Randomized Controlled Trial

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

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Background: Hip fracture surgeries in elderly patients often require spinal or general anesthesia, posing risks of severe hypotension and inadequate pain management. The optimal anesthesia type for minimizing these risks remains undetermined. Preliminary studies suggest that a combination of fascia iliaca block (FIB) and low-dose low-specific-gravity spinal anesthesia (LLSA) might offer a solution, but comprehensive evidence is lacking.

Objectives: This study aimed to assess the efficacy of combining FIB with LLSA for reducing severe hypotension and enhancing analgesia during hip fracture surgery in elderly patients.

Study Design: A prospective, randomized controlled trial was conducted.

Setting: An operating theatre of a tertiary hospital.

Methods: The study comprised 68 patients. They were separated into 2 equal parallel groups 34 patients each: the FIB+LLSA group and the general anesthesia (GA) group. Patients aged 75–96 undergoing primary hip arthroplasty for hip fracture were randomized to receive either FIB+LLSA or GA. The primary outcome was the incidence of severe hypotension; secondary outcomes included postoperative pain, use of rescue analgesia, vasopressor dosage, and complications.

Results: We found a significantly lower incidence of severe hypotension in the FIB+LLSA group compared to the GA group (32.4% vs 67.6%). Additionally, postoperative pain scores were significantly lower, and the need for rescue analgesia was reduced in the FIB+LLSA group. Vasopressor use during surgery was also significantly lower in the FIB+LLSA group. The hospital stay was shorter in the FIB+LLSA group, with an average of 5.9 days compared to 6.7 days in the GA group.

Limitations: The study's limitations include its single-center nature, which may limit the generalizability of the findings. Additionally, the inability to conduct a double-blind study could introduce biases, though measures were taken to minimize this. The sample size might not be sufficient to determine the broader implications of LLSA.

Conclusions: Combining FIB with LLSA for elderly patients undergoing hip fracture surgery significantly reduces the incidence of severe intraoperative hypotension and postoperative pain. It also decreases the need for rescue analgesia and shortens hospital stays, suggesting that FIB+LLSA could be a beneficial regional anesthesia technique for elderly hip fracture surgery patients, aligning with enhanced recovery protocols.

Key words: Hip fracture, elderly, hypotension, anesthesia, fascia iliaca block, low-dose spinal anesthesia, randomized controlled trial

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In 2025, the global incidence of hip fracture is anticipated to reach 2.6 million (0.03%) (1). Due to population ageing, the total number of hip fractures in people aged 55 and older in urban China increased approximately fourfold between 2012 and 2016 (2). Patients with a hop fracture almost always undergo surgery, so spinal or general anesthesia is required. However, the optimal anesthesia type remains undetermined, despite high-quality research (3-5).

Intraoperative hypotension during hip fracture surgery may detrimentally affect postoperative recovery. Lower intraoperative blood pressure correlates with higher mortality at 5 and 30 days postsurgery, regardless of anesthesia type (6,7). Single-shot spinal anesthesia can cause unfavorable hemodynamic changes in the elderly and risks insufficient duration in unexpectedly long surgeries. In addition, general anesthesia does not guarantee stability (7,8). Thus, consensus on the optimal anesthesia technique to maintain intraoperative hemodynamic stability for older people is lacking.

A recent preliminary cohort study by Carlos, et al (9) showed ultra-low dose single-shot spinal anesthesia plus deep fascia iliaca block enabled effective unilateral blockade for elderly patients with a hip fracture while minimizing hypotension. However, the deep fascia iliaca block lacks evidence of efficacy and safety compared to the classic fascia iliaca block (FIB), limiting applicability. FIB has been used preoperatively for hip fractures and is believed to provide rapid, adequate analgesia with fewer side effects than systemic options, especially in older adults (10-12). No published trials have evaluated FIB's intraoperative blood pressure effect in hip fracture surgery. We therefore conducted a randomized controlled trial assessing the hemodynamic effects of combining FIB with low-dose, low-specific-gravity spinal anesthesia (LLSA) for hip fracture surgery in the elderly.

Our trial's primary objective was to assess severe hypotension incidences, per a contemporary definition (13). Secondary aims were to evaluate FIB+LLSA's effects on vasopressor dosage, postoperative pain, rescue analgesia needs, and complications.

Methods

Ethics Approval and Registration

Ethical approval was obtained from the Ethics Committee of Nuclear Industry 215 Hospital of Shaanxi Province (No. 215EC-2023001, dated February 8, 2023) for this prospective, randomized controlled study. The study protocol was registered in the Chinese Clinical Trial Registry (registration No. ChiCTR2300068422; Registered February 17, 2023; https://www.chictr.org.cn/showproj.html?proj=189537). We followed the guidelines outlined in the Consolidated Standards of Reporting Trials (CONSORT) statement (14). The first patient was admitted to the hospital on March 4, 2023. All patients provided written informed consent.

Inclusion and Exclusion Criteria

This study was conducted at the Department of Anaesthesiology, Nuclear Industry 215 Hospital of Shaanxi Province, China, from February 2023 through June 2023. Patients aged 75-96, with an American Society of Anesthesiologists Physical Status Classification System of I-III, a body mass index (BMI; kg/m^2) 16-29, and Mini-Cog score ≥ 3, who were scheduled to undergo primary hip arthroplasty for hip fracture through the posterolateral hip approach were eligible for enrollment.

Exclusion criteria were patients with hypersensitivity to the drugs used in the study, pathological or multiple fractures, coagulation disorders, a history of using any analgesic within 24 hours presurgery, alcohol and substance addiction, psychiatric and neurological diseases, obesity (BMI > 30), and an infection in the area where FIB+LLSA would be performed.

Randomization and Blinding

Patients were randomly assigned to either the FIB+LLSA group or the General Anesthesia (GA) group using sequentially numbered opaque envelopes. The allocation was created by an anesthesiologist who was not involved in the investigation and was then sealed. FIB+LLSA was administered to each patient in the FIB+LLSA group, whereas the GA group received no intervention. The same attending anesthesiologist carried out the specific anesthetic management in each case. The health care professionals who assessed postoperative pain, postoperative nausea and vomiting, and antiemetic and analgesic consumption were blinded to group assignment.

Anesthesia Protocol

No patient took any preoperative, prophylactic analgesics. Before the study procedure, they were instructed to use the Numeric Rating Scale (NRS-11; 0 is no pain, and 10 is the worst pain imaginable). Upon arrival in the operating room, an 18G intravenous cannula was inserted into a peripheral vein in the unaffected arm, and an infusion of lactated Ringer's solution was started. Patients received standard institutional monitoring,

which included a 3-lead electrocardiogram, pulse oximetry, and radial arterial blood pressure monitoring.

In the FIB+LLSA group, a supra-inguinal FIB with 30 mL of 0.25% ropivacaine at the surgical site was performed before administering LLSA, referring to the previous research (12). After confirming that the FIB caused sensory blockade in the anterior, lateral, and medial compartments of the quadriceps, an ultralow dose LLSA was administered. Patients were placed in the lateral decubitus position with the hip to be operated on positioned above.

The amount of hypobaric levobupivacaine used varied depending on a patient's height, age, comorbidities, type of surgery, and the surgical team's experience. The hypobaric anesthetic solution consisted of 0.4 mL of fentanyl 50 μg/mL (20 μg fentanyl) and 0.6-0.7 mL of hypobaric levobupivacaine 5 mg/mL (3-3.5 mg levobupivacaine). A small amount of normal saline was added to achieve a total volume of 1.5 mL.

The anesthesiologist performed a subarachnoid block using a midline or paramedian approach with a 25G Quincke needle in the L2-L3 or L3-L4 interspace. On the fractured side, a block was deemed effective when a T10 sensory blockade level was reached at the start of surgery. If the anesthesiologist could not locate the subarachnoid space, or if the patient experienced a partial or incomplete spinal block, the protocol of the GA group was administered.

The GA group received anesthesia modified for elderly patients: propofol 1-2 mg/kg, sufentanil 0.2-0.5 μg/kg and for muscle relaxation, rocuronium 0.4-0.6 mg/kg. Sevoflurane 2% in O2 50% (1.0-2.0 L/min) and air mixture 50% was administered to maintain anesthesia. The depth of anesthesia was altered by capturing frontal electroencephalogram and electromyography signals with a bispectral index (BIS) electrode (BIS VISTA, Medtronic). The remifentanil infusion rate was adjusted between 0.05 and 0.5 μg/kg/min to maintain heart rate and blood pressure within 20% of baseline.

Postsurgery, the neuromuscular block was reversed, and the trachea was extubated when sufficient muscle strength was restored. In the postanesthesia care unit, patients in the GA group recovered for 60 minutes.

In both groups, the treatment of hypotension, defined as a mean arterial pressure (MAP) of less than 65 mm Hg, was standardized. Whenever the MAP dropped below 65 mm Hg, a 3-6 mg intravenous ephedrine bolus was administered intravenously. If the total ephedrine dose reached 30 mg, 0.16 mg/mL of norepinephrine was administered intravenously.

Using a posterolateral approach, 2 teams of orthopedic surgeons with each having more than 15 years of experience performed the hip fracture surgeries. At postprocedure, the surgeons administered an intraarticular injection of 20 mL 0.25% ropivacaine under direct visual observation for fundamental pain relief. In addition, all patients were administered 5 mg of intravenous tropisetron (this drug is not approved for use in the US) for postoperative nausea at the end of the surgery.

Our standard postoperative analgesia protocol included administering 1 g of acetaminophen intravenously every 8 hours, 8 mg of lornoxicam (this drug is not approved for use in the US) every 12 hours, and 1 mg/kg of tramadol every 8 hours. All patients received their initial dosage 15 minutes before the surgery's conclusion. Using the NRS-11, pain intensity at rest and during movement was measured. If the NRS-11 score was 4 or higher, patients received one mg/kg of intravenous tramadol as a rescue analgesic.

Outcomes

The primary outcome was the incidence of severe hypotension during surgery, defined as a MAP < 65 mm Hg for > 12 consecutive minutes. When intraoperative hypotension is defined in absolute or relative MAP thresholds, the correlation between intraoperative hypotension and postoperative myocardial injury is relatively robust across a broad range of preoperative baseline blood pressures. However, absolute thresholds are more straightforward to use than their relative counterparts. Choosing hypotensive episodes lasting longer than 12 consecutive minutes was based on findings from prior research indicating that this time threshold is associated with substantially increased odds of postoperative myocardial and renal injury (13).

The secondary outcomes were: (a) postoperative NRS-11 score at rest and during movement; (b) pre- and postoperative cardiac troponin T (cTnT) values and serum creatinine (Scr) values; (c) use of rescue analgesia; (d) amount of vasopressors used during surgery; (e) complications (myocardial injury, defined as blood troponin T concentration more significant than the limit of the reference range for the assay in our center, within 72 postsurgery; acute kidney injury, defined as > 0.3 mg/dL (26 mol/L) increase in postoperative creatinine levels; and 30-day mortality); (f) characteristics associated with surgery, including blood loss, fluid infusion, hospital stay duration, and hemoglobin values (preoperative and postoperative).

Sample Size Calculation

The sample size estimate was derived from the findings of a previous study (15) and our pilot investigation. Thirty percent of patients in the FIB+LLSA group experienced severe hypotension, according to the 10-patient pilot study. Based on this information, we assumed a 68% prevalence of severe hypotension in the GA group. We determined that 48 patients were required to obtain 80% power and a 0.05 α error rate. Nonetheless, to account for the possibility of missing data (10%) and a failure rate of 5% for LLSA, we chose to include 68 patients (34 in each cohort).

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics 22.0 (IBM Corporation). Appropriate central tendency and dispersion measures or counts and percentages for categorical data were used to summarize and express patient data.

For the primary outcome, a logistic regression model was used for binary data, and the difference in proportions, odds ratio (OR), and 95% CIs were provided. Continuous variables were presented as a mean and SD for secondary outcomes and were compared using independent sample t tests. Student t test assumes a normal distribution. The median (interquartile range [IQR]) is reported for nonnormally distributed data, which was analyzed using the Mann-Whitney U test. Using Pearson's χ^2 test, categorical variables were reported as numbers and percentages and compared. Analysis of variance was utilized for repetitive measurements between groups on multiple occasions. Adjustments were made to the *P* values when using multiple and repeated comparisons. All data were analyzed on an intention-to-treat principle. $P < 0.05$ was considered statistically significant.

Results

A total of 108 patients were initially assessed for eligibility in our study. However, 33 patients were excluded because they refused to participate or met other exclusion criteria. The remaining 75 patients were allocated, randomized, and treated according to the protocol. Four patients from the FIB+LLSA group and 3 from the GA group were excluded from the data analysis due to loss to follow-up (FIB+LLSA group, n = 34; GA group, n = 34). Figure 1 presents the Consolidated Standards of Reporting Trials (CONSORT) flow chart illustrating patient recruitment. The groups had similar patient characteristics and surgery duration, as shown in Table 1.

Primary Outcome

The occurrence of severe hypotension was significantly higher in the GA group (67.6%) compared to the FIB+LLSA group (32.4%; OR, 2.9; 95% CI, 1.4–6.0; $P = 0.004$; Fig. 2). The median (IQR) time spent with a MAP less than 65 mmHg was also significantly longer in the GA group compared to the FIB+LLSA group (12 minutes [9–13] vs 13 minutes [11–19]; $P = 0.037$). The percentage of patients who received vasopressors was significantly higher in the GA group compared to the FIB+LLSA group. This was observed for ephedrine (70.6% vs 35.3%; $P = 0.01$) and norepinephrine (64.7% vs 23.5%; $P = 0.001$).

Secondary Outcomes

Spinal anesthesia failure in the FIB+LLSA group was observed in 3 patients (8.8%); these 3 patients underwent GA for surgery. Among the cases where spinal anesthesia was successful, the mean (SD) number of punctures was 1.8 (1.4). In the GA group, the median (IQR) BIS value was 81.0 (75.0–93.0) at preintubation and 43.0 (38.0–51.0) at 3 minutes postintubation.

In the GA group, patients receiving vasopressors had significantly higher mean doses of ephedrine and norepinephrine than the FIB+LLSA group (Table 2). The NRS-11 scores were significantly lower in the FIB+LLSA group compared to the GA group, both at rest and during movement at postoperative hours one, 4, 8, 12, and 24 ($P < 0.01$ at each time point; Fig. 3 and Fig. 4). Our statistical analysis showed that both the time effect and group effect were significant in the groups ($P < 0.01$ for each; Figs. 3 and 4). Additionally, there was a significant interaction between time and group ($P < 0.01$).

Table 3 presents the postoperative rescue analgesic requirement between the 2 groups. It was observed that the number of patients needing rescue analgesia was significantly higher in the GA group at all time points ($P < 0.05$ at each time point). The total amount of tramadol consumed within the first 24 hours postsurgery was lower in the FIB+LLSA group (median 60 mg; IQR [50-80]) compared to the GA group (median 80 mg; IQR [70-120]); $P = 0.002$.

During the first postoperative 24 hours, nausea was observed in 15 (44.1%) patients in the GA group and 5 (14.7%) patients in the FIB+LLSA group. Vomiting was observed in 6 (17.6%) patients in the GA group and 2 (5.9%) patients in the FIB+LLSA group ($P = 0.006$ and $P = 0.151$, respectively). During the first postoperative 24hours, the median consumption of metoclopramide

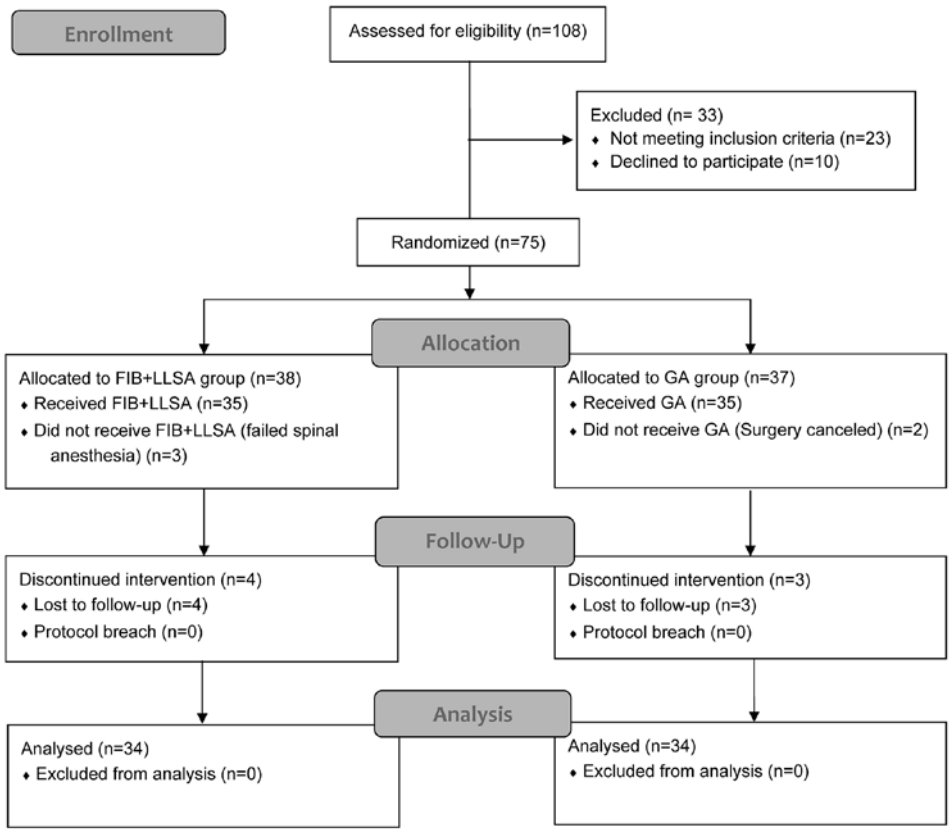

Fig. 1. *Consolidated Standards of Reporting Trials (CONSORT) flow diagram of patient enrollment, inclusion and exclusion process.*

was higher in the GA group (5 mg, IQR [0-10]) compared to the FIB+LLSA group (0 mg, IQR [0-0]) ($P < 0.001$). The FIB+LLSA group had a shorter mean (SD) hospital stay than the GA group. The FIB+LLSA group averaged 5.9 (1.2) days of hospitalization, while the GA group averaged 6.7 (1.4) ($P = 0.016$; Table 2).

Table 2 shows no significant difference between the FIB+LLSA and GA groups regarding preoperative and postoperative cTnT or Scr. Myocardial injury was seen in a total of 11.8% of patients and kidney injury was seen in a total of 8.2% of patients. In our study, the total 30-day mortality rate was 4.4%; there was no significant difference between the 2 groups (2.9% in the FIB+LLSA group vs 5.9% in the GA group; $P = 0.556$).

Discussion

Using the contemporary definition of severe hypotension, our current investigation revealed that compared to GA, the use of FIB+LLSA significantly reduced the incidence and duration of intraoperative hypotension, the percentage of patients with a decrease in intraoperative MAP below 65 mm Hg, and vasopressor dosage during surgery. Effective pain relief post hip fracture surgery is critical for rehabilitation. Compared to GA, FIB+LLSA significantly decreased pain scores in the first postoperative 24 hours, the need for rescue analgesia, nausea incidence, and hospital stay length.

The LLSA technique was related to decreased odds of hypotensive events and served as a protective factor. Previous research on LLSA is consistent with this finding, although some heterogeneity exists. The key differences lie in the definitions of hypotension and the spinal anesthesia (SA) strategy used. While Carlos, et al (9) reported that an ultralow dose, single-shot spinal anesthesia combined with a deep fascia iliaca block provides high hemodynamic stability with low vasopressor consumption in hip fracture surgery, they did not define a hypotensive threshold. In contrast, 2 other studies using continuous spinal anesthesia with fractionated low doses (2.5 mg) of local anesthetic

demonstrated it could maintain hemodynamic stability compared to GA (16,17) and single-shot spinal anesthesia (18). However, to enable early treatment and avoid severe hypotension, they defined hypotension as a 20% decrease in MAP from baseline, which is often inappropriate according to recent definitions.

Defining hypotension based on relative decreases in MAP depends on the reference value used, which

Table 1. *Characteristics at baseline and intraoperatively.*

	FIB+LLSA group (n = 34)	GA group (n = 34)	*P* value
Gender, men, n (%)	18 (52.9)	17 (50.0)	0.81
Height, cm, mean (SD)	166.7 (8.3)	164.2 (7.5)	0.28
Weight, kg, mean (SD)	72.4 (9.6)	69.8 (8.2)	0.27
Age, years, mean (SD)	81.9 (4.7)	80.1 (5.3)	0.15
ASA physical status, n (%)			0.85
I	2 (5.9)	3 (8.8)	
II	20 (58.8)	19 (55.9)	
III	12 (35.3)	12 (35.3)	
Comorbidities, n (%)			0.78
Hypertension	23 (67.6)	24 (70.6)	
Diabetes	15 (44.1)	18 (52.9)	
COPD	6 (17.6)	5 (14.7)	
Heart disease	8 (23.5)	9 (26.5)	
Surgery duration, min, mean (SD)	92.4 (16.3)	94.7 (17.2)	0.61
Surgery type, n (%)			0.81
Total hip replacement	21 (61.8)	22 (64.7)	
Hemihip replacement	13 (38.2)	12 (35.3)	

Abbreviations: ASA, American Society of Anesthesiologists; COPD, chronic obstructive pulmonary disease; LLSA, Iliofascial block combined with low-dose light spinal anesthesia; FIB, Fascia iliaca block; GA, general anesthesia.

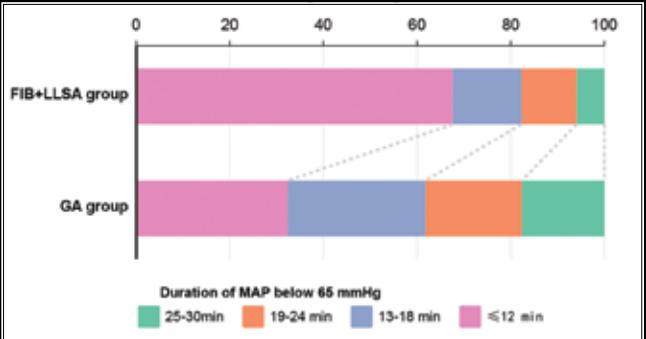

Fig. 2. *Proportion of patients with intraoperative hypotension in the FIB+LLSA group and the GA group. FIB indicates fascia iliaca block; LLSA, low-dose, low-specific-gravity spinal anesthesia; GA, general anesthesia; MAP, mean arterial pressure.*

Table 2. *Characteristics of secondary outcomes, preoperative, intraoperative, and postoperative care.*

Variable	FIB+LLSA group (n = 34)	GA group (n = 34)	*P* value
Ephedrine usage, n (%)	12 (35.3)	24 (70.6)	0.01
Ephedrine dosage, mg, mean (SD)	15.7 (5.8)	21.4 (6.2)	0.003
Norepinephrine usage, n (%)	8 (23.5)	22 (64.7)	0.001
Norepinephrine dosage, μg, mean (SD)	307.5 (102.6)	512.4 (188.7)	0.005
Fluid infusion, n (%)			
500 mL	5 (14.7)	4 (11.8)	0.916
1000 mL	15 (44.1)	16 (47.1)	
1500 mL	8 (23.5)	9 (26.5)	
2000 mL	6 (17.6)	5 (14.7)	
Blood loss, mL, mean (SD)	592.6 (112.4)	607.5 (122.8)	0.881
Pre-op Hb, mean (SD)	12.4 (1.1)	12.6 (1.3)	0.387
Post-op Hb, mean (SD)	10.2 (0.9)	10.1 (1.0)	0.516
Length of stay, days, mean (SD)	5.9 (1.2)	6.7 (1.4)	0.016
Pre-op cTnT, μg/L, mean (SD)	0.076 (0.039)	0.082 (0.042)	0.327
Post-op cTnT, μg/L, mean (SD)	0.107 (0.041)	0.114 (0.038)	0.181
Pre-op Scr, μmol/L, mean (SD)	80.2(12.4)	76.9(10.6)	0.284
Post-op Scr, μmol/L, mean (SD)	86.3(14.5)	82.8(12.8)	0.307
FIB+LLSA group characteristics			
Puncture attempts, mean (SD)	1.8 (1.4)		
Failed spinal anesthesia, n (%)	3 (8.8)		
GA group characteristics			
BIS before intubation,		81.0 (75.0-93.0)	
BIS at three minutes after intubation		43.0 (38.0-51.0)	
Mortality in 30 days, n (%)	1 (2.9)	2 (5.9)	0.556

Abbreviations: LLSA, Iliofascial block combined with low-dose light spinal anesthesia; FIB, Fascia iliaca block; GA, general anesthesia; cTnT, cardiac troponin T; Scr, Serum Creatinine; BIS, bispectral index.

can be unstable before anesthesia induction for hip fracture surgery. Anxiety about surgery, pain from the fracture, and associated quadriceps spasms can all influence blood pressure. Multiple studies have confirmed that associations based on relative MAP thresholds were not more robust than those based on absolute thresholds (13,19-21). Therefore, in our study, we introduced an absolute MAP threshold of < 65 mm Hg as the definition of hypotension.

We combined a suprainguinal FIB and LLSA to provide a semiredundant anesthetic technique blocking the lumbar plexus anterior branches, thereby reducing the need for continuous spinal, epidural, combined spinal-epidural, or posterior lumbar plexus blocks (22). The only innervation dependent on LLSA was the less critical sacral roots for hip surgery (23). The suprainguinal FIB is an innovative hip surgery analgesic technique recently implemented in clinical practice. It uses the anterosuperior iliac spine as a reference to locate the iliac fascia and iliopsoas muscle. Unlike the conventional FIB approach, the needle puncture direction is cephalad, enabling easier analgesic diffusion for complete obturator and lateral femoral cutaneous nerve blocks (24,25).

FIB is associated with a broader spectrum of innervation and produces superior postoperative analgesia. This consistently favors fewer rescue analgesics and shorter hospital stays, unlike the intraarticular injection technique. Although pain scores were significantly lower in the FIB+LLSA group, severe pain was not observed in the GA group, indicating that intraarticular injection combined with multimodal analgesia may be beneficial. In addition, FIB+LLSA significantly decreased total opioid consumption, decreasing the risk of postoperative adverse events such as nausea and vertigo. During the first postoperative 24 hours, significant differences in pain scores were observed between the 2 groups, indicating the clinical efficacy of FIB in the first postoperative 24 hours.

This is the first randomized controlled trial evaluating FIB +LLSA for intraoperative hypotension and postoperative analgesia in elderly patients undergoing hip fracture surgery. While numerous prior prospective intraoperative hypotension studies (15,17,18,26) focused on anesthetic strategies' effects on systolic or MAP, postoperative analgesia has been largely overlooked. Aside from LLSA's transient analgesic effect, our findings indicate FIB dominated and improved postoperative analgesia post hip fracture surgery, reducing pain scores and rescue analgesic needs in the first postoperative 24 hours.

Our results align with previous reports. Garlich, et al (27) found FIB reduced preoperative opioid use and related adverse events in geriatric patients with a hip fracture, while Chen, et al (12) showed suprainguinal FIB provided adequate analgesia and improved exercise tolerance compared to the conventional approach. Although pain scores were significantly lower with FIB+LLSA, severe pain was not seen in the GA group, suggesting wound infiltration and multimodal analgesia may also be beneficial. Additionally, FIB+LLSA decreased total opioid consumption, reducing postoperative adverse events like nausea, which differed significantly between the 2 groups.

Our findings indicate that FIB +LLSA provides stable hemodynamics, optimal postoperative analgesia, decreased rescue analgesia needs, and shorter hospitalization, aligning with enhanced postsurgery recovery protocols. Therefore, FIB+LLSA could be a beneficial regional anesthesia technique for managing postoperative pain in modern accelerated hip surgery.

Limitations

Our study has some limitations. First, as a single-center study, the findings' generalizability is reduced. Second, although a double-blind study was infeasible, we minimized potential biases using a standardized protocol for hypotension management. Another limitation is that hypotension rarely causes adverse outcomes, making enrollment difficult with myocardial ischemia, renal impairment, or mortality as the primary endpoint. Finally, our sample size was insufficient to determine if LLSA results in a higher failure rate or has positive or negative effects on patients.

Conclusions

In conclusion, the combination of FIB and LLSA has proven effective for both anesthesia and analgesia. Compared to GA in elderly patients undergoing hip fracture surgery, FIB+LLSA results in fewer episodes of severe intraoperative hypotension, less vasopressor use, lower rescue analgesic needs, and shorter hospitalization stays. FIB+LLSA is a valid fast-track analgesia option for hip surgery protocols and should be considered.

Author Contributions

Study conception/design: XC, JL, ZA. Data acquisition/analysis/interpretation: LY, GH. Drafting/critical revising for important intellectual content: all authors. Approval of final version of paper: all authors. All authors agree to be accountable for all aspects of the

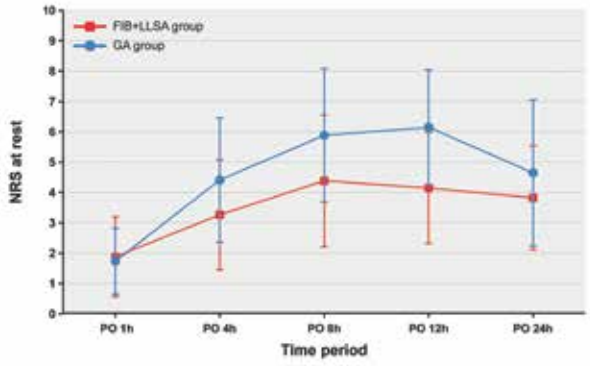

Fig. 3. *Postoperative numeric rating scores at rest with SD. NRS-11, Numeric Rating Scale 0-10 (higher score indicating a greater degree of pain).*

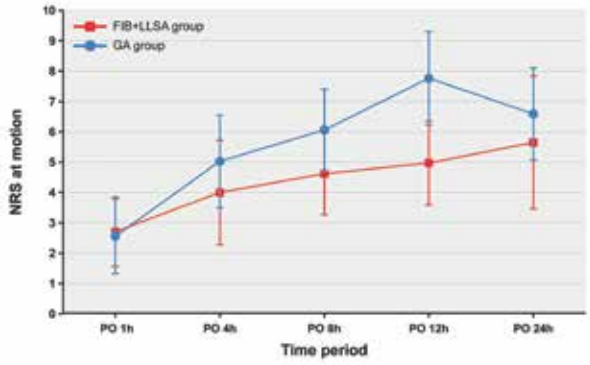

Fig. 4. *Postoperative numeric rating scores at movement with SD. NRS-11, Numeric rating scale 0-10 (higher score indicating a greater degree of pain).*

Table 3. *Postoperative rescue analgesic requirement in the 2 groups. Data are presented as n (%).*

Time frame (h)	FIB+LLSA group (n = 34)	GA group (n = 34)	*P* value
0-4, n (%)	6 (17.6)	15 (44.1)	0.018
4-8, n (%)	7 (20.6)	16 (47.1)	0.022
8-12, n (%)	7 (20.6)	17 (50.0)	0.014
12-24, n (%)	5 (14.7)	13 (38.2)	0.039

Abbreviations: LLSA, Iliofascial block combined with low-dose light spinal anesthesia; FIB, Fascia iliaca block; GA, general anesthesia.

work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Ethics approval and consent to participate

Ethical approval was obtained from the Ethics Committee of Nuclear Industry 215 Hospital of Shaanxi Province (No. 215EC-2023001, dated February 8, 2023) for this prospective, randomized controlled study. The study protocol was registered in the Chinese Clinical Trial Registry (registration No. ChiCTR2300068422).

Availability of data and material

De-identified data are available from the corresponding author upon reasonable request.

References

1. Gullberg B, Johnell O, Kanis JA. World-wide projections for hip fracture. *Osteoporos Int* 1997; 7:407-413.
2. Zhang C, Feng J, Wang S, et al. Incidence of and trends in hip fracture among adults in urban China: A nationwide retrospective cohort study. *PLoS Med* 2020; 17:e1003180.
3. Li T, Li J, Yuan L, 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* 2022; 327:50-58.
4. Neuman MD, Feng R, Carson JL, et al. Spinal anesthesia or general anesthesia for hip surgery in older adults. *N Engl J Med* 2021; 385:2025-2035.
5. Bhushan S, Huang X, Duan Y, Xiao Z. The impact of regional versus general anesthesia on postoperative neurocognitive outcomes in elderly patients undergoing hip fracture surgery: A systematic review and meta-analysis. *Int J Surg* 2022; 105:106854.
6. White SM, Griffiths R. Problems defining 'hypotension' in hip fracture anaesthesia. *Br J Anaesth* 2019; 123:e528-e529.
7. White SM, Moppett IK, Griffiths R, et al. Secondary analysis of outcomes after 11,085 hip fracture operations from the prospective UK Anaesthesia Sprint Audit

of Practice (ASAP-2). *Anaesthesia* 2016; 71:506-514.

8. Ben-David B, Frankel R, Arzumonov T, Marchevsky Y, Volpin G. Minidose bupivacaine-fentanyl spinal anesthesia for surgical repair of hip fracture in the aged. *Anesthesiology* 2000; 92:6-10.
9. Almeida CR, Vieira L. Combination of a deep fascia iliaca block with ultra-low dose spinal anesthesia for hip fracture surgery. *Can J Anaesth* 2022; 69:402-404.
10. Steenberg J, Møller AM. Systematic review of the effects of fascia iliaca compartment block on hip fracture patients before operation. *Br J Anaesth* 2018; 120:1368-1380.
11. Scurrah A, Shiner CT, Stevens JA, Faux SG. Regional nerve blockade for early analgesic management of elderly patients with hip fracture - a narrative review. *Anaesthesia* 2018; 73:769-783.
12. Chen L, Shen Y, Liu S, Cao Y, Zhu Z. Ultrasound-guided supra-inguinal fascia Iliaca compartment block for older adults admitted to the emergency department with hip fracture: A randomised controlled, double-blind clinical trial [published *BMC Geriatr* 2021; 21:669. Correction: *BMC Geriatr* 2022;22:5.
13. Salmasi V, Maheshwari K, Yang D, et al. Relationship between intraoperative hypotension, defined by either reduction from baseline or absolute thresholds, and acute kidney and myocardial injury after noncardiac surgery: A retrospective cohort analysis. *Anesthesiology* 2017; 126:47-65.
14. Moher D, Hopewell S, Schulz KF, et al. CONSORT 2010 explanation and elaboration: Updated guidelines for reporting parallel group randomised trials. *BMJ* 2010; 340:c869.
15. Simonin M, Delsuc C, Meuret P, et al. Hypobaric unilateral spinal anesthesia versus general anesthesia for hip fracture surgery in the elderly: A randomized controlled trial. *Anesth Analg* 2022; 135:1262-1270.
16. Biboulet P, Jourdan A, Van Haevre V, 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; 37:433-440.
17. Messina A, Frassanito L, Colombo D, et al. Hemodynamic changes associated with spinal and general anesthesia for hip fracture surgery in severe ASA III elderly population: A pilot trial. *Minerva Anestesiol* 2013; 79:1021-1029.
18. Minville V, Fourcade O, Grousset D, et al. Spinal anesthesia using single injection small-dose bupivacaine versus continuous catheter injection techniques for surgical repair of hip fracture in elderly patients. *Anesth Analg* 2006; 102:1559-1563.
19. Mathis MR, Naik BI, Freundlich RE, et al. Preoperative risk and the association between hypotension and postoperative acute kidney injury. *Anesthesiology* 2020; 132:461-475. Correction: *Anesthesiology* 2020; 132:937.
20. Sessler DI, Bloomstone JA, Aronson S, et al. Perioperative quality initiative consensus statement on intraoperative blood pressure, risk and outcomes for elective surgery. *Br J Anaesth* 2019; 122:563-574.
21. Weinberg L, Li SY, Louis M, et al. Reported definitions of intraoperative hypotension in adults undergoing non-cardiac surgery under general anaesthesia: A review. *BMC Anesthesiol* 2022; 22:69.
22. Almeida CR, Francisco EM, Pinho-Oliveira V, Assunção JP. Fascia iliaca block associated only with deep sedation in high-risk patients, taking P2Y12 receptor inhibitors, for intramedullary femoral fixation in intertrochanteric hip fracture: A series of 3 cases. *J Clin Anesth* 2016; 35:339-345.
23. Girón-Arango L, Peng PWH, Chin KJ, Brull R, Perlas A. Pericapsular nerve group (PENG) block for hip fracture. *Reg Anesth Pain Med* 2018; 43:859-863.
24. Desmet M, Vermeylen K, Van Herreweghe I, et al. A longitudinal supra-inguinal fascia iliaca compartment block reduces morphine consumption after total hip arthroplasty. *Reg Anesth Pain Med* 2017; 42:327-333.
25. Vermeylen K, Desmet M, Leunen I, et al. Supra-inguinal injection for fascia iliaca compartment block results in more consistent spread towards the lumbar plexus than an infra-inguinal injection: A volunteer study [published online ahead of print, 2019 Feb 22]. *Reg Anesth Pain Med* 2019; rapm-2018-100092.
26. Herrera R, De Andrés J, Estañ L, Olivas FJ, Martínez-Mir I, Steinfeldt T. Hemodynamic impact of isobaric levobupivacaine versus hyperbaric bupivacaine for subarachnoid anesthesia in patients aged 65 and older undergoing hip surgery. *BMC Anesthesiol* 2014; 14:97.
27. Garlich JM, Pujari A, Moak Z, et al. Pain management with early regional anesthesia in geriatric hip fracture patients. *J Am Geriatr Soc* 2020; 68:2043-2050.