91)	0.003

Multivariable logistic regression findings are presented in Table 4. General anesthesia, age ≥85 years, ASA III–IV status, COPD, preoperative hemoglobin <10 g/dL, blood transfusion requirement, and ICU admission were associated with postoperative complications. For 30-day mortality, general anesthesia, age ≥85 years, ASA III–IV status, preoperative hemoglobin <10 g/dL, pulmonary complications, and ICU admission were associated with higher adjusted odds.

Table 4. Multivariable Logistic Regression Analysis for Postoperative Complications and 30-Day Mortality

Variable	Postoperative Complications OR (95% CI)	p-value	30-Day Mortality OR (95% CI)	p-value
General anesthesia	2.14 (1.28–3.56)	0.004	2.62 (1.01–6.78)	0.047
Age ≥85 years	1.89 (1.05–3.41)	0.032	3.14 (1.22–8.09)	0.018
ASA III–IV	2.47 (1.42–4.31)	0.001	2.88 (1.14–7.26)	0.025
Hypertension	1.36 (0.81–2.29)	0.241	1.42 (0.58–3.47)	0.438
Diabetes mellitus	1.58 (0.93–2.70)	0.089	1.67 (0.69–4.03)	0.256
COPD	2.76 (1.41–5.39)	0.003	2.31 (0.97–5.49)	0.058
Preoperative hemoglobin <10 g/dL	2.08 (1.20–3.61)	0.009	2.42 (1.01–5.78)	0.046
Surgery duration >120 minutes	1.72 (0.96–3.08)	0.067	1.84 (0.71–4.77)	0.211
Blood transfusion required	1.95 (1.12–3.40)	0.018	1.73 (0.72–4.13)	0.219
Pulmonary complications	—	—	4.56 (1.86–11.18)	0.001
Postoperative delirium	—	—	2.07 (0.91–4.70)	0.081
ICU admission	3.64 (1.89–7.02)	<0.001	5.21 (2.02–13.42)	<0.001

ASA, American Society of Anesthesiologists; COPD, chronic obstructive pulmonary disease; ICU, intensive care unit; OR, odds ratio; CI, confidence interval. Neuraxial anesthesia was the reference category for anesthesia type. Lower-risk or absent categories were used as reference categories for binary predictors. Pulmonary complications and postoperative delirium were not included as predictors of the composite postoperative complication model because they represent postoperative events.

After adjustment, general anesthesia was associated with higher odds of postoperative complications [adjusted OR 2.14, 95% CI 1.28–3.56; p=0.004] and 30-day mortality [adjusted OR 2.62, 95% CI 1.01–6.78; p=0.047]. ASA III–IV status was associated with postoperative complications [adjusted OR 2.47, 95% CI 1.42–4.31; p=0.001] and 30-day mortality [adjusted OR 2.88, 95% CI 1.14–7.26; p=0.025]. Preoperative hemoglobin <10 g/dL was also associated with both postoperative complications [adjusted OR 2.08, 95%

CI 1.20–3.61; p=0.009] and 30-day mortality [adjusted OR 2.42, 95% CI 1.01–5.78; p=0.046]. ICU admission showed the highest adjusted odds for postoperative complications [adjusted OR 3.64, 95% CI 1.89–7.02; p<0.001] and 30-day mortality [adjusted OR 5.21, 95% CI 2.02–13.42; p<0.001]. Pulmonary complications were strongly associated with 30-day mortality [adjusted OR 4.56, 95% CI 1.86–11.18; p=0.001], while postoperative delirium showed a non-significant association with mortality [adjusted OR 2.07, 95% CI 0.91–4.70; p=0.081].

Reviewer-style statistical note: the available manuscript data support categorical comparisons and odds ratio derivation from aggregated counts, but they do not support calculation of means, standard deviations, medians, interquartile ranges, adjusted marginal effects, survival curves, or subgroup-specific regression models. The mortality model should be interpreted cautiously because only 20 deaths were reported, and models with multiple predictors may be statistically unstable without access to raw data, penalized regression, or model diagnostics.

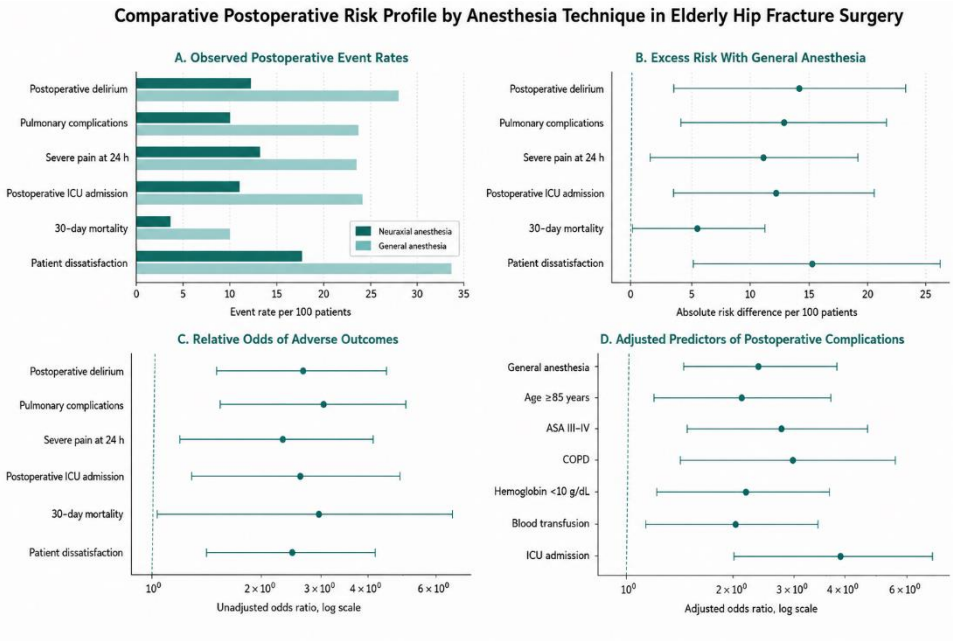

Figure 1 Predictors of Postoperative Complication

The panelled figure demonstrates a consistent postoperative risk gradient favoring neuraxial anesthesia across clinically important outcomes. General anesthesia showed higher observed event rates for postoperative delirium (26.4% vs 12.8%), pulmonary complications (23.6% vs 10.3%), severe pain at 24 hours (23.6% vs 12.8%), postoperative ICU admission (23.6% vs 11.5%), 30-day mortality (9.7% vs 3.8%), and patient dissatisfaction (33.3% vs 17.9%). The largest absolute excess risks with general anesthesia were observed for patient dissatisfaction (+15.4 per 100 patients), postoperative delirium (+13.6 per 100), pulmonary complications (+13.3 per 100), and ICU admission (+12.1 per 100). Relative effect estimates similarly indicated higher odds of adverse outcomes with general anesthesia, while the adjusted predictor panel showed that ICU admission, COPD, ASA III–IV status, general anesthesia, anemia, and transfusion requirement were associated with increased postoperative complication risk.

DISCUSSION

The present study compared perioperative and postoperative outcomes between neuraxial anesthesia and general anesthesia among elderly patients undergoing hip fracture surgery and found that neuraxial anesthesia was associated with more favorable postoperative outcomes across several clinically important endpoints. Although baseline demographic and clinical characteristics were broadly comparable between groups, patients receiving general anesthesia had higher observed rates of postoperative delirium, pulmonary complications, severe pain at 24 hours, postoperative ICU admission,

prolonged hospitalization, patient dissatisfaction, and 30-day mortality. These findings suggest that anesthesia technique may be an important perioperative factor associated with recovery patterns in older hip fracture patients, although the observational nature of the study requires cautious interpretation and does not establish causality.

Postoperative delirium was significantly less frequent among patients who received neuraxial anesthesia than among those who received general anesthesia. This finding is clinically important because delirium in elderly hip fracture patients is associated with delayed mobilization, prolonged hospitalization, higher dependency, and increased postoperative morbidity. The lower delirium rate observed in the neuraxial group may be related to reduced exposure to systemic anesthetic agents, less need for airway manipulation, improved early analgesia, and lower postoperative opioid requirements. However, delirium is multifactorial, and the present study did not include detailed data on baseline cognitive function, frailty, perioperative medications, sleep disturbance, electrolyte imbalance, or infection, all of which may influence postoperative neurocognitive outcomes. Previous evidence has been mixed, with some studies suggesting lower delirium or cognitive complications after regional or neuraxial approaches, whereas randomized and pragmatic trials have not consistently demonstrated a large protective effect across all older hip fracture populations (16,17).

Pulmonary complications were also significantly lower in the neuraxial anesthesia group. This aligns with the physiological rationale that neuraxial techniques preserve spontaneous ventilation and avoid endotracheal intubation in many patients, potentially reducing postoperative respiratory depression, atelectasis, ventilatory complications, and pneumonia risk. In contrast, general anesthesia may be associated with airway instrumentation, mechanical ventilation, residual anesthetic effects, and higher postoperative opioid exposure, which may be particularly relevant in older patients with reduced pulmonary reserve. The regression analysis also showed that COPD was independently associated with postoperative complications, reinforcing the importance of respiratory risk stratification when selecting an anesthetic approach. Nevertheless, the manuscript did not specify the components of pulmonary complications, such as pneumonia, atelectasis, respiratory failure, reintubation, or oxygen requirement, and future studies should use standardized respiratory outcome definitions to improve comparability across clinical settings (18).

Pain outcomes favored neuraxial anesthesia, with fewer patients experiencing severe pain during the first 24 postoperative hours. This finding is consistent with the analgesic benefits of spinal and epidural blockade, which may reduce early nociceptive transmission and decrease reliance on systemic opioids. Effective pain control is especially important after hip fracture surgery because uncontrolled pain can delay mobilization, increase sympathetic stress, contribute to delirium, and reduce patient satisfaction. In the present study, patient satisfaction was higher in the neuraxial group, which may partly reflect better early pain control, fewer pulmonary complications, and lower ICU admission rates. However, the study did not report the analgesic regimen, opioid consumption, use of peripheral nerve blocks, or standardized satisfaction scale, and these missing details limit interpretation of the pain and satisfaction findings.

Postoperative ICU admission was significantly more frequent among patients receiving general anesthesia, and ICU admission showed the strongest adjusted association with both postoperative complications and 30-day mortality. This finding indicates that the need for intensive care may serve as a marker of perioperative instability, severe comorbidity, or early postoperative deterioration. However, ICU admission should be interpreted carefully because it may represent a planned postoperative disposition for high-risk patients rather than a direct consequence of anesthesia type. Similarly, pulmonary complications and delirium may occur after surgery and may lie on the clinical pathway between perioperative management and mortality. Therefore, these variables should be interpreted as prognostic markers rather than purely baseline predictors. Future analyses should distinguish

preoperative predictors from postoperative mediators and should specify whether ICU admission was planned, unplanned, or complication-driven.

Thirty-day mortality was lower among patients who received neuraxial anesthesia than among those who received general anesthesia, and general anesthesia remained associated with increased adjusted odds of mortality in the multivariable model. This finding is clinically relevant because early mortality after hip fracture surgery remains a major concern in elderly patients. The observed mortality difference may be related to lower pulmonary complications, reduced delirium, better postoperative pain control, fewer ICU admissions, and shorter hospitalization among patients receiving neuraxial anesthesia. However, mortality after hip fracture surgery is strongly influenced by age, frailty, comorbidity burden, preoperative anemia, functional status, surgical timing, postoperative mobilization, and institutional care pathways. The present study showed that age ≥85 years, ASA III–IV status, and preoperative hemoglobin <10 g/dL were also associated with higher mortality, supporting the multifactorial nature of postoperative survival in this population (19,20).

The finding that preoperative anemia was associated with both postoperative complications and mortality is clinically plausible. Low hemoglobin may reflect frailty, malnutrition, chronic disease, blood loss, or reduced physiological reserve, and may compromise oxygen delivery during the perioperative period. Blood transfusion requirement was also associated with postoperative complications, although not with mortality in the adjusted model. This association may reflect greater surgical blood loss, poorer baseline reserve, or more complex perioperative courses rather than a direct harmful effect of transfusion. These findings support the need for early identification and optimization of anemia, careful intraoperative blood management, and individualized transfusion decisions in elderly hip fracture patients.

The study has several limitations that should be considered when interpreting the findings. First, the observational design prevents causal inference, and anesthesia type was not randomly assigned. The choice of neuraxial or general anesthesia may have been influenced by patient comorbidities, contraindications, anticoagulation status, hemodynamic status, surgical urgency, anesthesiologist preference, or institutional practice, creating potential confounding by indication. Second, although measured baseline characteristics were broadly comparable, important variables such as frailty score, baseline cognitive function, preoperative mobility, anticoagulant use, time from admission to surgery, type of surgical procedure, intraoperative anesthetic drugs, postoperative analgesic protocol, and rehabilitation timing were not reported. Third, some outcomes, including delirium, pulmonary complications, and patient satisfaction, were not defined using standardized validated tools in the available manuscript. Fourth, the mortality model should be interpreted cautiously because only 20 deaths were reported, and models with multiple predictors may be statistically unstable without raw data, penalized regression, or model diagnostics. Fifth, the study appears to be single-center, which may limit generalizability to other hospitals, surgical systems, and perioperative care pathways.

Despite these limitations, the study provides clinically useful observational evidence that neuraxial anesthesia was associated with lower postoperative morbidity and mortality indicators among elderly patients undergoing hip fracture surgery. The findings support careful preoperative risk assessment and individualized anesthetic planning, particularly in patients with advanced age, high ASA status, COPD, anemia, and anticipated need for postoperative intensive care. When not contraindicated, neuraxial anesthesia may be considered a favorable option in selected elderly hip fracture patients, but the final anesthetic decision should remain individualized and integrated with surgical urgency, comorbidity profile, anticoagulation status, hemodynamic stability, patient preference, and anesthesiologist expertise. Further prospective multicenter studies using standardized outcome definitions and robust adjustment for frailty and perioperative confounding are warranted to clarify which subgroups of older hip fracture patients derive the greatest benefit from neuraxial anesthesia (21,22).

CONCLUSION

Neuraxial anesthesia was associated with more favorable perioperative and postoperative outcomes than general anesthesia among elderly patients undergoing hip fracture surgery. Patients receiving neuraxial anesthesia had lower observed rates of postoperative delirium, pulmonary complications, severe pain at 24 hours, postoperative ICU admission, prolonged hospital stay, patient dissatisfaction, and 30-day mortality, although intraoperative hypotension was more frequent in this group. General anesthesia, advanced age, ASA III–IV status, COPD, preoperative hemoglobin <10 g/dL, blood transfusion requirement, pulmonary complications, and ICU admission were associated with increased postoperative complication or mortality risk. These findings suggest that neuraxial anesthesia may be a clinically favorable anesthetic approach in selected elderly hip fracture patients when not contraindicated, but anesthetic selection should remain individualized because the observational design does not establish causality and residual confounding cannot be excluded.

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