Invest Clin 66(2): 217 - 230, 2025 https://doi.org/10.54817/IC.v66n2a08

Impact of regional anesthesia vs general anesthesia on postoperative outcomes in elderly patients with hip fracture: a meta-analysis.

Feng Han[1], Yue Yang[1] and Xinxin Tian[2]

[1]Department of Anesthesiology, Hangzhou Geriatric Hospital, Hangzhou, China.
[2]Department of Infectious Diseases, Hangzhou Ninth People's Hospital, Hangzhou, China.

Keywords: hip fracture; anesthesia; elderly; meta-analysis.

Abstract. The objective of this study was to utilize meta-analysis to compare the impact of regional anesthesia (RA) versus general anesthesia (GA) on postoperative outcomes in elderly patients undergoing hip fracture surgery. Electronic databases (PubMed, Web of Science, Cochrane Library, and Embase) were searched for randomized controlled trials (RCTs) comparing the effects of RA and GA in elderly patients undergoing hip fracture surgery. The random or fixed-effects model was used to calculate pooled relative risks (RR) and mean differences (MD). Fourteen RCTs involving 5626 elderly patients undergoing hip fracture surgery were included. Meta-analysis indicated that RA was associated with a lower incidence of intraoperative blood loss (MD: -39.7 mL; 95% CI: -68.61, -10.84; p = 0.007), adverse events including intraoperative hypotension (RR: 1.09; 95% CI: 0.90, 1.32; p = 0.005) and postoperative cognitive dysfunction (RR: 0.56; 95% CI: 0.37, 0.86; p = 0.007) compared to GA. However, no statistically significant differences were found between RA and GA regarding surgical time, anesthesia time, intraoperative transfusion, hospital length, delirium, and mortality. RA can effectively reduce intraoperative blood loss and the risk of hypotension. Due to the current lack of evidence, no positive effects of RA on other postoperative outcomes were identified. A rigorously designed, high-quality study is warranted to determine the impact of anesthesia type on elderly hip fracture patients.

Corresponding author. Xinxin Tian. Department of Infectious Diseases, Hangzhou Ninth People's Hospital. No. 98 Yilong Road, Yipong Street, Qiantang District, Hangzhou, China. Tel: 86-18317898728.
Email: tianxinxintxxtxx@163.com

Impacto de la anestesia regional vs anestesia general en los resultados posoperatorios en pacientes ancianos con fractura de cadera: un meta-análisis.

Invest Clin 2025; 66 (2): 217 – 230

Palabras clave: fractura de cadera; anestesia; ancianos; meta-análisis.

Resumen. El objetivo de este estudio fue utilizar meta-análisis para comparar el impacto de la anestesia regional (AR) versus la anestesia general (AG) en los resultados posoperatorios en pacientes ancianos sometidos a cirugía de fractura de cadera. Se buscó en las bases de datos electrónicas (PubMed, Web of Science, Cochrane Library y Embase) ensayos controlados aleatorios (ECA) que compararan los efectos de AR vs AG en pacientes de edad avanzada sometidos a cirugía de fractura de cadera. Se utilizó el modelo de efectos aleatorios o fijos para calcular los riesgos relativos agrupados (RR) y las diferencias de medias (DM). Se incluyeron 14 ECA con 5.626 pacientes de edad avanzada sometidos a cirugía de fractura de cadera. El metanálisis indicó que la AR se asoció con una menor incidencia de pérdida de sangre intraoperativa (DM: -39,7 mL; IC 95%: -68,61, -10,84; p = 0,007), eventos adversos incluyendo hipotensión intraoperativa (RR: 1,09; IC del 95%: 0,90, 1,32; p = 0,005) y disfunción cognitiva posoperatoria (RR: 0,56; IC 95% : 0,37, 0,86; p = 0,007) comparado con GA. Sin embargo, no se encontraron diferencias estadísticamente significativas entre AR y AG en términos de tiempo quirúrgico, tiempo de anestesia, transfusión intraoperativa, duración hospital, delirio y mortalidad. La AR puede reducir eficazmente la pérdida de sangre intraoperatoria y el riesgo de hipotensión. Debido a la actual falta de pruebas, no se identificaron efectos positivos de la AR en otros resultados posoperatorios. Se justifica un estudio de alta calidad y rigurosamente diseñado para determinar el impacto del tipo de anestesia en pacientes ancianos con fractura de cadera.

Received: 21-10-2024 Accepted: 03-05-2025

INTRODUCTION

Hip fracture represents one of the significant challenges to healthcare in the 21st century. It is estimated that approximately 1.6 million people suffered from hip fractures globally in 2000, and this number is expected to rise to 4.5 million by 2050 due to the aging global population, imposing a substantial burden on both families and society [1-3]. Despite patients receiving optimal care, the postoperative survival of elderly patients remains poor [4].

Almost all hip fracture patients undergo surgical treatment, and the choice of anesthesia can influence postoperative recovery and long-term prognosis [5]. The application of regional anesthesia (RA) and general anesthesia (GA) in elderly patients with hip fractures has been debated. Approximately 60% of elderly patients receive GA, while 40% undergo spinal anesthesia (SA) or nerve blocks [6,7]. RA is favored by clinicians as an integral part of multimodal analgesia due to its ease of administration and reduced opioid consumption compared to GA [8]. Pre-

vious studies have shown that RA can reduce the incidence of postoperative cognitive dysfunction and the risk of death and major complications by limiting anesthesia and morphine use, compared to GA [9,10]. However, the complexity of RA, the high requirement for patient cooperation, and potential local complications have limited its application in certain situations. GA provides a more stable anesthetic effect and better surgical conditions but is associated with physiological suppression, postoperative cognitive dysfunction, and respiratory complications, raising concerns about its safety in elderly patients.

In recent years, with the continuous advancement of anesthetic techniques and drugs, comparative studies on the application of RA and GA in hip fracture surgery in the elderly have increased. However, existing results are inconsistent, with some studies supporting the superiority of RA [9,10], while others consider GA and RA to have equivalent efficacy [11]. This inconsistency may arise from differences in study design, patient population heterogeneity, and non-uniform postoperative assessment standards. This study aims to systematically evaluate and compare the efficacy and safety of RA and GA in hip fracture surgery in older patients through a meta-analys address. We will conduct a comprehensive analysis of existing randomized controlled trials to provide clinical physicians with a more scientific and objective basis for decision-making and improve the postoperative outcomes of elderly patients with hip fractures.

MATERIALS AND METHODS

In accordance with the PRISMA 2020 statement [12], a systematic search was conducted across four electronic databases: PubMed, Web of Science, Cochrane Library, and Embase. The search period was from the databases' inception to August 20, 2024. The search strategy included the following keywords: "Hip fracture," "General anesthesia," "Regional anesthesia," "Conduction Anesthesia," "Local Anesthesia," "Spinal anesthesia," OR "Epidural anesthesia." Additionally, targeted literature was identified by reviewing the reference lists of included studies.

Inclusion and exclusion criteria

Inclusion criteria: (1) Studies published in peer-reviewed journals in Chinese or English; (2) Study subjects were elderly patients aged ≥60 years (or with a majority aged ≥60 years) with hip fractures undergoing surgical treatment; (3) The experimental group received RA; (4) The control group received GA; (5) At least one of the following outcomes was reported: primary outcomes [surgical time, duration of anesthesia, blood loss, intraoperative transfusion (in units of packed red blood cells), and hospital length (from the day of admission to the day of discharge)], secondary outcomes [adverse events (intraoperative hypotension, postoperative cognitive dysfunction, intraoperative delirium, etc.)]; (6) Randomized controlled trials (RCT).

Exclusion criteria: (1) Non-population-based studies; (2) Conference papers, case reports, systematic reviews, and other study types; (3) Insufficient outcome information for data analysis; (4) Duplicate reporting of studies; (5) Studies where full-text articles could not be obtained.

Studies screening and data extraction

Two researchers independently conducted literature screening based on the inclusion and exclusion criteria. Initial screening was performed by reading the titles and abstracts of the literature, followed by a full-text review of potentially eligible studies. In cases of disagreement between the two researchers, a third researcher was consulted, and a consensus was reached through discussion. After the literature screening, two researchers independently extracted data according to a predefined data extraction form, which included information on publi-

cation details, demographic characteristics of the study subjects, intervention characteristics, study period, and outcome events.

Quality assessment

The quality of the literature was assessed using the Cochrane Collaboration's risk assessment tool[13], which evaluates aspects such as the method of randomization, allocation concealment, blinding, completeness of outcome data, selective reporting of study results, and other sources of bias.

STATISTICAL METHODS

Statistical analysis was performed using the Revman 5.3 software. Continuous data were expressed as mean differences (MD), and the effect size for categorical data was represented by the relative risk (RR), with the 95% confidence interval (CI) used to estimate the range of the effect size. Heterogeneity was assessed using the I^2 statistic and Q-test to determine the degree of heterogeneity. The values of I^2 <40%, I^2 = 40–60%, and I^2 > 60% indicated low, moderate, and high heterogeneity, respectively. If I^2 was <50% or $p>0.1$, a fixed-effect model was used for analysis; if I^2 was >50% or $p\leq0.1$, a random-effects model was used for analysis. If significant heterogeneity was present, sensitivity analysis was conducted to explore the sources of heterogeneity. Unless otherwise specified, the significance level was set at $p<0.05$.

RESULTS

Basic information of included studies

After searching the electronic databases, 3792 studies were identified and included in the literature review process, as shown in Fig. 1. After excluding 1731 duplicate studies and 1964 irrelevant studies, 97 studies were reviewed in full text to determine their eligibility for this study, and ultimately, 14 qualified studies were included [11, 14-26].

The publication years of the 14 RCTs spanned from 2003 to 2024, with four studies originating from China, two multi-country studies (USA and Canada), and the remaining studies from Israel (n=1), Iran (n=1), France (n=1), Greece (n=1), Korea (n=1), USA (n=1) Denmark (n=1) and the UK (n=1). The 14 studies involved 5626 elderly patients undergoing hip fracture surgery, of which 2768 patients received RA, and the remaining 2858 patients received GA. The average age of the study subjects ranged from 62.5 to 85 years, and in four studies, most of the patients were male (male≥50%). A summary of the basic information of the included studies is presented in Table 1.

Quality of included studies

We utilized the Cochrane Risk of Bias tool to assess the quality of the included studies, revealing a significant risk of bias in the implementation of blinding and a potential risk in allocation concealment, as shown in Supplementary Figs. 1-2. Overall, the quality of the included studies was acceptable.

Surgical time

Eight studies provided results on the impact of different anesthesia methods on surgical time for elderly patients with hip fractures, involving 1,231 patients who received RA and 1,245 patients who received GA. The heterogeneity assessment showed heterogeneity among the included studies (I^2=87%, $p<0.00001$), and the random-effects model was used to evaluate the impact of RA versus GA on surgical time. The meta-analysis results indicated no statistically significant difference in the impact of the two anesthesia methods on surgical time (MD: -3.10; 95%CI: -6.99, 0.79), as seen in Fig. 2.

Anesthesia time

Six studies provided results on the impact of different anesthesia methods on anesthesia time for elderly patients undergoing hip fracture surgery, involving 1,307 patients who received RA and 1,389 patients who received GA. The assessment of heterogeneity revealed

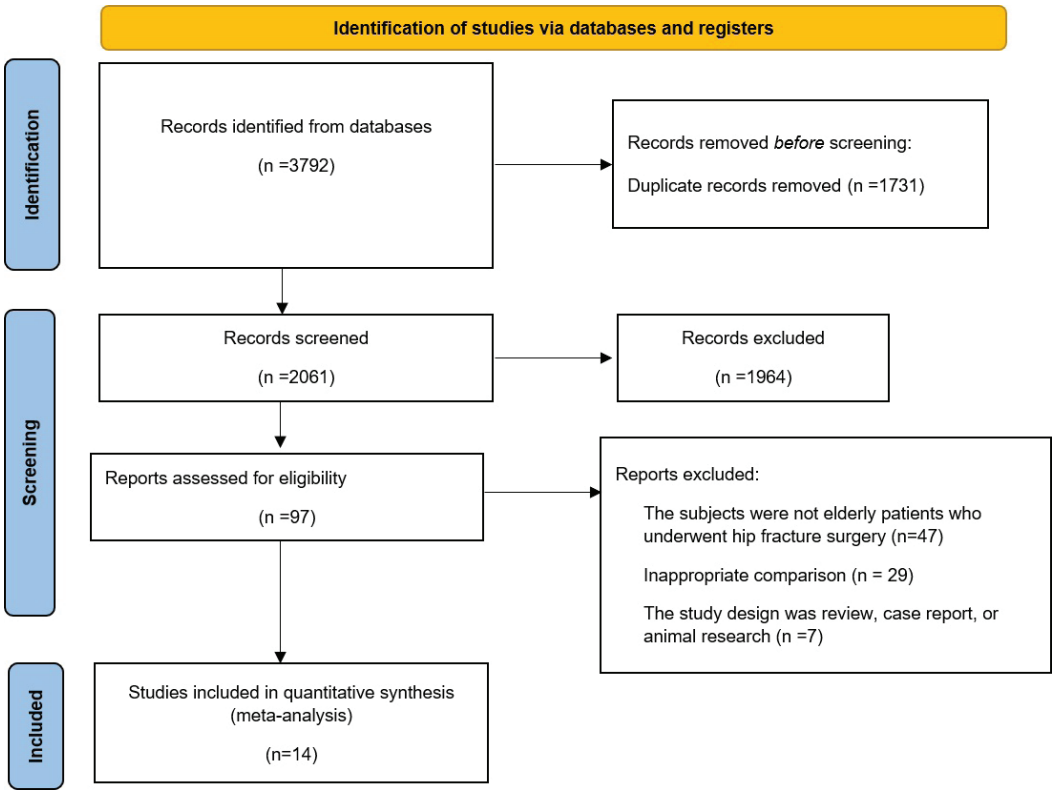
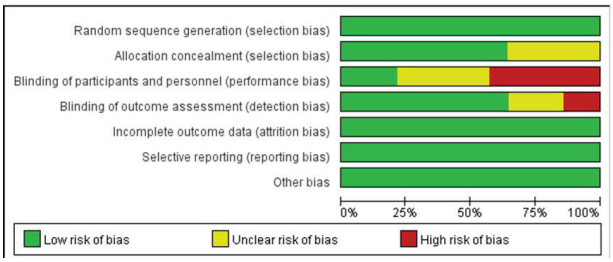


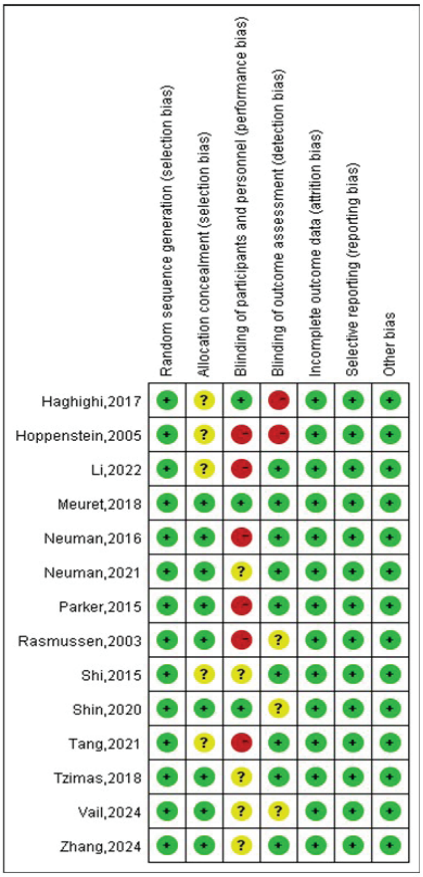
Fig. 1. Literature selection flowchart.

Table 1. Basic information of eligible studies.

Study	Location	Sample-RA	Sample-GA	Mean age	Male %	ASA
Rasmussen,2003	Denmark	211	217	70.8/71.1	84.36/88.02	I-IV
Hoppenstein,2005	Israel	30	30	81.5/83.5	NA	I-III
Parker,2015	UK	158	164	82.9/83.0	19.0/34.8	NA
Shi,2015	China	50	50	68.3	43	NA
Neuman,2016	USA	6	6	80.5/62.5	67/83	NA
Haghighi,2017	Iran	50	50	66.22/65.98	84/76	I-III
Meuret,2018	France	19	21	83/85	11/29	I-III
Tzimas,2018	Greece	37	33	77.11/75.09	47.14	I-III
Shin,2020	Korea	58	118	81.6/80.0	29.3/24.6	NA
Tang,2021	Chia	55	55	78.00/76.60	29.1/36.4	II-IV



Supplementary Figure 1 Risk of bias graph.



Supplementary Figure 2 Risk of bias summary.

heterogeneity among the included studies (I^2=69%, p=0.006), and the random-effects model was used to calculate the pooled effect size. The results indicated no statistically significant difference in the impact of RA versus GA on anesthesia time for elderly hip fracture surgery patients (MD: -0.87; 95%CI: -4.25, 2.50), as shown in Fig. 3.

Blood Loss

Five studies provided results on the impact of different anesthesia methods on intraoperative blood loss for elderly patients undergoing hip fracture surgery, involving 1,169 patients who received RA and 1,245 patients who received GA. The assessment of heterogeneity revealed heterogeneity among the included studies (I^2=97%, p<0.00001), and the random-effects model was used to calculate the pooled effect size. The results showed that, compared to GA, the use of RA in elderly patients during hip fracture surgery was associated with lower intraoperative blood loss (MD: -39.7 mL; 95%CI: -68.61, -10.84; p = 0.007), as depicted in Fig. 4.

Intraoperative transfusion

Five studies reported the impact of different anesthesia methods on intraoperative transfusion for elderly patients undergoing hip fracture surgery, involving 1,064 patients who received RA and 1,078 patients who received GA. The assessment of heterogeneity revealed heterogeneity among the included studies (I^2=85%, p<0.0001), and the random-effects

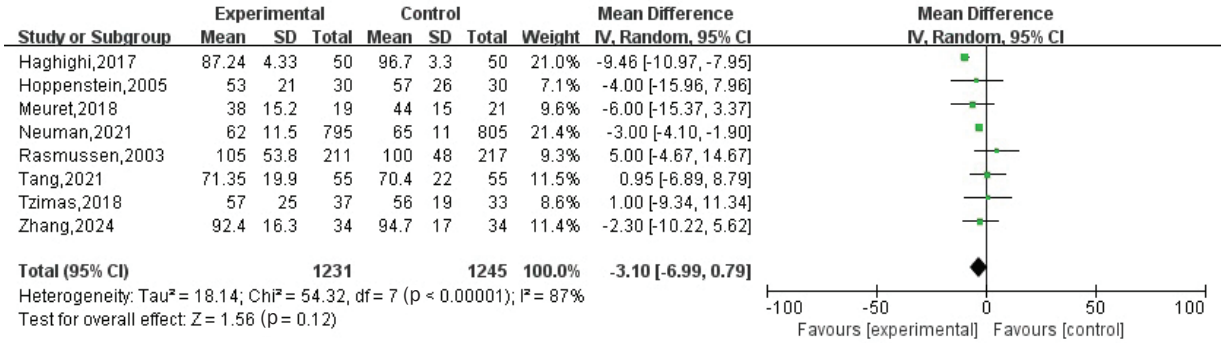


Fig. 2. Efficacy of RA and GA on surgery time in elderly patients for hip fracture surgery.

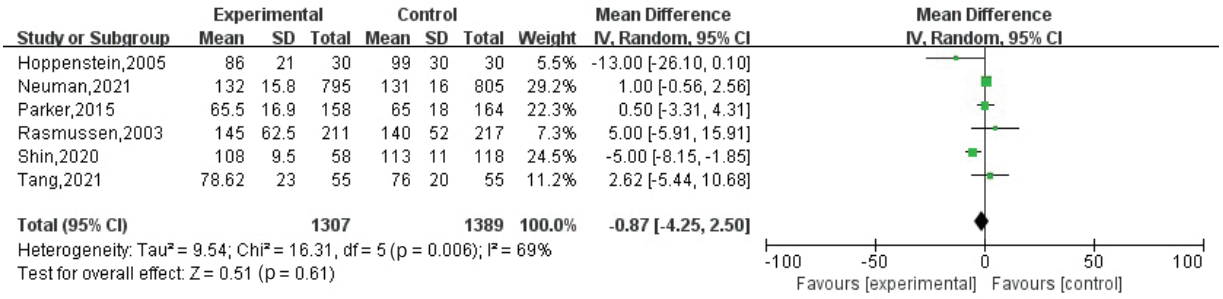


Fig. 3. Efficacy of RA and GA on anesthesia time in elderly patients for hip fracture surgery.

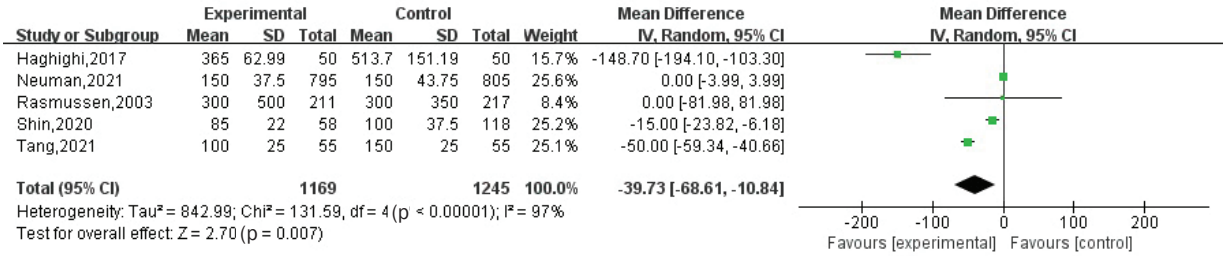


Fig. 4. Efficacy of RA and GA on blood loss (mL) in elderly patients for hip fracture surgery.

model was used to evaluate the impact of anesthesia methods. The meta-analysis results indicated no statistically significant difference in the impact of the two anesthesia methods on intraoperative transfusion for elderly hip fracture surgery patients (RR: 0.75; 95%CI: 0.41, 1.36), as illustrated in Fig. 5.

Hospital stay length

Five studies reported the impact of different anesthesia methods on postoperative hospital stay length for elderly patients who underwent hip fracture surgery, involving 932 patients who received RA and 1,004 patients who received GA. The assessment of heterogeneity revealed heterogeneity among the included studies (I^2=69%, p=0.01), and the random-effects model was used to calculate the pooled effect size. The results showed that RA did not have a significant positive effect on hospital stay length, and there was no statistically significant difference in the efficacy between the two anesthesia methods (MD: 0.05; 95%CI: -0.38, 0.49), as shown in Fig. 6.

Adverse events

Five studies reported the impact of different anesthesia methods on intraoperative hypotension for elderly patients undergoing hip fracture surgery, involving 737 patients who received RA and 745 patients who received GA. The meta-analysis based on the random-effects model showed that RA could significantly reduce the risk of intraoperative hypotension (RR: 0.58; 95%CI: 0.39, 0.85), as depicted in Fig. 7. Additionally, the analysis of two studies suggested that RA had an advantage in reducing the risk of postoperative cognitive dysfunction (RR: 0.56; 95%CI: 0.37, 0.86). However, a similar positive effect on cognitive function was not found in the risk of intraoperative delirium (RR: 1.09; 95%CI: 0.90, 1.32). For serious adverse events, the impact of RA versus GA on postoperative mortality was not statistically significant (RR: 1.01; 95%CI: 0.81, 1.26), as shown in Fig. 8.

Sensitivity analysis

We conducted a sensitivity analysis by excluding one study at a time to explore po-

tential bias risks and determine the stability of the results. After excluding one study [20], the heterogeneity among the included studies decreased from 87% to 0% for surgery time. The meta-analysis based on the fixed-effect model showed that RA was related to less surgery time for elderly patients with hip fractures by approximately (RR=-2.82; 95%CI: -3.88, -1.77, Fig. 9), but its clinical effect was limited. For intraoperative hypotension, after excluding one study24, the heterogeneity among the included studies decreased from 74% to 24%, and the evaluation results based on the combined effect model indicated that RA could still significantly reduce the risk of intraoperative hypotension (RR: 0.42; 95%CI: 0.37, 0.48), as shown in Fig. 10. Additionally, the sensitivity analysis for anesthesia time, blood loss, transfusion, and hospital length did not identify significant sources of heterogeneity, and there was no change in the direction of the results, indicating that the analysis results of this study are robust.

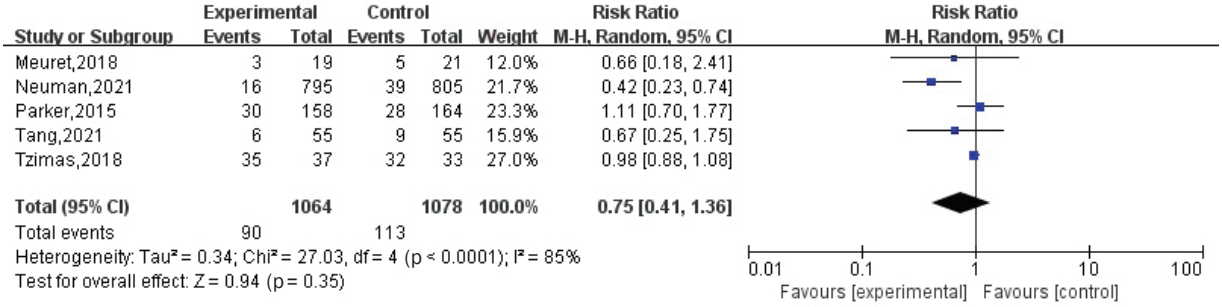


Fig. 5. Efficacy of RA and GA on blood transfusion in elderly patients for hip fracture surgery.

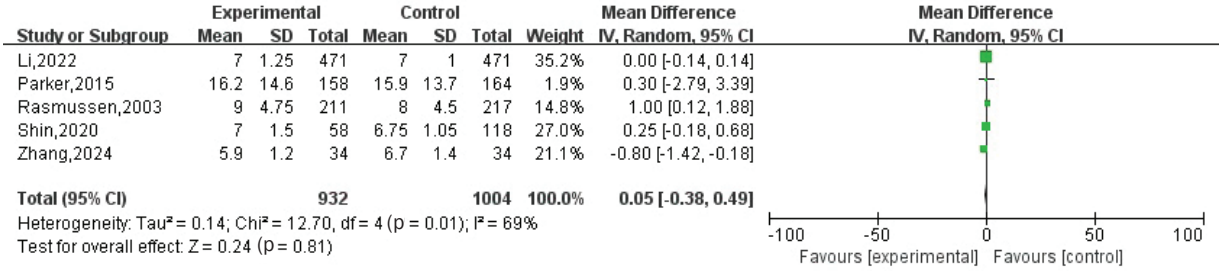


Fig. 6. Efficacy of RA and GA on hospital length of stay in elderly patients for hip fracture surgery.

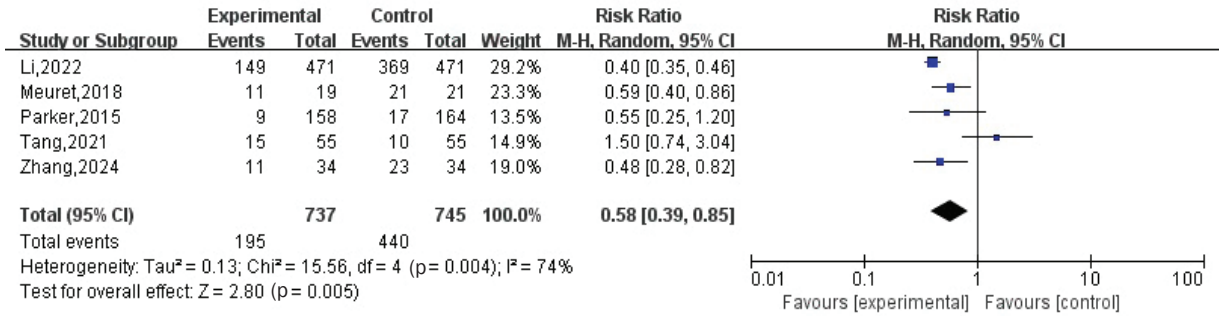


Fig. 7. Efficacy of RA and GA on intraoperative hypotension in elderly patients for hip fracture surgery.

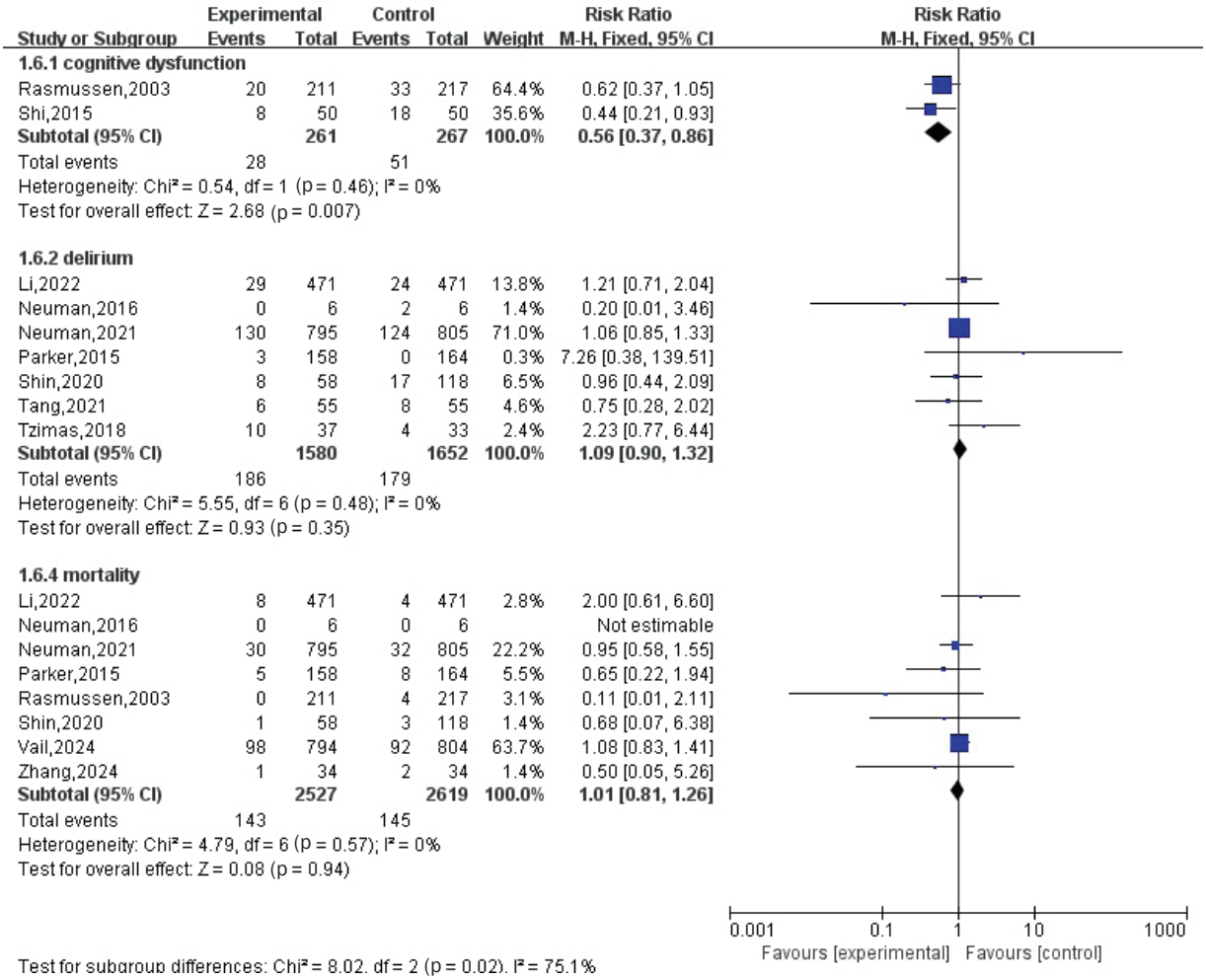


Fig. 8. Efficacy of RA and GA on cognitive dysfunction, delirium, and mortality in elderly patients for hip fracture surgery.

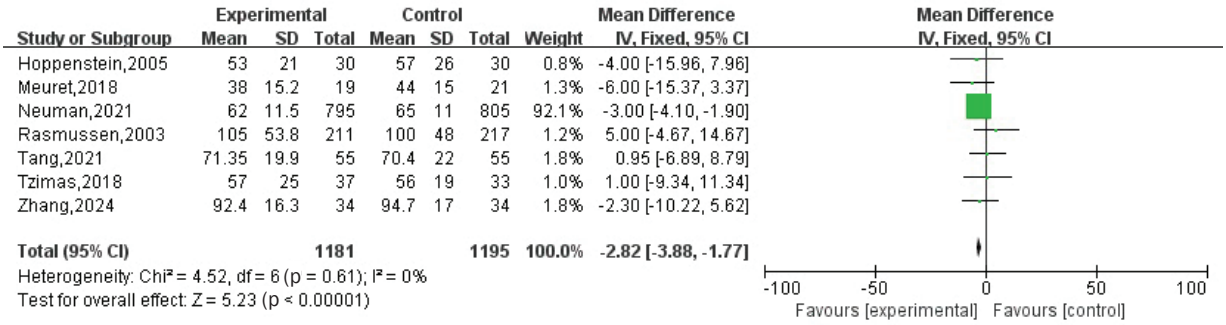


Fig. 9. Sensitivity analysis of RA and GA on surgery time in elderly patients for hip fracture surgery.

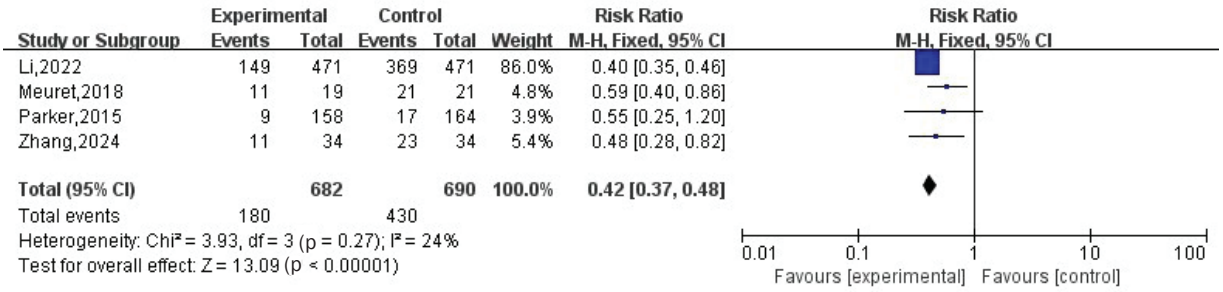


Fig 10. Sensitivity analysis of RA and GA on intraoperative hypotension in elderly patients for hip fracture surgery.

DISCUSSION

This study included research comparing the postoperative outcomes of RA and GA in elderly patients undergoing hip fracture surgery. Using meta-analysis, we evaluated the impact of RA versus GA on surgical time, anesthesia time, blood loss, intraoperative transfusion, hospital stay length, and adverse events. A total of 14 studies involving 5,626 elderly patients who underwent hip fracture surgery were included, of which 2,768 patients received RA, and the remaining 2,858 patients received GA during surgery. The meta-analysis results showed that RA had a significant positive effect on blood loss and intraoperative hypotension but did not find that this anesthesia method significantly improved other patient outcomes.

In our study, RA was significantly associated with a reduced risk of intraoperative hypotension, possibly related to its advantage in maintaining hemodynamic stability. Hypovolemia can decrease preload, subsequently causing a reduction in cardiac output and organ perfusion. Although GA is still widely used in hip fracture surgery, various RA techniques are becoming increasingly popular. The use of SA in hip fracture surgery has increased by 50% in the past decade[27]. SA can reduce the body's compensatory ability to change blood pressure, especially in patients with complex basic health status and physical weakness [28]. In addition, continuous spinal anesthesia (CSA), due to its low-dose medication characteristics, has been proven to be more effective in maintaining hemodynamic stability than single-shot spinal anesthesia [29,30].

Furthermore, lower doses of spinal anesthesia, through synergistic effects with opioids, can provide effective sensory blockage while minimizing systemic effects, including hemodynamic effects [31]. Multiple nerve blocks, as an alternative to spinal anesthesia, have been used to reduce the occurrence of hypotension, and some studies have reported positive effects [32,33]. Based on previous research evidence, choosing the appropriate anesthesia method is of great significance for improving the postoperative outcomes of elderly patients with hip fractures. Future research should explore the specific impact of different anesthesia methods on the postoperative recovery of elderly patients and how to optimize anesthesia strategies to improve surgical safety and patient satisfaction.

Delirium is an acute neuropsychiatric syndrome commonly seen in elderly patients undergoing hip fracture surgery and is associated with increased morbidity, mortality, and medical costs [34,35.] However, our study did not find a significant impact of RA and GA on the risk of postoperative delirium in patients. Although large-scale cohort studies targeting older people have shown that GA is associated with an increased risk of postoperative delirium [10], our study results are similar to previous meta-analysis results, which did not find that RA or GA affects the

incidence of postoperative delirium [36,37]. Delirium-related factors include age, cognitive impairment, frailty, comorbidities, surgery, and psychotropic medications, among others. Future research should further explore the efficacy differences of GA and RA in different population subgroups.

This study has the following limitations. First, eight of the 14 studies included had a sample size of less than 100 in each arm. Therefore, the results of the studies included with small sample sizes should be interpreted with caution. In addition, there is a particular risk of bias in implementing blinding and random concealment in the included studies, which may be the reason for the high heterogeneity in some of the study results. Furthermore, due to the purpose of the study, the original studies reported insufficiently on some postoperative outcomes, making it impossible for this study to conduct a quantitative evaluation.

CONCLUSION

In our study, compared with GA, RA can improve the incidence of intraoperative hypotension and reduce intraoperative blood loss in elderly patients undergoing hip fracture surgery. No significant improvement in other clinical indicators was found for RA. Due to the limitations of this study, the more comprehensive evaluation of evidence regarding RA and GA is still unclear, and more high-quality prospective studies are needed to systematically evaluate whether RA has significant clinical efficacy for elderly patients undergoing hip fracture surgery.

ACKNOWLEDGMENTS

Not applicable.

Funding

The study is funded by the Hangzhou Medical and Health Science and Technology Project (A20220667).

Ethical statement

An ethics statement is not applicable because this study is based exclusively on published literature.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analyzed during this study are included in this article.

Competing interest

The authors had no separate personal, financial, commercial, or academic conflicts of interest.

Number ORCID of author

- Feng Han: 0009-0007-6312-7526
- Yue Yang: 0009-0004-9317-8680
- Xinxin Tian: 0009-0001-9433-0064

Author contributions

HF conceived and designed the study. HF and TXX took part in the data collection and did the data analysis. All authors helped draft the manuscript. All authors helped to revise the manuscript. All authors read and approved the final manuscript.

REFERENCES

1. **Johnell O, Kanis JA**. An estimate of the worldwide prevalence and disability associated with osteoporotic fractures. Osteoporos Int. 2006;17(12):1726-1733.
2. **Cauley JA, Chalhoub D, Kassem AM, Fuleihan Gel-H.** Geographic and ethnic disparities in osteoporotic fractures. Nat Rev Endocrinol. 2014;10(6):338-351.

3. **Marsillo E, Pintore A, Asparago G, Oliva F, Maffulli N.** Cephalomedullary nailing for reverse oblique intertrochanteric fractures 31A3 (AO/OTA). Orthop Rev (Pavia). 2022 13;14(6):38560.
4. **Hawley S, Javaid MK, Prieto-Alhambra D, Lippett J, Sheard S, Arden NK, Cooper C, Judge A; REFReSH study group**. Clinical effectiveness of orthogeriatric and fracture liaison service models of care for hip fracture patients: population-based longitudinal study. Age Ageing. 2016;45(2):236-342.
5. **National hip fracture database (NHFD).** Annual report 2017. London: Royal College of Physicians; 2017.
6. **White SM, Moppett IK, Griffiths R.** Outcome by mode of anaesthesia for hip fracture surgery. An observational audit of 65 535 patients in a national dataset. Anaesthesia 2014;69(3):224-230.
7. **National Hip Fracture Database.** Annual report, The National Hip Fracture Database (nhfd.co.uk), 2020. Available from (Accessed April 21 2022).
8. **Zywiel MG, Prabhu A, Perruccio AV, Gandhi R.** The influence of anesthesia and pain management on cognitive dysfunction after joint arthroplasty: a systematic review. Clin Orthop Relat Res. 2014;472(5):1453-1466.
9. **Ahn EJ, Kim HJ, Kim KW, Choi HR, Kang H, Bang SR.** Comparison of general anaesthesia and regional anaesthesia in terms of mortality and complications in elderly patients with hip fracture: a nationwide population-based study. BMJ Open. 2019;9(9):e029245.
10. **Ravi B, Pincus D, Choi S, Jenkinson R, Wasserstein DN, Redelmeier DA.** Association of Duration of Surgery With Postoperative Delirium Among Patients Receiving Hip Fracture Repair. JAMA Netw Open. 2019;2(2):e190111.
11. **Li T, Li J, Yuan L, Wu J, Jiang C, Daniels J, et al.; RAGA Study Investigators.** Effect of regional vs general anesthesia on incidence of postoperative delirium in older patients undergoing hip fracture surgery: The RAGA Randomized Trial. JAMA. 2022;327(1):50-58.
12. **Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al.** The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71.
13. **Higgins J, Altman DG.** Chapter 8: Assessing risk of biasin included studies. In Cochrane Handbook for Systematic Reviews of Interventions Version 5.0 (eds J. Higgins & S. Green), 2008. Available at:http://www.cochrane-handbook.org (last accessed July 20 2010).
14. **Rasmussen LS, Johnson T, Kuipers HM, Kristensen D, Siersma VD, Vila P, et al.; ISPOCD2(International Study of Postoperative Cognitive Dysfunction) Investigators.** Does anaesthesia cause postoperative cognitive dysfunction? A randomised study of regional versus general anaesthesia in 438 elderly patients. Acta Anaesthesiol Scand. 2003;47(3):260-266.
15. **Hoppenstein D, Zohar E, Ramaty E, Shabat S, Fredman B.** The effects of general vs spinal anesthesia on frontal cerebral oxygen saturation in geriatric patients undergoing emergency surgical fixation of the neck of femur. J Clin Anesth. 2005;17(6):431-438.
16. Vail EA, Feng R, Sieber F, Carson JL,et al ; REGAIN (Regional versus General Anesthesia for Promoting Independence after Hip Fracture) Investigators. Long-term Outcomes with Spinal versus General Anesthesia for Hip Fracture Surgery: A Randomized Trial. Anesthesiology. 2024;140(3):375-386.
17. **Parker MJ, Griffiths R.** General versus regional anaesthesia for hip fractures. A pilot randomised controlled trial of 322 patients. Injury. 2015;46(8):1562-1566.
18. **Shi HJ, Xue XH, Wang YL, Zhang WS, Wang ZS, Yu AL.** Effects of different anesthesia methods on cognitive dysfunction after hip replacement operation in elder patients. Int J Clin Exp Med. 2015;8(3):3883-3888.
19. **Neuman MD, Mehta S, Bannister ER, Hesketh PJ, Horan AD, Elkassabany NM.** Pilot randomized controlled trial of spinal versus general anesthesia for

hip fracture surgery. J Am Geriatr Soc. 2016;64(12):2604-2606.

20. **Haghighi M, Sedighinejad A, Nabi BN, Mardani-Kivi M, Tehran SG, Mirfazli SA, et al.** Is spinal anesthesia with low dose lidocaine better than sevoflorane anesthesia in patients undergoing hip fracture Surgery. Arch Bone Jt Surg. 2017;5(4):226-230.
21. **Meuret P, Bouvet L, Villet B, Hafez M, Allaouchiche B, Boselli E.** Hypobaric unilateral spinal anaesthesia versus general anaesthesia in rlderly patients undergoing hip fracture surgical repair: a prospective randomised Open Trial. Turk J Anaesthesiol Reanim. 2018;46(2):121-130.
22. **Tzimas P, Samara E, Petrou A, Korompilias A, Chalkias A, Papadopoulos G.** The influence of anesthetic techniques on postoperative cognitive function in elderly patients undergoing hip fracture surgery: General vs spinal anesthesia. Injury. 2018;49(12):2221-2226.
23. **Shin S, Kim SH, Park KK, Kim SJ, Bae JC, Choi YS.** Effects of anesthesia techniques on outcomes after hip fracture surgery in elderly patients: A prospective, randomized, controlled trial. J Clin Med. 2020;9(6):1605.
24. **Tang L, Fang P, Fang Y, Lu Y, Xu G, Liu X.** Comparison of effects between combined lumbar-sacral plexus block plus general anesthesia and unilateral spinal anesthesia in elderly patients undergoing hip fracture surgery: A pilot randomized controlled trial. Evid based complement alternat med. 2021;2021:6685497.
25. **Neuman MD, Feng R, Carson JL, Gaskins LJ, Dillane D, Sessler DI, et al.; REGAIN Investigators.** Spinal anesthesia or general anesthesia for hip surgery in older adults. N Engl J Med. 2021;385(22):2025-2035.
26. **Zhang A, Gao H, Lu Y, Jiang L, Xu C.** Fascia iliaca block combined with low-dose spinal anesthesia for hip fracture surgery in the elderly: effects on severe hypotension and analgesia. A randomized controlled trial. Pain Physician. 2024;27(5):E579-E587.
27. **Maxwell BG, Spitz W, Porter J.** Association of increasing use of spinal anesthesia in hip fracture repair with treating an aging patient population. JAMA Surg. 2020;155(2):167-168.
28. **Boddaert J, Raux M, Khiami F, Riou B.** Perioperative management of elderly patients with hip fracture. Anesthesiology. 2014;121(6):1336-1341.
29. **Biboulet P, Jourdan A, Van Haevre V, Morau D, Bernard N, Bringuier S, et al.** Hemodynamic profile of target-controlled spinal anesthesia compared with 2 target-controlled general anesthesia techniques in elderly patients with cardiac comorbidities. Reg Anesth Pain Med. 2012;37(4):433-440.
30. **Futier E, Lefrant JY, Guinot PG, Godet T, Lorne E, Cuvillon P, et al.; INPRESS Study Group.** Effect of individualized vs standard blood pressure management strategies on postoperative organ dysfunction among high-risk patients undergoing major surgery: A eandomized clinical trial. JAMA. 2017;318(14):1346-1357.
31. **Messina A, La Via L, Milani A, Savi M, Calabrò L, Sanfilippo F, et al.** Spinal anesthesia and hypotensive events in hip fracture surgical repair in elderly patients: a meta-analysis. J Anesth Analg Crit Care. 2022;2(1):19.
32. **de Visme V, Picart F, Le Jouan R, Legrand A, Savry C, Morin V.** Combined lumbar and sacral plexus block compared with plain bupivacaine spinal anesthesia for hip fractures in the elderly. Reg Anesth Pain Med. 2000;25(2):158-162.
33. **Johnston DF, Stafford M, McKinney M, Deyermond R, Dane K.** Peripheral nerve blocks with sedation using propofol and alfentanil target-controlled infusion for hip fracture surgery: a review of 6 years in use. J Clin Anesth. 2016;29:33-39.
34. **Yang Y, Zhao X, Dong T, Yang Z, Zhang Q, Zhang Y.** Risk factors for postoperative delirium following hip fracture repair in elderly patients: a systematic review and meta-analysis. Aging Clin Exp Res. 2017;29(2):115-126.
35. **Inouye SK, Bogardus ST Jr, Charpentier PA, Leo-Summers L, Acampora D, Holford TR, et al.** A multicomponent intervention

to prevent delirium in hospitalized older patients. N Engl J Med. 1999;340(9):669-676.

36. **Patel V, Champaneria R, Dretzke J, Yeung J.** Effect of regional versus general anaesthesia on postoperative delirium in elderly patients undergoing surgery for hip fracture: a systematic review. BMJ Open. 2018;8(12):e020757.

37. **Guay J, Parker MJ, Gajendragadkar PR, Kopp S.** Anaesthesia for hip fracture surgery in adults. Cochrane Database Syst Rev. 2016;2(2):CD000521.