

Effect of lumbar erector spinae plane block versus supra-inguinal fascia iliaca compartment block on early recovery quality after total hip arthroplasty via the posterolateral approach: a randomised controlled trial

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Research Article

Keywords: erector spinae plane block, fascia iliaca compartment block, postoperative quality of recovery, total hip arthroplasty, lower-limb muscle strength, analgesic therapy

Posted Date: October 18th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10926398/v1>

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Additional Declarations: No competing interests reported.

Abstract

Background Moderate-to-severe pain after total hip arthroplasty (THA) may delay recovery. Ultrasound-guided regional blockade relieves postoperative pain and reduces opioid consumption; however, which technique better preserves motor function and promotes early recovery after posterolateral THA remains unclear. This randomised controlled trial compared the effects of lumbar erector spinae plane block (ESPB) and supra-inguinal fascia iliaca compartment block (SFICB) on early recovery quality after posterolateral THA.

Methods This randomised trial enrolled patients undergoing unilateral posterolateral THA under general anaesthesia. Patients were randomised 1:1 to receive pre-operative ultrasound-guided ESPB or SFICB, both with 40 mL of 0.375% ropivacaine. The primary outcome was the 15-item Quality of Recovery (QoR-15) score at 24 h postoperatively. Secondary outcomes included QoR-15 score at 48 h, numerical rating scale (NRS) pain scores at rest and during movement, morphine milligram equivalent (MME) consumption, time to first patient-controlled analgesia (PCA) demand, proportion of patients with quadriceps muscle strength $\geq$ grade 3 on the Medical Research Council scale at 6 h, time to first ambulation, and incidence of adverse events.

Results All 106 patients (53 per group) completed the study. The ESPB group had a higher QoR-15 score at 24 h (113 [103, 124] vs. 104 [99, 111.5]; median difference 8 [2, 14]; $P = 0.008$), exceeding the minimal clinically important difference of 6 points, with significance maintained at 48 h (136 [125.5, 140] vs. 130 [118.5, 137.5]; $P = 0.024$). The ESPB group showed lower MME consumption at 0–6 h, lower movement NRS scores at 2 h, delayed first PCA demand, better quadriceps strength recovery at 6 h, and earlier ambulation. Rescue analgesia, postoperative nausea and vomiting, and length of hospital stay did not differ significantly between groups, and no block-related complications occurred.

Conclusions In patients undergoing posterolateral THA, lumbar ESPB improved early recovery quality more effectively than SFICB, probably through superior early analgesia, better preservation of quadriceps strength, and earlier ambulation. ESPB may serve as an effective component of multimodal perioperative analgesia for THA.

Trial registration ChiCTR2600119889. Registered 5 March 2026.

Introduction

As the global population ages and orthopaedic techniques continue to advance, total hip arthroplasty (THA) is increasingly performed worldwide^[1]. The posterolateral approach, a classic surgical approach widely used in China, offers excellent surgical exposure and is associated with lower complication rates^[2]. Nevertheless, this approach induces considerable soft-tissue trauma and frequently results in moderate-to-severe acute postoperative pain. Suboptimal pain control can impede early functional rehabilitation, compromise overall postoperative recovery, and prolong hospital length of stay^[3].

Traditional analgesic regimens have relied predominantly on systemic opioids; however, their associated adverse effects can directly impede enhanced recovery after surgery^[4]. Achieving effective analgesia while reducing opioid consumption has therefore become a key priority in the perioperative management of THA^[5, 6]. In recent years, multimodal analgesic strategies centred on ultrasound-guided regional blockade have attracted considerable attention^[7]; by interrupting the transmission of nociceptive stimuli, such strategies provide effective analgesia while markedly reducing opioid consumption, thereby facilitating early mobilisation and accelerated recovery. Nevertheless, the efficacy and safety of different regional analgesic techniques for postoperative pain management after THA remain inconsistent, and further comparative evaluation is warranted.

The Procedure-Specific Postoperative Pain Management (PROSPECT) guidelines recommend regional analgesic techniques including fascia iliaca compartment block (FICB) and surgical-site local infiltration analgesia for patients with contraindications to baseline analgesic agents or high predicted postoperative pain intensity^[5]. The supra-inguinal fascia iliaca compartment block (SFICB) involves the injection of a local anaesthetic into the potential space between the iliac fascia and the iliacus muscle, superior to the inguinal ligament, primarily targeting the anterior branches of the L2–L4 lumbar plexus. Theoretically, this block can cover the innervation territories of the femoral nerve, obturator nerve, and lateral femoral cutaneous nerve to relieve anterolateral hip pain. Nevertheless, posterolateral-approach THA involves the posterior hip musculature and joint capsule, whose afferent innervation lies outside the analgesic coverage of the fascia iliaca block. Accordingly, the surgical approach may influence the analgesic efficacy of SFICB^[8, 9].

The erector spinae plane block (ESPB) was first described by Forero et al.^[10] in 2016. Existing studies have validated its application for postoperative analgesia across multiple surgical procedures, including shoulder and hip surgery^[11–14], conferring broad clinical utility. Comparative investigations have demonstrated that lumbar ESPB yields analgesic efficacy comparable to fascia iliaca compartment block for total hip arthroplasty, while providing superior motor-sparing properties^[15, 16]. Nevertheless, there remains a paucity of studies assessing the influence of lumbar ESPB on postoperative pain management and recovery quality following posterolateral-approach total hip arthroplasty.

Assessment of postoperative recovery quality requires standardised instruments. The 15-item Quality of Recovery (QoR-15) scale^[17], with well-established reliability and validity, has been widely adopted to comprehensively evaluate patients' early postoperative physical comfort, psychological support, and functional recovery. Compared with conventional single-item pain-related outcomes, the QoR-15 enables a more holistic assessment of perioperative management quality.

With the 15-item Quality of Recovery (QoR-15) score as the primary outcome, this study aimed to systematically compare the effects of the two block techniques on early postoperative recovery quality in patients undergoing posterolateral-approach total hip arthroplasty, and to provide high-level evidence for optimising perioperative analgesic regimen selection in this procedure.

Materials and Methods

Study design

This was a prospective, randomised controlled trial(RCT). The trial protocol adhered to the principles of the Declaration of Helsinki, and the study was reported in accordance with the CONSORT guidelines. Ethical approval was obtained from the Ethics Committee of the Affiliated Hospital Ethics Committee of Xuzhou Medical University (Approval No.: XYFY2026-KL045-01). Written informed consent was obtained from all participants prior to enrolment. This trial was prospectively registered with the Chinese Clinical Trial Registry (Registration No.: ChiCTR2600119889; Registration Date:March 5, 2026).

Participants

Inclusion criteria: aged 45–85 years; American Society of anaesthesiologists (ASA) physical status I–III; body mass index (BMI) 18–30 kg/m²; scheduled for unilateral posterolateral-approach total hip arthroplasty (THA) under general anaesthesia for hip osteoarthritis, avascular necrosis of the femoral head, or hip dysplasia; and written informed consent provided.Exclusion criteria: (1) opioid dependence or long-term analgesic use (> 3 months); (2) contraindications to regional anaesthesia; (3) emergency or revision surgery; (4) localised spinal pathology or a history of spinal surgery; (5) severe cardiovascular, hepatic, or renal dysfunction (New York Heart Association (NYHA) functional class $\geq$ III; Child-Pugh class C; serum creatinine > 442 μ mol/L or glomerular filtration rate (GFR) < 60 mL/min); (6) cognitive impairment, communication difficulties, or inability to adhere to the study protocol.

Randomisation and blinding

Eligible participants were randomly assigned (1:1) to the LE group (lumbar erector spinae plane block) or the SF group (supra-inguinal fascia iliaca compartment block) using a computer-generated sequence. Allocation was concealed in sequentially numbered, opaque, sealed envelopes prepared by an independent investigator not involved in clinical care or outcome assessment. An experienced anaesthesiologist opened the envelopes and performed the assigned ultrasound-guided block. Owing to the distinct positioning requirements for the two techniques, the operators could not be blinded; however, participants, surgeons, postoperative data collectors, and outcome assessors remained blinded to group allocation throughout the study.

Intervention

Baseline demographic data, including age, sex, and BMI, were recorded one day before surgery. All patients received a standardised anaesthetic protocol with routine preoperative fasting and fluid restriction. In the operating room, continuous electrocardiography, pulse oximetry, and noninvasive blood pressure monitoring were initiated. After intravenous access was established, radial artery cannulation was performed under local anaesthesia for invasive arterial blood pressure monitoring. Once haemodynamic stability was confirmed, an experienced anaesthesiologist performed the assigned nerve block.

Patients in the LE group were positioned in the lateral decubitus position with the operative side up. The L4 level was identified using Tuffier's line^[18]. After skin disinfection and sterile draping, a low-frequency curvilinear ultrasound probe was placed in the midline sagittal plane over the spinous processes and then shifted 4–5 cm laterally to visualize the transverse process and the overlying erector spinae muscle (see Additional file 1: Fig. S1A). Using an in-plane approach, the needle tip was advanced to the lateral border of the transverse process, deep to the erector spinae muscle^[19]. After negative aspiration, 2–5 mL of normal saline was injected to hydrodissect the plane, followed by 40 mL of 0.375% ropivacaine. Ultrasound visualization confirmed cranial and caudal spread of the local anaesthetic, with elevation of the fascial plane indicating accurate needle placement.

Patients in the SF group were placed in the supine position. After skin disinfection and sterile draping, a high-frequency linear ultrasound probe was positioned at the medial aspect of the anterior superior iliac spine (ASIS) and the intersection of the umbilicus–ASIS line to identify the characteristic "slope sign" (see Additional file 1: Fig. S1B). Under ultrasound visualization, the iliacus muscle was seen adjacent to the inner surface of the iliac bone, with the transversus abdominis and internal oblique muscles visualised superficially; the deep circumflex iliac artery coursed between the transversalis fascia and the fascia iliaca, with the latter overlying the iliacus muscle. Using an in-plane approach, the needle tip was advanced to the fascia iliaca compartment, inferior to the deep circumflex iliac artery and deep to the fascia iliaca. After confirming correct placement with 2–5 mL of normal saline hydrodissection, 40 mL of 0.375% ropivacaine was injected.

Thirty minutes after block completion, the operating anaesthesiologist assessed sensory blockade in the territories of the femoral (FN), obturator (ON), and lateral femoral cutaneous (LFCN) nerves using cold stimulus testing. A successful block was defined as reduced sensation in these territories relative to the contralateral side; patients with failed blockade were excluded from the study.

anaesthesia methods and postoperative analgesia

Anaesthesia was induced with propofol (2–2.5 mg/kg), rocuronium (0.8 mg/kg), etomidate (0.3 mg/kg), sufentanil (0.3 µg/kg), and tropisetron (2 mg). Tidal volume and respiratory rate were adjusted to maintain end-tidal CO₂ at 35–45 mmHg after intubation. Anaesthesia was maintained with propofol (4–6 mg/kg/h) and remifentanyl (0.2–0.5 µg/kg/min), with rocuronium given as needed. Flurbiprofen axetil (50 mg) was given 15 min before wound closure. Residual neuromuscular block was reversed with sugammadex (2 mg/kg).

All patients underwent posterolateral approach THA performed by the orthopaedic team at the Affiliated Hospital of Xuzhou Medical University. No local infiltration was given into the wound. Patients were transferred to the PACU for extubation and recovery, and a standardised rehabilitation protocol was followed.

Postoperative analgesia included oral nonsteroidal anti-inflammatory drugs (NSAIDs), patient-controlled intravenous analgesia (PCIA), and rescue analgesia. Acetaminophen 1 g was administered every 6 hours

until postoperative day 2. The PCIA pump was programmed with sufentanil 100 µg and tropisetron 6 mg in normal saline to a total volume of 100 mL, without a background infusion, delivering a 2-mL bolus with a 15-minute lockout interval. Pain was assessed using the 10-point Numerical Rating Scale (NRS), and patients were instructed in its use preoperatively. Rescue analgesia (intravenous dezocine, 5 mg) was administered if resting NRS scores remained ≥ 4 despite PCA use.

Primary outcome

The primary outcome was the 15-item Quality of Recovery (QoR-15) score at 24 hours postoperatively. The QoR-15 comprises five dimensions: pain (2 items), physical comfort (5 items), physical independence (2 items), psychological support (2 items), and emotional state (4 items), with each item scored from 0 to 10 (total range: 0-150, higher scores indicating better recovery quality).

Secondary outcomes

Secondary outcomes included the 15-item Quality of Recovery (QoR-15) score at 48 h postoperatively; morphine milligram equivalents (MME) consumption during 0–6 h, 6–12 h, 12–24 h, and 24–48 h postoperatively; resting and movement-evoked NRS pain scores at 0.5, 2, 6, 12, 24, and 48 h postoperatively; the incidence of rescue analgesia; time to first PCIA demand; quadriceps muscle strength at 6 h postoperatively, assessed using the Medical Research Council (MRC) scale ^[20] by palpating quadriceps contraction (grade 0, no contraction; grade 1, trace contraction without joint movement; grade 2, active movement with gravity eliminated; grade 3, active movement against gravity; grade 4, active movement against gravity and some resistance; grade 5, active movement against full resistance); time to first ambulation (the interval from the end of surgery to walking at least 3 m with walker assistance); length of hospital stay (the duration from the end of surgery until discharge criteria were met and discharge procedures completed); and the incidence of adverse events, such as PONV.

Sample Size Calculation

Sample size was estimated using PASS 15.0 software, with the 24-hour QoR-15 score as the primary outcome. Based on pilot data (SF group: 104.20 ± 8.40 , $n = 18$; LE group: 114.94 ± 9.14 , $n = 18$) and the reported minimal clinically important difference (MCID) of 6 points for the QoR-15 ^[21], with a two-sided α of 0.05 and a power of 0.80, a minimum of 55 patients per group (110 in total) was required after accounting for a 20% attrition rate.

Statistical Analysis

All statistical analyses were performed using SPSS 25.0, GraphPad Prism 10.1.2, and Origin 2025b. Normality was assessed using the Shapiro–Wilk test, and homogeneity of variances was examined using Levene's test. Normally distributed continuous variables were presented as mean $\pm$ standard deviation (SD) and compared between groups using independent-samples t-tests. Non-normally distributed variables were expressed as median (Q1, Q3) and compared using the Mann–Whitney U test.

Categorical variables were presented as frequency (percentage) and compared using the Pearson χ^2 test or Fisher's exact test, as appropriate.

Resting and movement-evoked NRS pain scores and MME consumption at various postoperative time points were analysed using generalized estimating equations (GEE) to account for correlations among repeated measurements within the same patient. An exchangeable working correlation matrix was specified, with group, time, and the group-by-time interaction term included in the model, and age, sex, and body mass index (BMI) entered as covariates; the group effect, time effect, and interaction effect were evaluated separately. When the interaction effect was statistically significant, simple-effect analyses were performed at each time point with Bonferroni correction for multiple comparisons. Between-group differences in normally distributed continuous variables were expressed as mean differences (MD) with 95% CIs; categorical variables were compared using risk ratios (RR) with 95% CIs; median differences for non-normally distributed continuous variables were estimated using the asymptotic Hodges–Lehmann estimator with 95% CIs. All statistical tests were two-sided, and statistical significance was defined as $P < 0.05$.

Results

The CONSORT flow diagram is presented in Fig. 1. Between March 10 and June 30, 2026, 122 participants were screened; 12 were excluded before Randomisation (did not meet criteria or declined). The remaining 110 were allocated 1:1 to two groups ($n = 55$ each). One SF-group patient was transferred to the ICU, one LE-group patient was discharged early, and one in each group had block failure due to poor ultrasound visualization. Ultimately, 106 patients (53 per group) completed the trial and were included in the per-protocol analysis.

Baseline demographic and clinical characteristics (age, sex, body mass index, ASA physical status, comorbidities, and disease type) were comparable between the two groups (all $P > 0.05$, Table 1). There were no statistically significant intergroup differences in total anaesthesia duration, surgical duration, surgical side, or intraoperative remifentanil consumption (all $P > 0.05$, Table 1).

Table 1
Patient Demographics, Clinical Characteristics, and Surgical Characteristics

Age(years)	Group LE(n = 53)	Group SF(n = 53)	P value
	62.62 ± 10.93	60.26 ± 10.27	0.255
Gender (Male)	30(56.6%)	23.70 ± 2.98	0.331
BMI (kg/m ²)	23.70 ± 2.98	24.44 ± 2.97	0.203
ASA			0.513
I	9	5	
II	38	41	
III	6	7	
Comorbidities			
Hypertension	31	29	0.695
Diabetes mellitus	16	21	0.308
Coronary heart disease	9	8	0.791
Cerebral infarction	7	7	1.000
Hepatitis	2	4	0.678
Surgery side(Right)	28(52.8%)	31(58.5%)	0.558
Type of disease			0.408
Osteoarthritis	10	6	
Osteonecrosis	36	42	
Developmental hip dysplasia	7	5	
Duration of anaesthesia(min)	115.40 ± 29.59	107.21 ± 21.93	0.109
Duration of surgery(min)	87.15 ± 24.75	83.23 ± 18.26	0.355
Total intraoperative remifentanil consumption (mg)	1.69 ± 0.37	1.81 ± 0.40	0.105
Notes: Values are presented as mean ± SD or number of patients.			
Abbreviations: BMI, body mass index; ASA, American Society of anaesthesiologists.			

At 24 h postoperatively, the total QoR-15 score was significantly higher in the LE group than in the SF group (113 [103, 124] vs. 104 [99, 111.5]; $P = 0.008$), with a median difference of 8 points (95% CI 2–14). Except for the psychological support domain ($P = 0.719$), scores for pain, physical comfort, physical

independence, and emotional state were higher in the LE group (all $P < 0.05$) (Table 2; see Additional file 1: Fig. S2). At 48 h postoperatively, the intergroup difference in total QoR-15 scores remained significant ($P < 0.05$), with a median difference of 5 points (95% CI 1–9). Higher scores in the LE group were observed only for the physical independence ($P < 0.001$) and emotional state ($P = 0.001$) domains (Table 2; see Additional file 1: Fig. S2). Violin plots of QoR-15 scores at 24 and 48 h postoperatively are presented in Fig. 2.

Table 2
Outcomes.

Total QoR-15 at 24 h [†]	Group LE(n = 53)	Group SF(n = 53)	Difference in medians (95% CI)	P value
	113(103,124)	104(99,111.5)	8(2 to 14)	0.008*
Pain,24h [†]	16(15,19)	14(13.5,16.5)	2(1 to 3)	0.003*
Physical comfort,24h [†]	39(33.5,46)	36(33,39)	3(0 to 5)	0.030*
Physical independence,24h [†]	2(0,4)	0(0,1)	1(0 to 2)	<0.001*
Psychological support,24h [†]	20(20,20)	20(20,20)	0(0 to 0)	0.719
Emotional state,24h [†]	36(34.5,37)	34(32,36)	2(0 to 3)	0.021*
Total QoR-15 at 48 h [†]	136(125.5,140)	130(118.5,137.5)	5(1 to 9)	0.024*
Pain,48h [†]	18(15,20)	18(17,19)	0(-1 to 1)	0.827
Physical comfort,48h [†]	42(39,45)	42(39,44)	0(-2 to 2)	0.901
Physical independence,48h [†]	16(13,18)	11(10,14.5)	4(2 to 5)	<0.001*
Psychological support,48h [†]	20(20,20)	20(20,20)	0(0 to 0)	0.575
Emotional state,48h [†]	39(39,40)	38(35,40)	1(0 to 2)	0.001*
First time to PCA [†] request(min)	225(103,457.5)	130(81.5,266.5)	81 (19 to 196)	0.009*
Length of hospital stay after surgery(h) [†]	70.60(63.58,93.02)	71.21(69.95,92.93)	-3.47(-13.9 to 5)	0.097
			Difference in means (95% CI)	
Notes: Data are presented as mean ± SD, n (%), or median (Q1, Q3). Effect sizes are presented as median differences (Hodges-Lehmann) [†] , mean differences [‡] , or relative risks [§] with 95% CIs, as appropriate. Mean/median differences > 0 indicate higher values in the LE group; RR > 1 indicates higher risk in the LE group (SF group as reference). Statistically significant values with P < 0.05 are indicated with *.				
Abbreviations:QoR-15, Quality of Recovery-15; PONV, postoperative nausea and vomiting; PCA, patient-controlled analgesia; MRC, Medical Research Council.				

Total QoR-15 at 24 h [†]	Group LE(n = 53)	Group SF(n = 53)	Difference in medians (95% CI)	P value
	113(103,124)	104(99,111.5)	8(2 to 14)	0.008*
Time to first ambulation(h) [‡]	46.18 ± 10.50	50.23 ± 9.36	-4.04(-7.87 to -0.21)	0.039*
			Relative risk (95% CI)	
Number of patients requiring rescue analgesia [§]	3(5.7%)	5(9.4%)	0.74(0.29–1.84)	0.716
Number of patients with MRC grade ≥ 3 at 6 h [§]	36(67.9%)	24(45.3%)	1.50(1.058–2.126)	0.019*
Number of patients with PONV [§]	5(9.4%)	9(17.0%)	0.68(0.33–1.42)	0.253
Notes: Data are presented as mean ± SD, n (%), or median (Q1, Q3). Effect sizes are presented as median differences (Hodges-Lehmann) [†] , mean differences [‡] , or relative risks [§] with 95% CIs, as appropriate. Mean/median differences > 0 indicate higher values in the LE group; RR > 1 indicates higher risk in the LE group (SF group as reference). Statistically significant values with P < 0.05 are indicated with *.				
Abbreviations:QoR-15, Quality of Recovery-15; PONV, postoperative nausea and vomiting; PCA, patient-controlled analgesia; MRC, Medical Research Council.				

The time to first PCA demand was longer in the LE group than in the SF group (225 [103, 457.5] min vs. 130 [81.5, 266.5] min; P = 0.009), and the corresponding Kaplan-Meier survival curve was shown in Fig. 3a. The proportion of patients with quadriceps strength of MRC grade ≥ 3 at 6 h postoperatively was higher in the LE group, and the time to first ambulation was shorter in the LE group (all P < 0.05). No significant intergroup differences were observed in rescue analgesia use, PONV incidence, or length of hospital stay (all P > 0.05; Table 2).

Generalized estimating equation (GEE) analyses, adjusted for age, sex, and BMI, were performed for resting/movement-evoked NRS scores and morphine milligram equivalents (MME) across time intervals. For resting NRS, time effect was significant (Wald $\chi^2 = 2632.413$, P < 0.001); group (Wald $\chi^2 = 1.242$, P = 0.265) and group-by-time interaction (Wald $\chi^2 = 6.274$, P = 0.280) were not. No intergroup differences were observed at any time point (see Additional file 2: Table S1, Fig. 3b).

For movement-evoked NRS, time effect (Wald $\chi^2 = 6412.921$, P < 0.001) and group-by-time interaction (Wald $\chi^2 = 18.772$, P = 0.002) were significant; group effect was not (Wald $\chi^2 = 2.561$, P = 0.110). Simple-effect analyses showed no intergroup differences at 0.5, 6, 12, 24, or 48 h; only at 2 h was the score higher in the SF group (P = 0.029) (Table 3, Fig. 3c).

Table 3
Postoperative Numerical Rating Scale (NRS) scores on movement

Group	0.5h	2h	6h	12h	24h	48h	Wald χ^2	P Value
Group LE	3(3, 4)	3(3, 5)	4(3.5, 5.5)	5(4, 6)	3(3, 4)	2(1, 3)	4474.427	<0.001*
Group SF	3(3, 4)	4(3.5, 5)	5(4, 6)	6(4.5, 6)	4(2, 4)	2(2, 3)	3195.320	<0.001*
Wald χ^2	2.379	4.791	3.678	2.199	0.761	0.282		
P Value	0.123	0.029*	0.055	0.138	0.383	0.595		
Group	Wald χ^2 = 2.561,P = 0.110							
Time	Wald χ^2 = 6412.921,P<0.001*							
Group*Time	Wald χ^2 = 18.772,P = 0.002							
Notes:Data are presented as median (Q1, Q3).P values for between-group differences at each time point were derived from GEE models adjusted for age, sex, and BMI,with the Wald χ^2 statistic reported. Simple-effect analyses at each time point were performed following a significant interaction; Values with P < 0.05 are indicated with*.								

For MME consumption, group effect (Wald χ^2 = 5.029, P = 0.025), time effect (Wald χ^2 = 1114.318, P < 0.001), and interaction (Wald χ^2 = 214.624, P < 0.001) were all significant. Simple-effect analyses revealed lower MME in the LE group only during 0–6 h (P < 0.001); no differences in other intervals (all P > 0.05). Thus, the opioid-sparing effect of LE block was limited to the early postoperative period (0–6 h) (Table 4, Fig. 3d).

Table 4
Interval-based Morphine Milligram Equivalent(MME, mg)

Group	0-6h	6-12h	12-24h	24-48h	Wald χ^2	P Value
Group LE	2(0, 4)	8(8, 10)	33(22.5, 36)	20(14, 22)	630.547	<0.001*
Group SF	10(8, 10)	10(8, 10.5)	32(27, 36)	19(11.5, 23)	1401.947	<0.001*
Wald χ^2	106.147	1.695	1.540	1.048		
P Value	<0.001*	0.193	0.215	0.306		
Group	Wald χ^2 = 5.029,P = 0.025*					
Time	Wald χ^2 = 1114.318,P<0.001*					
Group*Time	Wald χ^2 = 214.624,P<0.001*					
Notes:Data are presented as median (Q1, Q3).P values for between-group differences at each time point were derived from GEE models adjusted for age, sex, and BMI,with the Wald χ^2 statistic reported. Simple-effect analyses at each time point were performed following a significant interaction; Values with P < 0.05 are indicated with*.						

Discussion

Based on the Enhanced Recovery After Surgery (ERAS) consensus for hip and knee procedures [22], an ideal nerve block technique for hip surgery should provide effective analgesia while preserving motor function to facilitate early ambulation and improve recovery quality. The present study demonstrated that lumbar erector spinae plane block (LE group), compared with supra-inguinal fascia iliaca compartment block (SF group), improved QoR-15 scores at 24 and 48 h following total hip arthroplasty (median differences of 8 and 5 points), alleviated early pain, preserved quadriceps strength, and shortened time to first ambulation. No significant differences were observed between the two groups in later opioid consumption, rescue analgesia use, PONV incidence, or length of hospital stay.

Regarding analgesia, no significant intergroup differences were observed in resting and movement-evoked NRS pain scores across most time points. Nevertheless, the ESPB group exhibited lower movement-evoked NRS pain scores at 2 h postoperatively and reduced MME consumption within 0–6 h, indicating more comprehensive early analgesia provided by lumbar ESPB. This may be attributable to differences in target sites and nerve coverage between the two techniques. The posterolateral approach for THA involves a complex incision trajectory. The incision begins 5 cm distal to the greater trochanter, is centred over the femoral shaft, extends proximally toward the greater trochanter, and continues with a 6-cm curved incision posterosuperiorly toward the iliac spine [23]. The hip joint is predominantly innervated by the anterior rami of the lower lumbar plexus (L2–L4) and upper sacral plexus (L4–S1) [24]. Cutaneous sensation over the posterolateral incision is supplied by multiple nerves, including the lateral

femoral cutaneous nerve, lateral cutaneous branches of the iliohypogastric nerve, subcostal nerve, and superior cluneal nerves (posterior rami of L1–L3 spinal nerves), with substantial individual anatomical variation [24–26]. Accordingly, SFICB, which blocks only the anterior rami of the lumbar plexus, cannot fully cover all sensory afferents of the posterolateral incision, limiting its early analgesic completeness.

Early investigations suggested^[10] that thoracic ESPB allows spread through the paravertebral space to block both anterior and posterior rami of spinal nerves. Nevertheless, the lumbar compartment is denser; restricted by barriers including the thick erector spinae muscle, multilayered thoracolumbar fascia, and iliolumbar ligament^[27, 28], longitudinal spread of local anaesthetics is constrained. Cadaveric studies demonstrated^[28, 29] that when low-volume (20 mL) local anaesthetic is used for lumbar ESPB, injectate is largely confined to the L3–L5 segments, consistently blocking posterior rami but providing only limited and variable anterior rami coverage. As cadaveric models lack the physiological tissue tension, respiratory motion, and dynamic intra-abdominal pressure of living subjects^[30], they cannot accurately replicate in vivo local anaesthetic diffusion. Consequently, cadaver-derived findings have limitations and should be extrapolated to clinical practice with caution.

Multiple in-vivo clinical case series and imaging studies have confirmed^[14, 31–33] that lumbar ESPB at L4 with a large volume (30–40 mL) allows extensive spread within the thoracolumbar fascial plane, penetrating through intervertebral foramina into the paravertebral and epidural spaces and further infiltrating ventrally around the psoas major muscle, thereby achieving effective blockade of L2–L4 lumbar plexus branches and partial sacral plexus nerves—i.e., dual blockade of both anterior and posterior rami. In the present study, needle insertion was uniformly performed at the transverse process angle space^[19], which facilitates ventral spread of local anaesthetic and further improves lumbar plexus blockade. Owing to this dual analgesic mechanism—blockade of posterior rami supplying the surgical incision and anterior rami supplying deep hip nociception—lumbar ESPB may confer clinical advantages over fascia iliaca compartment block, which targets only lumbar plexus anterior rami and fails to cover posterior nociceptive pathways.

In terms of motor function, the LE group achieved significantly higher physical independence domain scores on the QoR-15 at 24 h and 48 h postoperatively, along with greater quadriceps strength at 6 h and earlier ambulation, indicating that lumbar ESPB effectively preserves lower-limb motor function. Injectate from fascia iliaca compartment block readily spreads to the femoral nerve trunk, often causing variable degrees of quadriceps weakness and increasing the risk of impaired early mobilization^[8, 34], which contradicts the principles of enhanced recovery after surgery (ERAS). In contrast, lumbar ESPB involves injection into the lumbar dorsal fascial plane, with its target site away from major lower-limb motor nerves, including the lumbar plexus and femoral nerve. Even when injectate spreads ventrally to the lumbar plexus, only mild and transient motor blockade is produced. Consequently, lumbar ESPB effectively preserves lower-limb muscle strength and independent mobility, creating favorable conditions for early postoperative rehabilitation and recovery.

The analgesic efficacy of lumbar ESPB for THA remains controversial. Flaviano et al. ^[16] compared SFICB with ESPB and found no significant intergroup differences in 24-h morphine consumption or pain scores, whereas the ESPB group showed better preservation of quadriceps strength. The use of neuraxial anaesthesia as the baseline anaesthetic in that study may have masked early analgesic differences between the two blocks. Chan et al. ^[36] compared general anaesthesia with L1-level ESPB versus general anaesthesia alone and found no differences in fentanyl consumption or pain scores. Injectate at the L1 level spreads mainly cephalad, providing limited coverage of the lumbosacral plexus. Moreover, most patients in that study underwent a lateral approach, from which ESPB may derive limited benefit. Lennon et al. ^[37] compared L3-level ESPB with placebo (all participants received neuraxial block, local anaesthetic infiltration, and oral multimodal analgesia) and found no additional analgesic benefit. The high intensity of their baseline analgesic regimen may have obscured the effects of ESPB. Nevertheless, most high-quality evidence ^[38, 39] supports ESPB as a safe and effective component of perioperative multimodal analgesia. The present study adds further evidence for ESPB in posterolateral-approach THA.

The median between-group difference in 24-hour postoperative QoR-15 scores was 8 points, which exceeded the minimal clinically important difference (MCID). Accordingly, the observed disparity in recovery quality was both statistically significant and clinically meaningful. Consistent with Enhanced Recovery After Surgery (ERAS) principles, these findings offer novel clinical insights for optimising perioperative multimodal analgesia strategies in total hip arthroplasty (THA).

This study has several limitations. First, dermatomal sensory block coverage was not evaluated postoperatively, as surgical dressings made mapping of sensory block distribution impractical. Additionally, studies suggest that the sensory loss area of fascial plane blocks often correlates poorly with actual analgesic effects; therefore, this omission likely has limited impact on the conclusions^[39,40]. Second, complete patient blinding could not be achieved owing to different positioning requirements for the two techniques. Some patients might infer their group assignment from positioning, introducing the risk of subjective bias. To minimize this bias, outcome collectors and assessors remained blinded, and secondary outcomes included objective parameters such as morphine equivalents consumption and time to first ambulation. Third, lumbar ESPB requires the lateral decubitus position, which is poorly tolerated by patients with femoral neck fractures or other conditions precluding position changes, thus limiting its applicability. Furthermore, the analgesic benefit of ESPB through posterior ramus blockade is mainly relevant to pain from posterolateral incisions. Therefore, these findings should be interpreted with caution when extrapolating to THA via the anterior or lateral approach.

Conclusions

In conclusion, for patients undergoing total hip arthroplasty via the posterolateral approach, lumbar erector spinae plane block optimises early postoperative analgesia, better preserves lower-limb muscle

strength, and improves early postoperative recovery quality compared with supra-inguinal fascia iliaca compartment block.

Abbreviations

THA	Total hip arthroplasty
ERAS	Enhanced recovery after surgery
PONV	Postoperative nausea and vomiting
SFICB	Supra-inguinal fascia iliaca compartment block
ESPB	Erector spinae plane block
QoR-15	Quality of Recovery-15
NRS	Numerical Rating Scale
PCIA	Patient-controlled intravenous analgesia
GEE	Generalized estimating equation
MME	Morphine milligram equivalents
MRC	Medical Research Council
MCID	Minimal clinically important difference

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Affiliated Hospital Ethics Committee of Xuzhou Medical University (Approval No.: XYFY2026-KL045-01). The trial was prospectively registered at the Chinese Clinical Trial Registry (Registration No.: ChiCTR2600119889; Registration Date: March 5, 2026). This study followed the CONSORT guidelines and Declarations of Helsinki. All participants provided written informed consent prior to enrolment.

Consent for publication

Not applicable.

Availability of data and materials

The datasets containing private patient information are available from the corresponding author (Mengxing Jia) upon reasonable request for academic research purposes.

Competing interests

The authors declare no competing interests.

Funding

This research was funded by the Medical Research Project of Jiangsu Provincial Health Commission (K.Z. MQ2025036) and the Talent Introduction Research Start-up Fund of the Affiliated Hospital of Xuzhou Medical University (K.Z.PYJH 2025304).

Authors' contributions

Beining Hang: conceptualization, data curation, formal analysis, investigation, methodology, project administration, writing—original draft. Li Xu, Yan Peng, Kang Zhou, and Hanwei Gong: conceptualization, data curation, investigation, project administration. Qianwei Sun and Mengxing Jia: conceptualization, data curation, project administration, supervision, writing, review, and editing. All authors critically reviewed and provided final approval of the manuscript.

Acknowledgements

The authors express sincere gratitude to all study participants for their essential contributions to this research. We extend professional acknowledgement to the clinical teams from the Department of Anesthesiology and Department of orthopaedic Surgery at the Affiliated Hospital of Xuzhou Medical University for their expert technical support and dedicated patient care throughout the study implementation.

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Figures

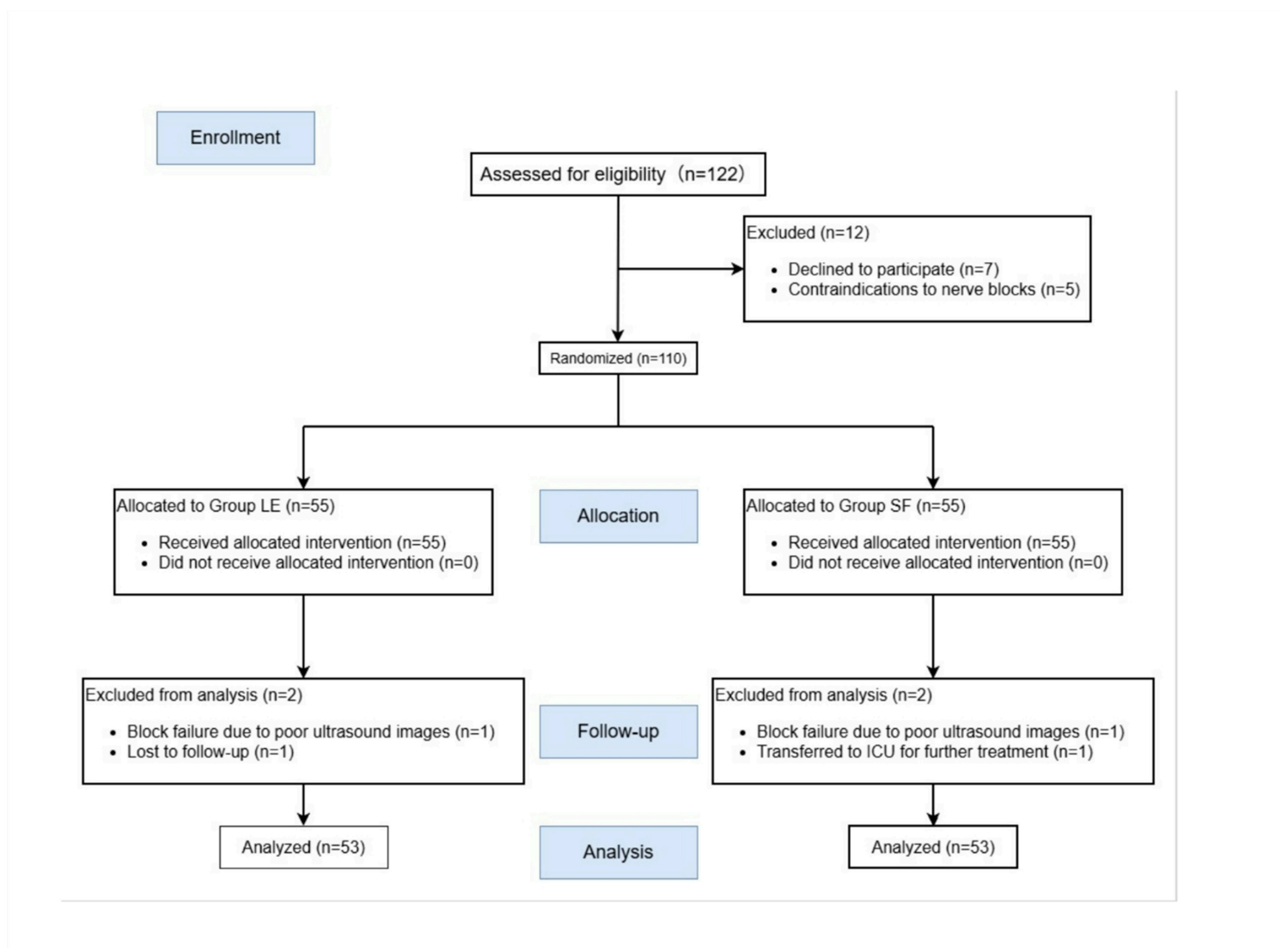


Figure 1

The CONSORT study flow chart.

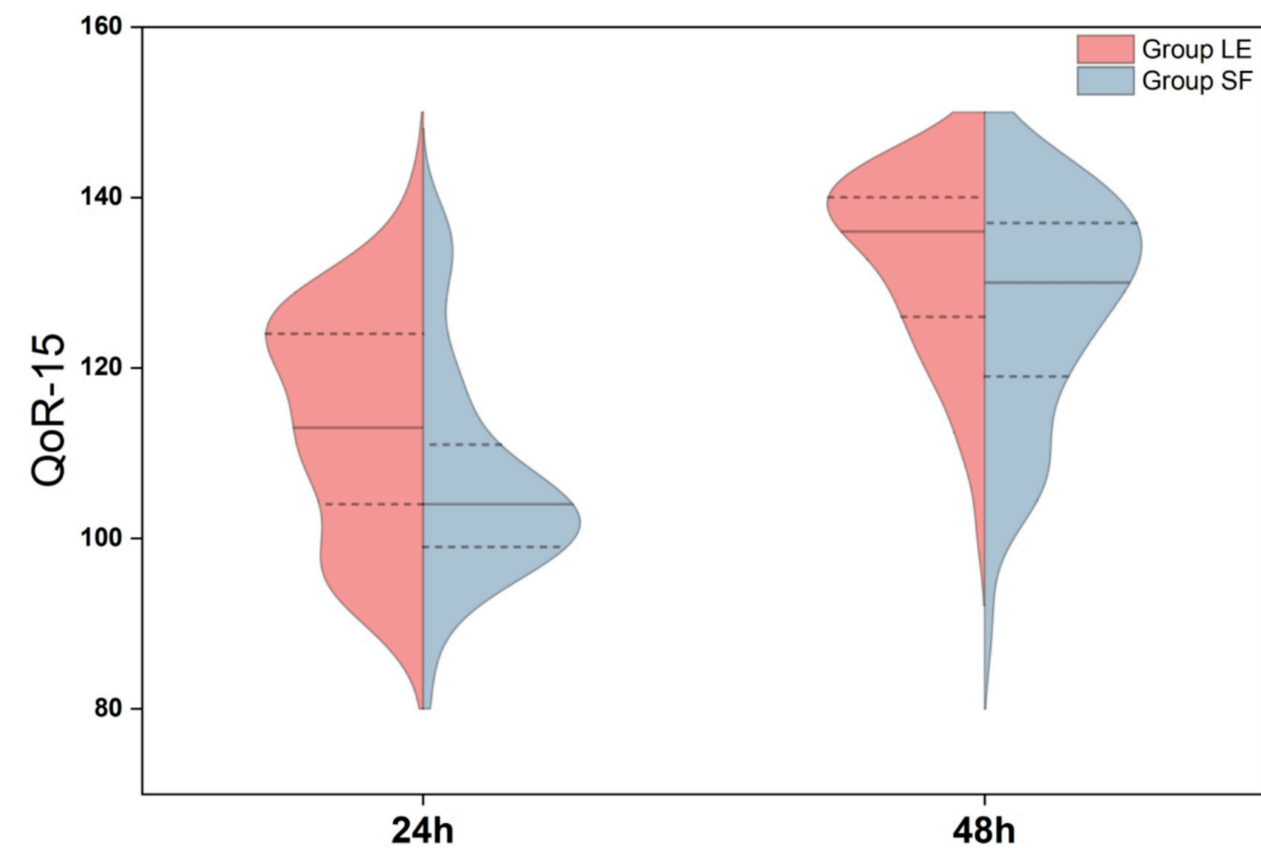


Figure 2

Split violin plots of the total Quality of Recovery-15 (QoR-15) scores at 24 h and 48 h postoperatively, with overlaid box plots showing the median (solid horizontal line) and interquartile range (dashed horizontal lines).

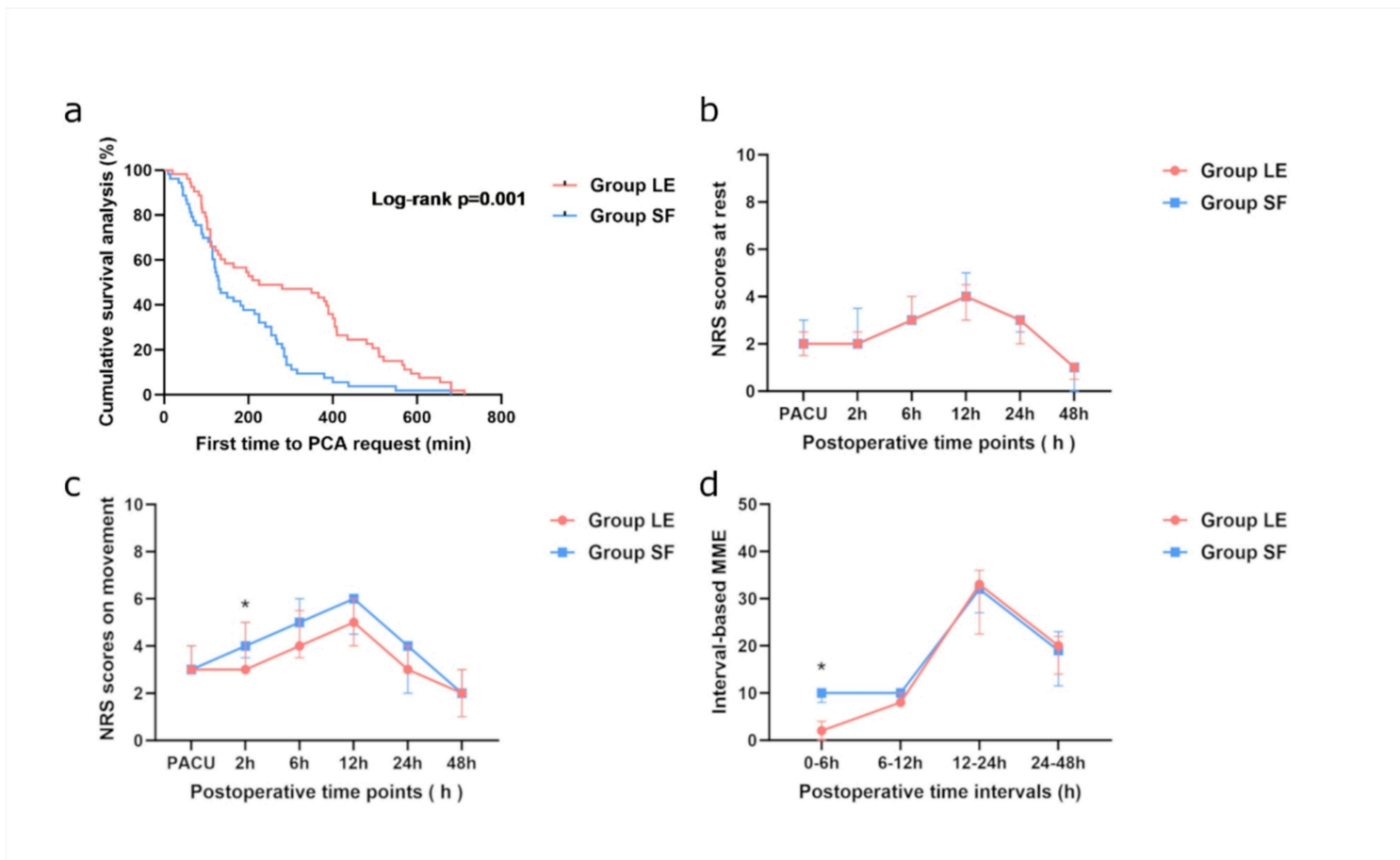


Figure 3

Post-operative pain and analgesia outcomes. (*: $P<0.05$)

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