International Journal of Biology and Life Sciences
ISSN: 2957-9511 | Vol. 9, No. 2, 2025

Comparison of Neuraxial Anesthesia versus General Anesthesia on Postoperative Delirium in Hip Fracture Surgery Patients: A Meta-Analysis of Random Controlled Trials

Shuting Hong, Tiancheng Ye, Zecheng Yang *

Department of Anesthesiology, Panyu Hospital of Chinese Medicine, Guangzhou, Guangdong 511400, China
* **Corresponding author**: Zecheng Yang (Email: 519246774@qq.com)

Abstract: Hip fractures are increasingly common in aging societies and are associated with high mortality rates. Surgery is the primary treatment for hip fracture patients, with the most commonly used anesthetic methods being neuraxial anesthesia and general anesthesia. Postoperative delirium (POD) is a frequent complication following hip fracture surgery, contributing to increased societal burden and patient mortality. Whether different anesthetic methods influence the incidence of POD remains unclear. To explore the impact of anesthetic methods on POD, we conducted this meta-analysis. We systematically searched PubMed, Embase, and the Cochrane Library for randomized controlled trials (RCTs) comparing neuraxial anesthesia and general anesthesia in hip fracture patients, assessing the effects on delirium incidence, mortality, pneumonia, pulmonary embolism, and myocardial infarction. Five RCTs involving 3118 participants were included. Our findings indicate no significant differences between neuraxial and general anesthesia in terms of POD (RR=1.11, P=0.29), mortality (RR=1.00, P=0.98), pneumonia (RR=0.61, P=0.12), pulmonary embolism (RR=0.62, P=0.43), or myocardial infarction (RR=0.76, P=0.53). Both neuraxial and general anesthesia are effective options for elderly patients undergoing hip fracture surgery.

Keywords: Postoperative Delirium; Hip Fractures; Neuraxial Anesthesia; General Anesthesia.

1. Introduction

With the aging population, hip fractures have become increasingly prevalent among the elderly, with a 20% risk of recurrent fractures, leading to high rates of disability and mortality, and imposing a significant economic burden on families and society [1]. Surgical intervention, followed by rehabilitation, is the most effective treatment for hip fractures, and nearly all hip fracture patients undergo surgery [2]. However, elderly patients face high surgical risks, with a one-year postoperative mortality rate of up to 31% [3]. In addition to complications such as pneumonia, myocardial infarction, and renal impairment, postoperative delirium is also common, occurring in up to 53% of elderly hip fracture patients [4].

Delirium is an acute neuropsychiatric syndrome characterized by cognitive dysfunction, attention deficits, and fluctuating consciousness [5]. It predominantly affects patients over 65 years old, significantly increasing hospital stays, healthcare costs, and mortality rates [5]. Postoperative delirium typically occurs within the first week after surgery, most commonly within 24-72 hours. It is often underdiagnosed or misdiagnosed, leading to inadequate treatment and poor patient outcomes [6, 7]. Reducing the incidence of POD remains a key focus for clinicians.

Hip fracture surgery can be performed under various anesthetic methods, with neuraxial anesthesia and general anesthesia being the most common [8]. General anesthesia ensures the patient is unconscious and pain-free during surgery, reducing anxiety and improving comfort [9]. Neuraxial anesthesia may offer benefits such as reduced intraoperative hypotension but can also cause patient discomfort and anxiety [9]. Currently, there is no consensus on the optimal anesthetic choice for hip fracture surgery. While some large cohort studies suggest that neuraxial anesthesia may reduce POD in elderly patients, recent large RCTs from China found no significant difference in POD incidence between neuraxial and general anesthesia [10]. Given the inconsistent findings in previous studies, we designed this meta-analysis to explore the impact of regional versus general anesthesia on POD in elderly hip fracture patients.

2. Materials and Methods

2.1. Inclusion and Exclusion Criteria

2.1.1. Study Type

Randomized controlled trials (RCTs).

2.1.2. Participants

Hip fracture surgery patients; neuraxial or general anesthesia; elderly patients aged >60 years; no gender restrictions; related to postoperative delirium.

2.1.3. Interventions

(1) Neuraxial anesthesia with or without intravenous sedation (combined spinal-epidural anesthesia, spinal anesthesia, epidural anesthesia);

(2) General anesthesia with or without nerve block (endotracheal intubation, laryngeal mask airway).

2.1.4. Outcome Measures

Incidence of delirium, postoperative mortality, pneumonia, pulmonary embolism, and myocardial infarction.

2.1.5. Exclusion Criteria

(1) Non-RCT studies;
(2) Non-hip fracture surgery;
(3) Non-elderly patients;
(4) Non-neuraxial or general anesthesia;
(5) No data on postoperative delirium;

(6) Case reports;

(7) Retrospective analyses, case-control studies, cohort studies;

(8) Reviews, systematic reviews, meta-analyses;

(9) Non-English or Chinese studies;

(10) Full text unavailable.

2.2. Search Strategy

2.2.1. Database Search

We searched PubMed (Medline), Cochrane Library, and Embase using a combination of MeSH terms and free-text keywords. The search covered the period from database inception to January 2025, with weekly updates until this article's publication. The PubMed search strategy is as follows:

#1 "Anesthesia, General"[MeSH Terms] OR "Anesthesias, General"[All Fields] OR "General Anesthesia" [All Fields] OR "General Anesthesias" [All Fields].

#2 "Anesthesia, Spinal"[MeSH Terms] OR "[All Fields] OR" [All Fields] OR" [All Fields] OR "[All Fields] OR "Anesthesias, Spinal" [All Fields] OR "Spinal Anesthesia" [All Fields] OR " Spinal Anesthesias"[All Fields].

#3 "Hip Fractures"[MeSH Terms] OR "Fractures, Hip"[All Fields] OR "Intertrochanteric Fractures" [All Fields] OR "Fractures, Intertrochanteric" [All Fields] OR "Subtrochanteric Fractures "[All Fields] OR "Fractures, Subtrochanteric" [All Fields] OR " Trochanteric Fractures" [All Fields] OR "Fractures, Trochanteric"[All Fields] OR "Trochlear Fractures, Femur" [All Fields] OR "Femur Trochlear Fracture" [All Fields] OR "Fracture, Femur Trochlear" [All Fields] OR "Femoral Trochlear Fractures" [All Fields] OR ""[All Fields] OR "Trochlear Fracture, Femoral" [All Fields].

#4 "Delirium"[MeSH Terms] OR "Delirium of Mixed Origin"[All Fields] OR "Mixed Origin Delirium" [All Fields] OR "Mixed Origin Deliriums" [All Fields] OR "Subacute Delirium"[All Fields] OR "Deliriums, Subacute" [All Fields] OR "Delirium, Subacute" [All Fields] OR "Subacute Deliriums"[All Fields].

#5 #1 AND #2 AND #3 AND #4.

Similar search strategies were applied to Cochrane Library and Embase.

2.2.2. Manual Search

We manually searched reference lists of included studies, related reviews, systematic reviews, retrospective analyses, cohort studies, and case reports to ensure comprehensive coverage. We also searched clinical trial registries (Chinese Clinical Trial Registry and ClinicalTrials.gov) for relevant studies.

2.3. Study Selection and Data Extraction

2.3.1. Study Selection

Two trained reviewers independently screened studies. After removing duplicates, studies were initially screened based on titles and abstracts. Full texts were reviewed for final inclusion. If full texts were unavailable, corresponding authors were contacted. Disagreements were resolved through discussion or consultation with a senior reviewer.

2.3.2. Data Extraction

Data were extracted independently by two reviewers, including:

(1) Baseline characteristics: author, year, sample size, age, region, study design;

(2) Quality assessment: random sequence generation, allocation concealment, blinding, outcome data completeness, selective reporting, and other biases;

(3) Outcomes: delirium incidence, mortality, pneumonia, pulmonary embolism, myocardial infarction;

(4) Other data: intervention details, follow-up duration, trial registration.

2.4. Risk of Bias Assessment

The Cochrane Risk of Bias Tool was used to assess bias in included studies, focusing on random sequence generation, allocation concealment, blinding, incomplete outcome data, selective reporting, and other biases. Risk of bias was evaluated using Review Manager 5.3.

2.5. Statistical Analysis

Review Manager 5.3 was used for meta-analysis. Mean difference (MD) and 95% confidence intervals (CI) were used for continuous variables, while risk ratios (RR) and 95% CI were used for dichotomous variables. Heterogeneity was assessed using the Chi-square test and I^2 statistic. A P-value <0.05 was considered statistically significant.

3. Results

3.1. Study Selection

A total of 1469 studies were identified from PubMed, Embase, and Cochrane Library, with an additional 80 studies from manual searches. After screening, 5 RCTs involving 3118 participants were included [10-14]. The study selection process is shown in Figure 1.

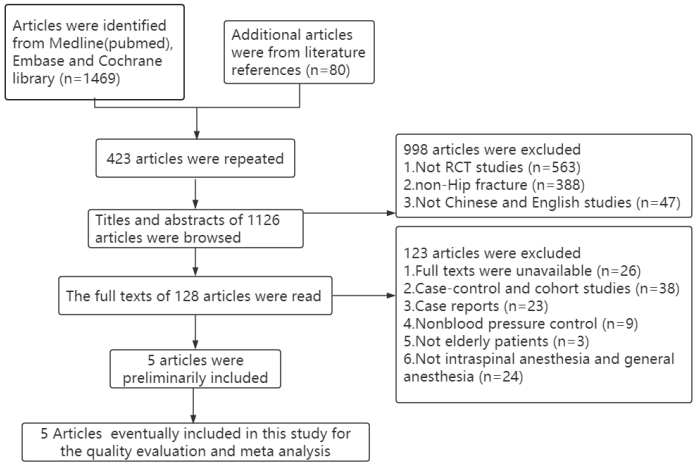

Figure 1. Literature screening process and results.

3.2. Characteristics and Risk of Bias of Included Studies

The 5 included studies were published between 2005 and 2021, with a total of 3118 participants. Studies were conducted in the USA, Canada, China, Greece, and Korea. All studies compared neuraxial and general anesthesia in elderly hip fracture patients. The basic characteristics of the included studies are shown in Table 1. Risk of bias assessment is summarized in Figures 2 and 3.

3.3. Meta-Analysis Results

3.3.1. Postoperative Delirium Incidence

Five studies involving 2719 participants were included. Heterogeneity was low (I^2=0%), and a fixed-effects model was used. The incidence of POD was slightly lower in the general anesthesia group (12.1%) compared to the neuraxial anesthesia group (13.6%), but the difference was not statistically significant (RR=1.11, 95% CI: 0.92-1.35, P=0.29; Figure 4). Funnel plot analysis showed no significant publication bias (Figure 5).

Table 1. Basic characteristics of the included studies.

Authors years	Intervention	Type of Patients	Number	Country	Design
Neuman 2021	Intravertebral anesthesia/General anesthesia	Hip fracture	1600	United States and Canada	RCT
Li 2021	Intravertebral anesthesia/General anesthesia	Hip fracture	950	China	RCT
Parker 2015	Intravertebral anesthesia/General anesthesia	Hip fracture	322	Canada	RCT
Tzimas 2018	Intravertebral anesthesia/General anesthesia	Hip fracture	70	Greece	RCT
Toraman 2005	Intravertebral anesthesia/General anesthesia	Hip fracture	176	Korea	RCT

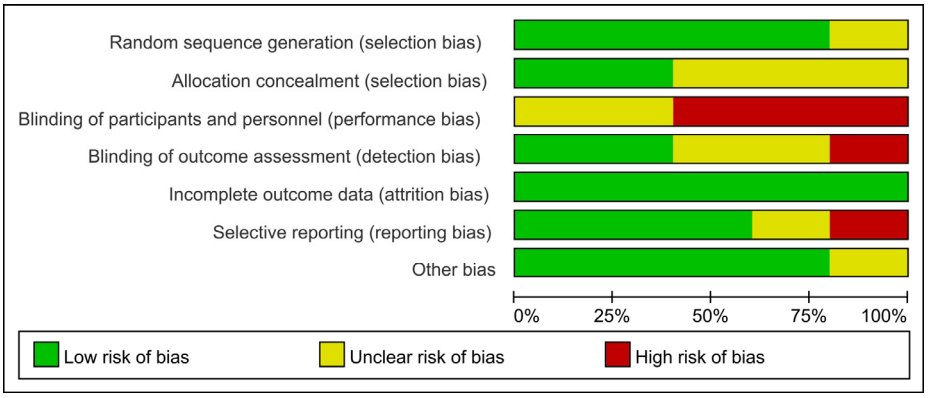

Figure 2. Risk of bias graph for included studies.

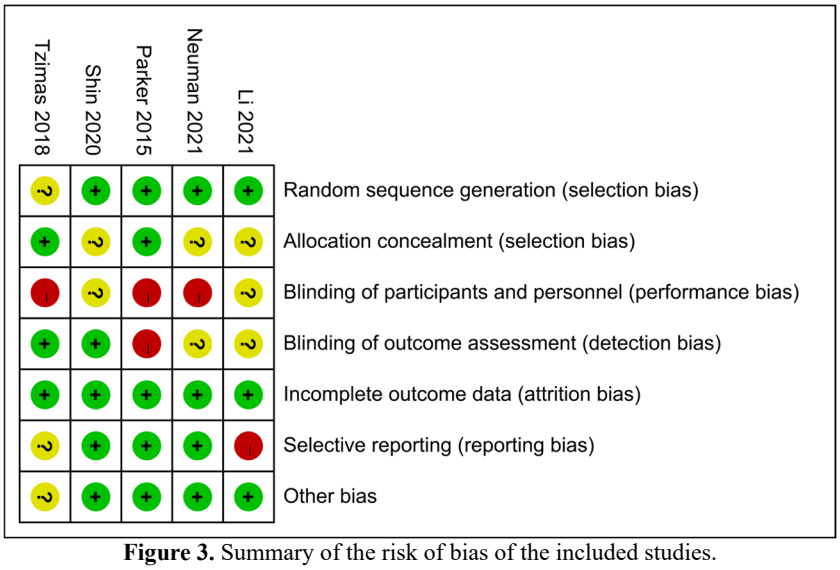

Figure 3. Summary of the risk of bias of the included studies.

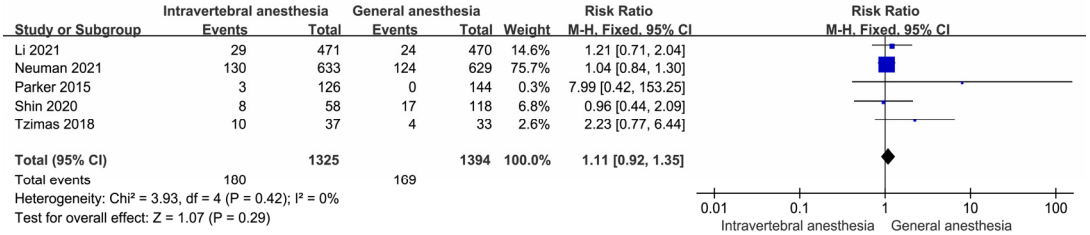

Figure 4. Meta-analysis of the Incidence of postoperative delirium under neuraxial anesthesia as compared with general Anesthesia

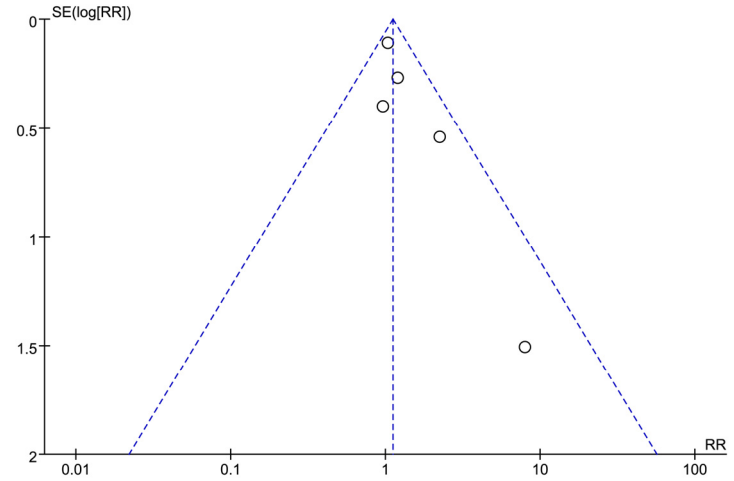

Figure 5. Results of funnel plot analysis of five studies on the incidence of postoperative delirium

3.3.2. Postoperative Mortality

Four studies involving 2931 participants were included. No significant difference in mortality was found between neuraxial anesthesia and general anesthesia (RR=1.00, 95% CI: 0.66-1.49, P=0.98; Figure 6). Funnel plot analysis showed no significant publication bias (Figure 7).

Study or Subgroup	Intravertebral anesthesia Events	Total	General anesthesia Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Li 2021	8	469	4	464	8.9%	1.98 [0.60, 6.53]
Neuman 2021	30	768	32	784	70.2%	0.96 [0.59, 1.56]
Parker 2015	5	126	8	144	16.5%	0.71 [0.24, 2.13]
Shin 2020	1	58	3	118	4.4%	0.68 [0.07, 6.38]
Tzimas 2018	0	0	0	0		Not estimable
Total (95% CI)		**1421**		**1510**	**100.0%**	**1.00 [0.66, 1.49]**
Total events	44		47			

Heterogeneity: Chi² = 1.77, df = 3 (P = 0.62); I² = 0%
Test for overall effect: Z = 0.02 (P = 0.98)

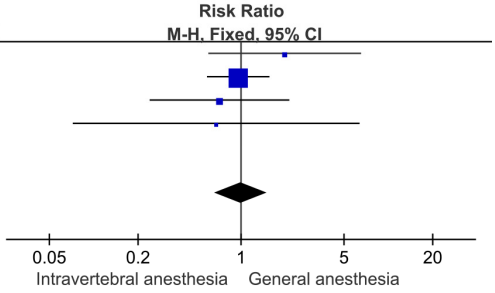

Figure 6. Meta-analysis of postoperative mortality under neuraxial anesthesia as compared with general Anesthesia.

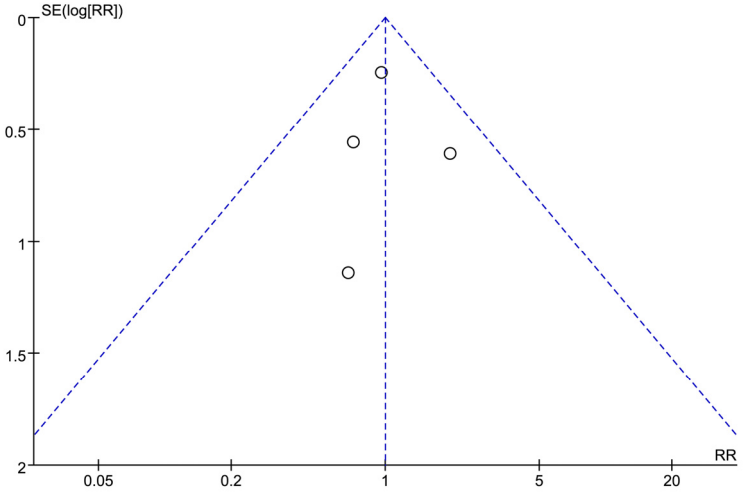

Figure 7. Results of funnel plot analysis of four studies on postoperative mortality.

3.3.3. Pneumonia Incidence

Study or Subgroup	Intravertebral anesthesia Events	Total	General anesthesia Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Li 2021	0	471	1	471	5.7%	0.33 [0.01, 8.16]
Neuman 2021	8	783	16	793	60.8%	0.51 [0.22, 1.18]
Parker 2015	2	126	3	144	10.7%	0.76 [0.13, 4.49]
Shin 2020	4	58	9	118	22.7%	0.90 [0.29, 2.81]
Tzimas 2018	0	0	0	0		Not estimable
Total (95% CI)		**1438**		**1526**	**100.0%**	**0.61 [0.33, 1.14]**
Total events	14		29			

Heterogeneity: Chi² = 0.84, df = 3 (P = 0.84); I² = 0%
Test for overall effect: Z = 1.55 (P = 0.12)

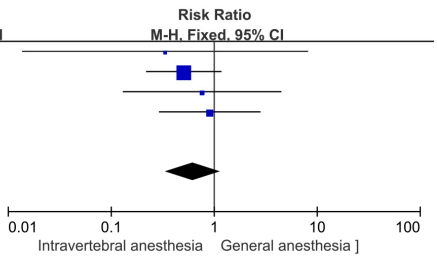

Figure 8. Meta-analysis of pneumonia incidence under neuraxial anesthesia as compared with general Anesthesia.

Four studies involving 2964 participants were included. The incidence of pneumonia was higher in the general anesthesia group (1.9%) compared to the neuraxial anesthesia group (0.97%), but the difference was not statistically significant (RR=0.61, 95% CI: 0.33-1.14, P=0.12; Figure 8). Funnel plot analysis showed no significant publication bias (Figure 9).

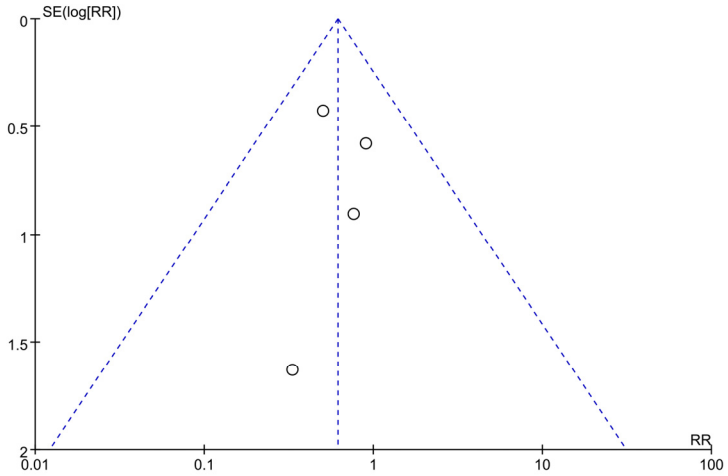

Figure 9. Results of funnel plot analysis of four studies on pneumonia incidence

3.3.4. Pulmonary Embolism Incidence

Two studies involving 1846 participants were included. No significant difference in pulmonary embolism incidence was found between the two groups (RR=0.62, 95% CI: 0.19-2.02, P=0.43).

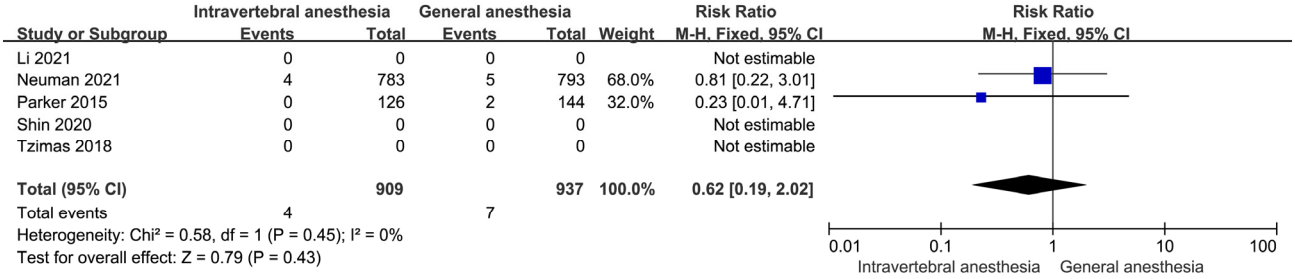

Figure 10. Meta-analysis of pulmonary embolism incidence under neuraxial anesthesia as compared with general anesthesia.

3.3.5. Myocardial Infarction Incidence

Four studies involving 2858 participants were included. No significant difference in myocardial infarction incidence was found between neuraxial anesthesia and general anesthesia (RR=0.76, 95% CI: 0.32-1.79, P=0.53; Figure 11). Funnel plot analysis showed no significant publication bias (Figure 12).

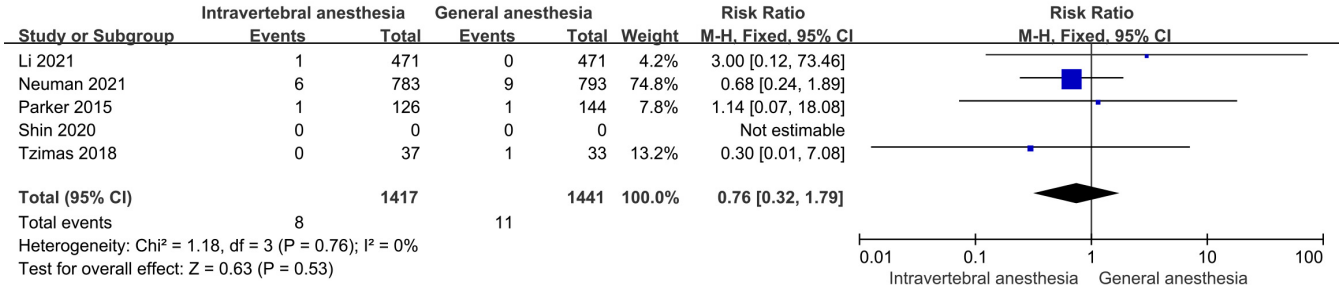

Figure 11. Meta-analysis of myocardial infarction incidence under neuraxial anesthesia as compared with general anesthesia.

4. Discussion

This study mainly analyzed the effects of different anesthesia methods (neuraxial anesthesia and general anesthesia) on postoperative delirium, postoperative mortality, pneumonia incidence, pulmonary embolism incidence, and myocardial infarction incidence in elderly patients undergoing hip fracture surgery. A total of 5 RCT studies were included in this study, involving 3,118 subjects. The study found that there were no significant differences in the effects of neuraxial anesthesia and general anesthesia on postoperative delirium, postoperative mortality, pneumonia incidence, pulmonary embolism incidence, and myocardial infarction incidence. Different anesthesia methods did not affect the incidence of these adverse events in patients.

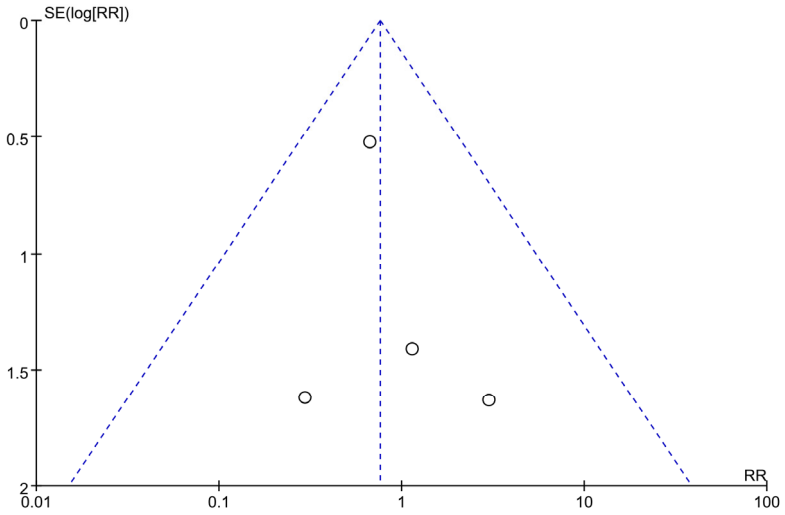

Figure 12. Results of funnel plot analysis of four studies on myocardial infarction incidence.

We found that there was no significant difference in the incidence of postoperative delirium between patients who received neuraxial anesthesia and those who received general anesthesia (RR = 1.11, P = 0.29), indicating that different anesthesia methods do not affect the incidence of postoperative delirium in elderly patients undergoing hip surgery. Similar to our study results, Zheng et al. and Fan et al. found no significant difference in the incidence of delirium between spinal anesthesia (intraspinal or epidural) and general anesthesia [15; 16]. Additionally, two recent randomized controlled clinical trials also found no significant difference in the incidence of postoperative delirium between general anesthesia and spinal anesthesia in elderly patients with hip fractures [10; 11]. Postoperative delirium, as an acute disturbance of consciousness, often occurs within 2-5 days after surgery [17]. Multiple factors before, during, and after surgery can affect the incidence of delirium, including fasting time, perioperative fluid administration, perioperative blood pressure management, and the choice of anesthesia method. Although previous cohort studies have found that neuraxial anesthesia may reduce the incidence of postoperative delirium, subsequent large-scale randomized controlled clinical trials, multiple meta-analyses, and our study have all found that the choice of anesthesia method may not be the main factor influencing postoperative delirium [10; 11]. Although our study found that the anesthesia method does not affect the incidence of postoperative delirium, further analysis of the impact of the anesthesia method on the incidence of postoperative delirium through larger RCT studies or meta-analyses is still necessary.

We found that there was no significant difference in postoperative mortality between patients who received neuraxial anesthesia and those who received general anesthesia (RR = 1.00, P = 0.98), indicating that different anesthesia methods do not affect postoperative mortality in elderly patients undergoing hip surgery. Diulus et al. found that in total hip arthroplasty patients, general anesthesia increased the 1-year mortality rate compared to neuraxial anesthesia [18]. However, both Lin et al.'s meta-analysis and our study found no significant difference in the impact of general anesthesia and spinal anesthesia on postoperative mortality [19]. In this study, we mainly focused on the 30-day postoperative mortality rate, while Diulus et al.'s study mainly focused on the 1-year postoperative mortality rate, which may be one of the reasons for the difference in our results.

This study found that there was no significant difference in the incidence of pneumonia, pulmonary embolism, and myocardial infarction between patients who received neuraxial anesthesia and those who received general anesthesia in elderly patients undergoing hip surgery, indicating that different anesthesia methods do not affect the incidence of postoperative pneumonia, pulmonary embolism, and myocardial infarction in elderly patients undergoing hip surgery. Similarly, Liu et al. found no significant difference in the incidence of pneumonia and myocardial infarction between general anesthesia and spinal anesthesia in hip fracture surgery patients [20]. The incidence of pneumonia, pulmonary embolism, and myocardial infarction may be related to factors such as the patient's age, underlying diseases, blood loss, and hemodynamic fluctuations, and further research is needed to clarify this.

5. Conclusion

In our meta-analysis, we explored the impact of different anesthesia methods (neuraxial anesthesia and general anesthesia) on the incidence of postoperative delirium, mortality, pneumonia, pulmonary embolism, and myocardial infarction in elderly patients undergoing hip joint surgery. We found that compared with general anesthesia, neuraxial anesthesia did not show significant differences in the incidence of postoperative delirium and postoperative complications. Different anesthesia methods are not the main cause of the incidence of the above adverse events. Both neuraxial anesthesia and general anesthesia are effective anesthesia methods that can be chosen for elderly hip fracture surgery.

Acknowledgments

We express our gratitude to the anesthesia team at Panyu Hospital of Chinese Medicine for their invaluable support in this study.

References

[1] E Schemitsch, J D Adachi, J P Brown, et al. “Hip fracture predicts subsequent hip fracture: A retrospective observational study to support a call to early hip fracture prevention efforts

in post-fracture patients," Osteoporos Int, vol. 33, pp. 113-122, 2022.

[2] M D Neuman, L A Fleisher, O Even-Shoshan, et al. "Nonoperative care for hip fracture in the elderly: The influence of race, income, and comorbidities," Med Care, vol. 48, pp. 314-320, 2010.

[3] C Downey, M Kelly, J F Quinlan. "Changing trends in the mortality rate at 1-year post hip fracture - a systematic review," World J Orthop, vol. 10, pp. 166-175, 2019.

[4] A M Albanese, N Ramazani, N Greene, et al. "Review of postoperative delirium in geriatric patients after hip fracture treatment," Geriatr Orthop Surg Rehabil, vol. 13, pp. 21514593211058947, 2022.

[5] E S Oh, T G Fong, T T Hshieh, et al. "Delirium in older persons: Advances in diagnosis and treatment," Jama, vol. 318, pp. 1161-1174, 2017.

[6] J E Wilson, M F Mart, C Cunningham, et al. "Delirium," Nat Rev Dis Primers, vol. 6, pp. 90, 2020.

[7] L Evered, B Silbert, D S Knopman, et al. "Recommendations for the nomenclature of cognitive change associated with anaesthesia and surgery-2018," Anesthesiology, vol. 129, pp. 872-879, 2018.

[8] L Morgan, T M McKeever, J Nightingale, et al. "Spinal or general anaesthesia for surgical repair of hip fracture and subsequent risk of mortality and morbidity: A database analysis using propensity score-matching," Anaesthesia, vol. 75, pp. 1173-1179, 2020.

[9] A R Bodenham, S J Howell. "General anaesthesia vs local anaesthesia: An ongoing story," Br J Anaesth, vol. 103, pp. 785-789, 2009.

[10] T Li, J Li, L Yuan, et al. "Effect of regional vs general anesthesia on incidence of postoperative delirium in older patients undergoing hip fracture surgery: The raga randomized trial," Jama, vol. 327, pp. 50-58, 2022.

[11] M D Neuman, R Feng, J L Carson, et al. "Spinal anesthesia or general anesthesia for hip surgery in older adults," N Engl J Med, vol. 385, pp. 2025-2035, 2021.

[12] M J Parker, R Griffiths. "General versus regional anaesthesia for hip fractures. A pilot randomised controlled trial of 322 patients," Injury, vol. 46, pp. 1562-1566, 2015.

[13] P Tzimas, E Samara, A Petrou, et al. "The influence of anesthetic techniques on postoperative cognitive function in elderly patients undergoing hip fracture surgery: General vs spinal anesthesia," Injury, vol. 49, pp. 2221-2226, 2018.

[14] S Shin, S H Kim, K K Park, et al. "Effects of anesthesia techniques on outcomes after hip fracture surgery in elderly patients: A prospective, randomized, controlled trial," J Clin Med, vol. 9, pp. 1605, 2020.

[15] X Zheng, Y Tan, Y Gao, et al. "Comparative efficacy of neuraxial and general anesthesia for hip fracture surgery: A meta-analysis of randomized clinical trials," BMC Anesthesiol, vol. 20, pp. 162, 2020.

[16] G Fan, M Zhong, W Su, et al. "Effect of different anesthetic modalities on postoperative delirium in elderly hip fractures: A meta-analysis," Medicine (Baltimore), vol. 103, pp. e38418, 2024.

[17] Z Jin, J Hu, D Ma. "Postoperative delirium: Perioperative assessment, risk reduction, and management," Br J Anaesth, vol. 125, pp. 492-504, 2020.

[18] S C Diulus, C Mucharraz, D R Schmitt, et al. "Morbidity and mortality following total hip and knee arthroplasty with spinal versus general anesthesia: A retrospective analysis," J Arthroplasty,vol. 39, pp. 2675-2679, 2024.

[19] H Lin, Y Zhu, C Ren, et al. "Comparing the effect of spinal and general anesthesia for hip fracture surgery in older patients: A meta-analysis of randomized clinical trials," Orthop Surg,vol. 15, pp. 3254-3262, 2023.

[20] S Liu, J Chen, H Shi, et al. "Comparing perioperative outcomes between regional anesthesia and general anesthesia in patients undergoing hip fracture surgery: A systematic review and meta-analysis," Can J Anaesth, vol. 71, pp. 849-869, 2024.