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Original Contribution

Clinical evaluation of obturator nerve involvement following a supra-inguinal fascia iliaca compartment block: A randomized, double-blind trial

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HIGHLIGHTS

- Cadaveric and imaging studies suggested that a 40-ml supra-inguinal fascia iliaca compartment block (SFICB) involved the obturator nerve in most cases.
- In contrast, clinical findings showed that SFICB with placebo obturator nerve block rarely anesthetized the obturator nerve.
- Adding an obturator nerve block to SFICB did not improve postoperative analgesia or recovery quality after total knee arthroplasty.

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ABSTRACT

Background: Clinical evidence on obturator nerve involvement after supra-inguinal fascia iliaca compartment block (SFICB) is limited. This study aimed to investigate whether a 40-mL SFICB reliably anesthetizes the obturator nerve and whether the addition of a selective obturator nerve block (ONB) improves postoperative analgesia in patients undergoing total knee arthroplasty.

Methods: In this randomized, double-blind, active-controlled trial, 84 patients who underwent total knee arthroplasty were randomized to receive SFICB (40 mL of 0.5% ropivacaine) plus either active (10 mL of 0.5% ropivacaine) or placebo (10 mL of normal saline) ONBs. Spinal anesthesia and postoperative analgesia were standardized. Two primary outcomes were (1) the success rate of ONB, measured 45 min after block completion, and (2) equivalent intravenous morphine consumption during the first 24 h postoperatively, tested following a predefined fixed-sequence procedure. Secondary outcomes included post-block sensorimotor function, pain scores, rescue analgesic use, patient satisfaction, sleep quality, recovery quality, and adverse effects within 48 h postoperatively.

Results: The success rate of ONB was significantly higher in the ONB group than in the placebo group (97.6% vs 2.4%; risk difference, 95.2%; 95% confidence interval, 81.2%–98.0%; $P < 0.001$). Equivalent intravenous morphine consumption during the first 24 h postoperatively did not differ significantly between the ONB and placebo groups (6.8 [2.5, 11.5] vs 7.8 [4.6, 17.5] mg; median difference, −2.5; 95% confidence interval, −5.0 to 0.5; $P = 0.156$). No differences were observed in the secondary outcomes, except for a greater reduction in adductor strength in the ONB group.

Conclusions: An SFICB with 40 mL of 0.5% ropivacaine rarely anesthetized the obturator nerve. The addition of a selective ONB did not improve postoperative analgesia or recovery quality within 48 h after total knee

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arthroplasty. Further studies are needed to define the minimum effective SFICB volume that reliably involves the femoral and lateral femoral cutaneous nerves.
Clinical trial registration: ChiCTR2300073558.

1. Introduction

The ultrasound-guided supra-inguinal fascia iliaca compartment block (SFICB) was first described by Hebbard et al. [1] In their cadaveric study, an injection of 20 mL dye consistently stained the femoral and lateral femoral cutaneous nerves, but not the obturator nerve. Although the technique was originally proposed with a relatively small injectate volume, [1] subsequent clinical practice has generally employed a larger volume (40 mL) in an attempt to achieve obturator nerve coverage. [2]

Vermeylen et al. [3] conducted a cadaveric study to determine the optimal volume of SFICB required to reach the femoral, obturator, and lateral femoral cutaneous nerves. They suggested 40 mL as the optimal volume, which consistently reached the femoral and lateral femoral cutaneous nerves and involved the obturator nerve in 75% (3/4) of specimens. In their subsequent volunteer study, administration of 40 mL of local anesthetic resulted in spread to the expected anatomical location of the obturator nerve on magnetic resonance imaging in 80% (8/10) of participants. [4] Furthermore, in a cadaveric dose-finding study, Kantakam et al. [5] reported that 62.5 mL was the minimum effective volume required to stain the obturator nerve in 90% of specimens, whereas a 40-mL SFICB successfully involved the obturator nerve in 83% (5/6) of specimens. Collectively, cadaveric and imaging studies suggest that a 40-mL SFICB achieves obturator nerve involvement in 75–83% of cases.

Reliable clinical assessment of obturator nerve block (ONB) relies on evaluating adductor strength. [6] Because femoral nerve block alone can reduce adductor strength by 10–20%, [7,8] a decrease exceeding 20% from baseline after an SFICB may indicate some degree of obturator nerve involvement. Two clinical trials reported that approximately 90% of patients experienced a postoperative reduction in adductor strength >20% following a 40-mL SFICB. However, this reduction is unlikely to reflect ONB exclusively, as it may also be attributable to surgical trauma or postoperative pain. [9] Nevertheless, whether SFICB constitutes a true ONB remains controversial, as the obturator nerve does not traverse the fascia iliaca compartment and may therefore not be reliably anesthetized. [10] Further clinical trials are warranted to evaluate obturator nerve involvement preoperatively following SFICB. In addition, although an earlier study suggested improved analgesia with the addition of an ONB to a femoral three-in-one nerve block for total knee arthroplasty, [11] advances in perioperative management—including intraoperative tranexamic acid and intravenous dexamethasone [12]—may attenuate the incremental clinical benefit of adding an ONB.

We hypothesized that a 40-mL SFICB with a placebo ONB would not reliably anesthetize the obturator nerve, and that the addition of an active ONB would improve postoperative analgesia in patients undergoing total knee arthroplasty.

2. Methods

2.1. Study Participants

This randomized, double-blind, active-controlled trial was approved by the Institutional Review Board of Beijing Hospital (2023BJYYEC-176-01) on June 27, 2023, and was registered prior to patient enrollment at www.chictr.org.cn (ChiCTR2300073558; principal investigator: H.Z.) on July 14, 2023. The study was conducted at Beijing Hospital, Beijing, China, from July 21, 2023, to November 15, 2024. Written informed consent was obtained from all patients.

We enrolled patients aged 18 to 80 years with American Society of Anesthesiologists (ASA) physical status I–III who were scheduled for unilateral total knee arthroplasty under spinal anesthesia. Exclusion criteria included inability to provide consent or communicate, contraindications to nerve block or study drugs, pre-existing neuromuscular deficits in lower extremities, inability to fully extend or adduct the knees, prior major surgery on the ipsilateral knee, chronic opioid use, hepatic or renal failure, body weight < 50 kg, body mass index >40 kg/m^2, or pregnancy.

2.2. Randomization and Blinding

Randomization in a 1:1 ratio with a block size of six was generated by an independent statistician using the PLAN Procedure in SAS 9.4 (SAS Institute, Cary, NC, USA). Allocation was concealed in sequentially numbered, sealed, opaque envelopes. Upon arrival in the anesthesia procedure room, eligibility was confirmed by the block operator. Only an independent research assistant then opened the envelope and, together with a designated nurse, prepared the study medications; neither was otherwise involved in the study. The study medications (active or placebo) were prepared in identical syringes in terms of number, size, and labeling to maintain blinding. All blocks were performed by the same experienced anesthesiologist (Y.M.) with the same assistant nurse. The block operator, trained by the surgical team for motor assessment, also evaluated sensorimotor function before and after block performance. Both the block operator and assistant nurse took no further part in the study. Consequently, patients, the block operator, and all study personnel involved in perioperative care and outcome assessment were blinded to group allocation.

2.3. Nerve Blocks

After standard ASA monitors were applied and intravenous access and supplemental oxygen were established, patients were placed in the supine position and sedated with 1–2 mg of intravenous midazolam. Both the SFICB and ONB were performed using a high-frequency (6–13 MHz) linear ultrasound transducer (X-Porte, SonoSite, USA), a 22-gauge, 100-mm nerve block needle (Pajunk, Germany), and an in-plane technique.

After sterile skin preparation and infiltration with 2 mL of 1% lidocaine, the SFICB was performed as described by Desmet et al. [13] Briefly, the needle was inserted in a caudad-to-cephalad direction. After penetrating the fascia iliaca and hydrodissecting with normal saline, the needle was advanced within the fascia iliaca compartment to a position posterior to the deep circumflex iliac artery. Subsequently, 40 mL of 0.5% ropivacaine was injected under real-time ultrasound guidance, and cranial spread of the local anesthetic within the compartment was confirmed.

The two injection sites for the ONB were identified based on established sonoanatomical landmarks of the obturator nerve. [14] With the hip slightly abducted and externally rotated, the ultrasound transducer was placed at the inguinal crease to visualize the femoral vessels and then moved medially to identify the pectineus and adductor muscles (Fig. 1). At this level, the characteristic “Y-shaped” intermuscular fascia formed by the pectineus, adductor longus, and adductor brevis muscles was identified. The transducer was then gently tilted cranially to trace the proximal course of the obturator nerve and subsequently returned to a neutral orientation to confirm the course of its branches. This maneuver allowed identification of the anterior and posterior branches within the fascial planes anterior and posterior to the adductor brevis, respectively. The needle was advanced in a lateral-to-posteromedial direction to sequentially block the posterior and then the anterior branches of the obturator nerve. After confirming correct needle

placement with a small volume of normal saline, each branch received a separate interfascial injection of 5 mL of 0.5% ropivacaine in the ONB group or 5 mL of normal saline in the placebo group.

2.4. Sensorimotor Assessment

Sensation to ice was evaluated at the anterior, medial, and lateral mid-thigh using a 3-point scale (0 = normal cold sensation; 1 = decreased cold sensation; 2 = no cold sensation) 45 min after block completion. Quadriceps motor block was assessed in the supine position, with the hip and knee flexed to 45° and 90°, respectively, using a 3-point scale (0 = knee extension against gravity and resistance; 1 = knee extension against gravity only; 2 = no knee extension). [15] Femoral nerve block success was defined as a cold sensation score of 2 at the anterior mid-thigh combined with a quadriceps motor block score of 2.

Adductor strength was measured using a mercury sphygmomanometer. [16] With the patient in the supine position, both knees fully extended and ankles dorsiflexed, a blood pressure cuff pre-inflated to 40 mmHg was placed between the knees. While the block operator stabilized the non-blocked leg, the patient was instructed to generate maximum adductor strength within two seconds, maintain it for three seconds, and then relax for 30 s. The maximum sustained pressure on the sphygmomanometer, minus 40 mmHg, was recorded as the adductor strength. Measurements were performed three times and averaged both before block performance and 45 min after block completion.

2.5. Intraoperative Anesthesia and Postoperative Analgesia

Spinal anesthesia was administered in the lateral decubitus position with the surgical side up, using either a landmark-guided or ultrasound-assisted midline or paramedian approach. The volume of 0.5% bupivacaine used for spinal anesthesia (prepared by diluting 0.75% bupivacaine with sterile water) was determined at the discretion of the attending anesthesiologist and ranged from 2.5 to 2.8 mL. Intraoperatively, patients received intravenous flurbiprofen (50 mg), dexmedetomidine (0.5 μg/kg), tranexamic acid (2 g), tropisetron (5 mg), and dexamethasone (5 mg). Additional sedation was provided with intravenous midazolam (1–2 mg) or propofol (target plasma concentration 0.5–1 μg/mL) as needed to maintain responsiveness to verbal stimuli. All surgeries were performed via a standard medial parapatellar approach with the use of a thigh tourniquet.

Postoperative analgesia was standardized. All patients received intravenous flurbiprofen (100 mg every 12 h), a nightly rectal indomethacin suppository (50 mg), and intravenous morphine patient-controlled analgesia (PCA) with 2.5 mg bolus doses, a 10-min lockout interval, and no background infusion. Patients were instructed to press the PCA button when the numerical rating scale (NRS; 0 = no pain, 10 = worst imaginable pain) score exceeded 3 or whenever they required analgesia. If pain persisted with an NRS score > 3, rescue analgesia was administered at the discretion of caregivers, including rectal indomethacin (50 mg), oral oxycodone/acetaminophen (5/325 mg), or intramuscular pethidine (50 mg).

2.6. Outcome measures

The two primary outcomes were (1) the success rate of ONB assessed 45 min after block completion and (2) equivalent intravenous morphine consumption during the first 24 h postoperatively. Based on prior clinical observations showing that the obturator nerve block reduced adductor strength by 42–73%, [17] whereas the femoral nerve block resulted in a 10–20% reduction, [7,8] we predefined a conservative threshold of a ≥ 50% decrease in adductor strength from baseline as indicative of successful ONB.

Secondary outcomes included NRS pain scores at rest and on movement (passive knee flexion to 45°) [18] at 2, 4, 24, and 48 h postoperatively; equivalent intravenous morphine consumption within 48 h; time to first PCA use; proportion of patients requiring rescue analgesics within 48 h; patient satisfaction with analgesia at 48 h (NRS, 0 = not satisfied to 10 = very satisfied); sleep quality score at 0–24 h and 24–48 h postoperatively (NRS, 0 = very poor to 10 = very good); the aggregate score of the 15-item quality of recovery scale (QoR-15, Chinese version; 0 = worst to 150 = best recovery), [19] proportion of patients with good recovery (QoR-15 ≥ 118), [20] and QoR-15 domain scores at 24 and 48 h; cold sensation scores at the anterior, medial, and lateral mid-thigh; quadriceps motor block score; success rate of femoral nerve block; post-block adductor strength; percent decrease in adductor strength from baseline; adductor strength reduction score (0 = 0–20% decrease; 1 = 21–70% decrease; 2 = 71–90% decrease); [15] and adverse effects.

2.7. Statistical analysis

Categorical variables were summarized as numbers (percentages), and continuous variables were expressed as means (standard deviations,

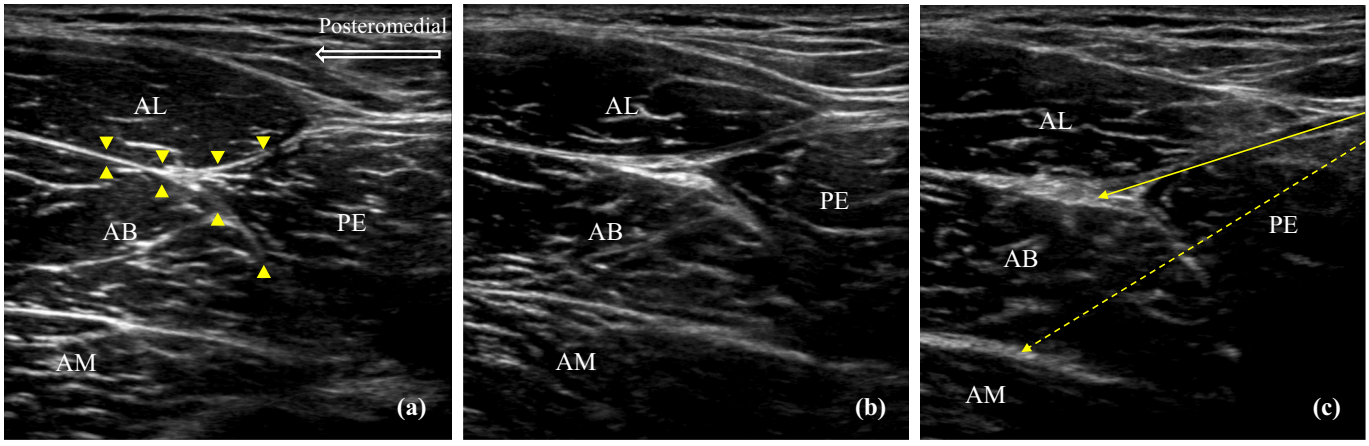

Fig. 1. Sonograms illustrating the ultrasound-guided obturator nerve block. (a) The ultrasound transducer is placed at the inguinal crease, medial to the femoral vessels, to visualize the pectineus (PE), adductor longus (AL), adductor brevis (AB), and adductor magnus (AM) muscles. At this level, the characteristic "Y-shaped" intermuscular fascia (yellow arrowheads) formed by the PE, AL, and AB muscles is identified. (b) The transducer is then tilted cranially to trace the course of the obturator nerve branches and (c) subsequently returned to the neutral orientation. The needle is advanced in-plane to perform two separate interfascial injections: one between the AB and AM muscles (yellow dotted arrow), and the other between the AL and AB muscles (yellow solid arrow). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

SD) if normally distributed, or medians (q1, q3) if non-normally distributed.

The primary and secondary outcomes were analyzed according to the intention-to-treat (ITT) principle. The first primary outcome—the success rate of ONB at 45 min after block completion—was compared between groups using the chi-square test. The 95% confidence interval (CI) for the risk difference was calculated using the Wilson method for independent proportions without continuity correction. [21] A fixed-sequence procedure was predefined to control the overall type I error rate at 0.05 (two-sided). [22] The second primary outcome—equivalent intravenous morphine consumption during the first 24 h—was analyzed only if a statistically significant difference was observed in the success rate of ONB; otherwise, no further hypothesis testing was permitted. The CI and *P*-value for morphine consumption were determined using the Hodges–Lehmann method and Mann–Whitney *U* test.

For secondary outcomes, continuous variables—including NRS pain scores at rest and on movement, equivalent intravenous morphine consumption within 48 h, patient satisfaction with analgesia at 48 h, sleep quality score, aggregate and domain scores of the QoR-15, post-block adductor strength, and percent decrease in adductor strength from baseline—were compared between groups using the Mann–Whitney U test. Categorical variables—including the proportion of patients

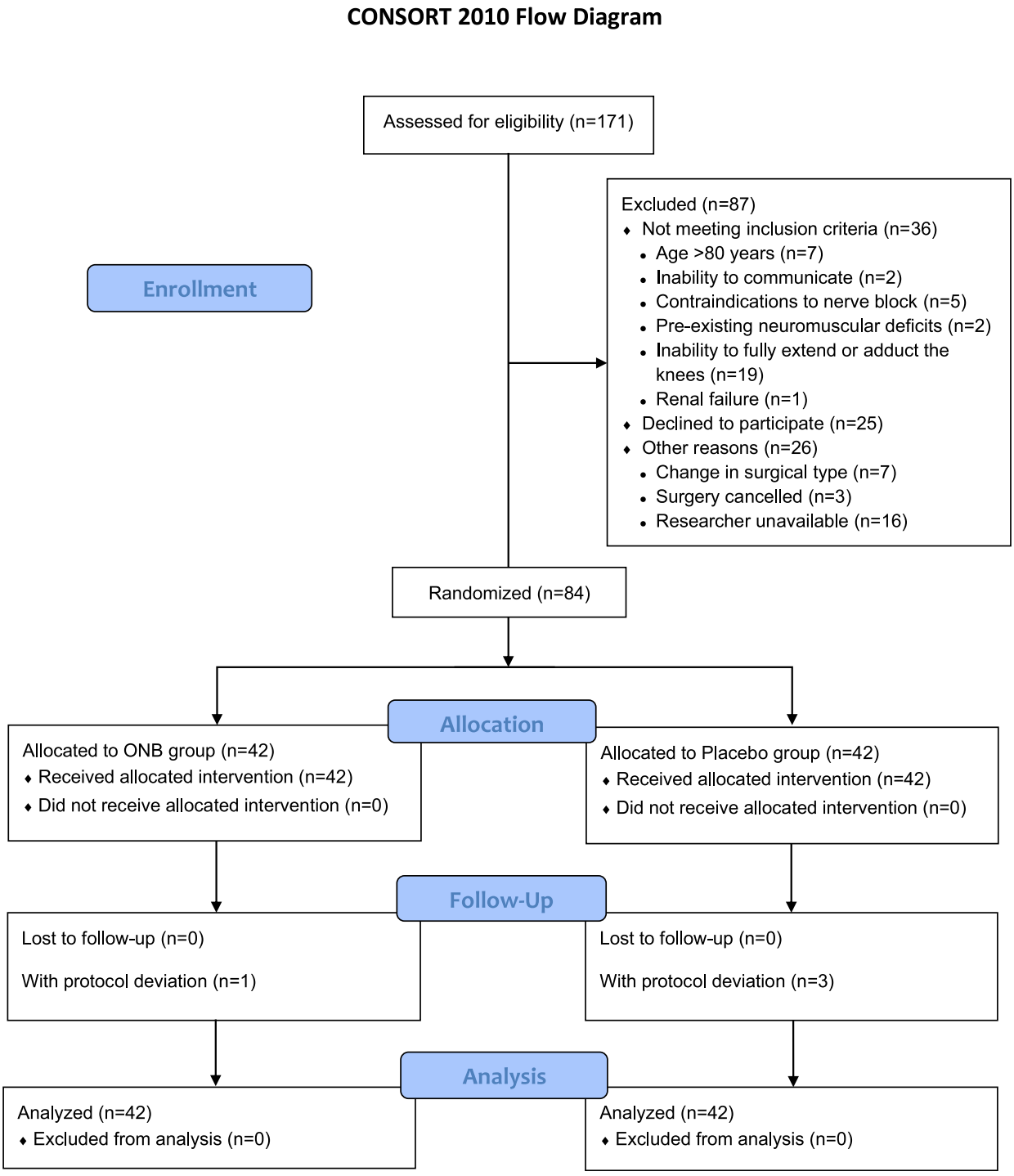

Fig. 2. Consolidated Standards of Reporting Trials (CONSORT) diagram of patient flow through the study. ONB, obturator nerve block.

requiring rescue analgesics within 48 h, proportion with good recovery, cold sensation scores at the mid-thigh, quadriceps motor block score, success rate of femoral nerve block, and adductor strength reduction score—were compared using the chi-square test. Fisher's exact test was applied when any cell had an expected count of less than five. Time to first PCA use was reported as median (q1, q3), and compared using the Cox proportional hazards model in which hazard ratio was estimated as effect size measure. Given the increased risk of type I error due to multiple comparisons, all secondary outcome analyses should be considered exploratory. Statistical analyses were conducted using IBM SPSS Statistics (version 26; IBM Corp., Armonk, NY, USA).

2.8. Sample Size Calculation

Based on preliminary data (unpublished) and literature review, [3,5] the success rate of ONB was assumed to be 50% in the placebo group and 90% in the ONB group. With a two-sided α of 0.05 and β of 0.20, the required sample size was 23 patients per group. Equivalent intravenous morphine consumption during the first 24 h was expected to be 11.7 (6.9) mg in the placebo group and 8.1 (3.8) mg in the ONB group, representing a 31% reduction in the ONB group. Using the same assumptions (two-sided $\alpha = 0.05$, $\beta = 0.20$), the estimated sample size was 39 patients per group. Therefore, the larger sample size was adopted. Allowing for a 5% dropout rate, the final sample size was set at 84 patients. Sample size calculations were performed using PASS 15 (NCSS, LLC, Kaysville, UT, USA).

3. Results

Between July 21, 2023, and November 15, 2024, 171 patients were screened for eligibility, of whom 84 were enrolled and randomized. All randomized patients received the allocated intervention, and complete primary and secondary outcome data were available for all patients (Fig. 2). Four protocol deviations occurred: one patient in the ONB group and two in the placebo group did not receive postoperative intravenous flurbiprofen, and one patient in the placebo group underwent intraoperative conversion to debridement and did not receive postoperative flurbiprofen. All randomized patients were included in the ITT analysis. Patient characteristics, baseline assessments, and surgical data are presented in Table 1.

The success rate of ONB was significantly higher in the ONB group than in the placebo group (97.6% [41/42] vs 2.4% [1/42]; risk difference, 95.2%; 95% CI, 81.2%–98.0%; $P < 0.001$). Equivalent intravenous morphine consumption during the first 24 h was not significantly different between the ONB and placebo groups (6.8 [2.5, 11.5] vs 7.8 [4.6, 17.5] mg; median difference, −2.5; 95% CI, −5.0 to 0.5; $P = 0.156$; Table 2).

There were no differences between groups in resting or movement NRS pain scores at any time point, equivalent intravenous morphine consumption within 48 h, time to first PCA use, proportion of patients requiring rescue analgesics within 48 h, or patient satisfaction with analgesia at 48 h (Table 2). Sleep quality scores were also comparable between groups during both 0–24 and 24–48 h postoperatively. Furthermore, aggregate QoR-15 scores, proportion of patients with good recovery, and all five QoR-15 domain scores showed no intergroup differences at either 24 or 48 h postoperatively (Supplemental Table S1).

Post-block measurements showed no intergroup differences in cold sensation scores at the mid-thigh, quadriceps motor block scores, or success rate of femoral nerve block. Post-block adductor strength was lower in the ONB group than in the placebo group (11.3 [7.8, 17.4] vs 75.4 [58.4, 93.0] mmHg; median difference, −59.4; 95% CI, −70.0 to −50.6; $P < 0.001$), and the percent decrease from baseline was greater in the ONB group (89.0% [83.0%, 91.3%] vs 18.6% [12.7%, 35.2%]; median difference, 67.4%; 95% CI, 59.8–72.2%; $P < 0.001$). Additionally, more patients in the ONB group had an adductor strength reduction score of 1–2 compared with the placebo group (41/42 vs 19/42; $P <$ 0.001; Table 3).

Table 1
Patient characteristics, baseline assessments, and surgical data.

Parameters	ONB group ($n = 42$)	Placebo group ($n = 42$)
Demographic data		
Age, years	69.4 (5.6)	69.1 (6.5)
Sex		
Male	11 (26.2%)	8 (19.0%)
Female	31 (73.8%)	34 (81.0%)
Height, cm	162.3 (8.3)	162.6 (7.0)
Weight, kg	72.4 (12.4)	72.2 (9.7)
BMI, kg m^{-2}	27.4 (3.3)	27.3 (3.0)
ASA status		
I	5 (11.9%)	3 (7.1%)
II	33 (78.6%)	36 (85.8%)
III	4 (9.5%)	3 (7.1%)
Baseline assessment		
Resting NRS pain score, 0–10	1 (0.8, 2.0)	2 (0.8, 2.0)
Movement NRS pain score, 0–10	4 (3.0, 5.3)	4 (3, 6)
Adductor strength, mmHg	108.7 (86.5, 122.2)	100.7 (83.8, 124.7)
QoR-15 score	132 (125, 139)	135 (130, 139)
QoR-15 domains		
Pain	17 (16, 18)	16 (13.8, 18.0)
Physical comfort	44.5 (39, 46)	46 (43, 47)
Physical independence	18 (17, 19)	18 (17, 19)
Psychological support	20 (19, 20)	20 (19, 20)
Emotions	36 (32, 37)	36 (34, 37)
Surgery		
Surgical side		
Left	22 (52.4%)	23 (54.8%)
Right	20 (47.6%)	19 (45.2%)
Duration of surgery, min	117.0 (106.5, 150.0)	121.5 (104.0, 135.3)

Values are mean (SD), median (q1, q3), or number (percentage).
Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; NRS, numerical rating scale; ONB, obturator nerve block; QoR-15, 15-item quality of recovery; SD, standard deviation.

No patients in the ONB group experienced bleeding, whereas one case occurred in the placebo group. Paresthesia was reported in 14.3% (6/42) of patients in the ONB group and 7.1% (3/42) in the placebo group. No cases of local anesthetic toxicity were observed. Postoperative nausea and vomiting scores, incidence of dizziness, and the proportion of patients whose ambulation was impaired by dizziness within 48 h did not differ between groups (Supplemental Table S2).

4. Discussion

In this study, we examined whether a 40-mL SFICB combined with a placebo ONB reliably anesthetized the obturator nerve, and whether the addition of an active ONB improved postoperative analgesia in patients undergoing total knee arthroplasty. Using our predefined criterion for ONB success (≥50% decrease in adductor strength from baseline at 45 min after block completion), SFICB combined with an active ONB achieved a success rate of 97.6% (41/42), whereas SFICB with a placebo ONB resulted in a negligible success rate of 2.4% (1/42). Despite the high ONB success rate, equivalent intravenous morphine consumption during the first 24 h did not differ between groups, and no differences were observed in other analgesic or recovery-related outcomes. These findings indicate that, although selective ONB can be reliably achieved, its addition to SFICB did not confer clinically meaningful analgesic or recovery benefits over SFICB alone.

Our post-block sensorimotor assessment confirmed consistent blockade of the femoral and lateral femoral cutaneous nerves in both groups, whereas reliable ONB was observed only in the active ONB group. In the placebo group, the mean percentage decrease in adductor strength from baseline was 23%. Considering that the femoral nerve contributes 20% to adductor strength, [8] this finding indicates that SFICB in the placebo group provided minimal, if any, anesthesia of the obturator nerve. Furthermore, when an adductor strength reduction

Table 2
Efficacy outcomes.

Outcomes	ONB group (n = 42)	Placebo group (n = 42)	Effect size	P-value
Primary outcomes				
Obturator nerve block success	41 (97.6%)	1 (2.4%)	95.2% (81.2 to 98.0)	<0.001[a]
24-h equivalent morphine consumption, mg	6.8 (2.5, 11.5)	7.8 (4.6, 17.5)	−2.5 (−5.0 to 0.5)	0.156[b]
Secondary outcomes				
Resting NRS pain score, 0–10				
At 2 h after surgery	0 (0,0)	0 (0, 0)	0 (0 to 0)	0.169[b]
At 4 h after surgery	0 (0, 0)	0 (0, 0)	0 (0 to 0)	0.733[b]
At 24 h after surgery	2 (2,3)	2 (2, 3)	0 (0 to 0)	0.931[b]
At 48 h after surgery	1 (0,2)	1 (0, 2)	0 (0 to 1)	0.389[b]
Movement NRS pain score, 0–10				
At 2 h after surgery	0 (0, 0)	0 (0, 0)	0 (0 to 0)	0.289[b]
At 4 h after surgery	2 (0, 2)	1 (0, 2)	0 (0 to 1)	0.433[b]
At 24 h after surgery	6 (4.8, 8.0)	6 (5, 8)	0 (−1 to 1)	0.766[b]
At 48 h after surgery	4 (3, 5)	4 (3, 6)	0 (0 to 1)	0.404[b]
48-h equivalent morphine consumption, mg	12.8 (7.5, 23.9)	17.5 (12.5, 27.6)	−4 (−7.5 to 0)	0.085[b]
Time to first PCA use, h	12 (6.0, 19.3)	12.5 (7.0, 18.0)	0.90 (0.58 to 1.40)	0.646[c]
Use of rescue analgesics within 48 h	18 (42.9%)	16 (38.1%)	1.13 (0.67 to 1.89)	0.657[a]
Satisfaction with analgesia at 48 h, NRS	8 (8, 9)	9 (8, 9)	0 (−1 to 0)	0.092[b]
Sleep quality score, NRS				
Within 24 h after surgery	2 (1, 6)	3.5 (2, 7)	−1 (−2 to 0)	0.180[b]
Within 24–48 h after surgery	9 (7, 9)	8.5 (7.8, 9)	0 (0 to 0)	0.959[b]

Abbreviations: CI, confidence interval; NRS, numerical rating scale; ONB, obturator nerve block; PCA, patient-controlled analgesia.
Values are number (percentage) or median (q1, q3).
[a] Obtained from the chi-square test, with effect size presented as risk difference (95% CI) for the primary outcome and relative risk (95% CI) for the secondary outcome.
[b] Obtained from the Mann–Whitney U test, with effect size presented as median difference (95% CI).
[c] Obtained from the Cox proportional hazards model, with effect size presented as hazard ratio (95% CI).

Table 3
Post-block measurements.

Parameters	ONB group (n = 42)	Placebo group (n = 42)	Effect size	P-value
Mid-thigh cold sensation score (0/1/2), n				
Anterior	0/0/42	0/1/41		>0.999[a]
Medial	0/1/41	0/3/39		0.616[a]
Lateral	0/0/42	0/3/39		0.241[a]
Quadriceps motor block score (0/1/2), n	0/2/40	0/5/37		0.433[a]
Femoral nerve block success	40 (95.2%)	36 (85.7%)	1.11 (0.97 to 1.28)	0.265[a]
Adductor strength, mmHg	11.3 (7.8, 17.4)	75.4 (58.4, 93.0)	−59.4 (−70.0 to −50.6)	<0.001[b]
Decrease in adductor strength, %	89.0 (83.0, 91.3)	18.6 (12.7, 35.2)	67.4 (59.8 to 72.2)	<0.001[b]
Adductor strength reduction score (0/1/2), n	1/3/38	23/18/1		<0.001[c]

Values are number (percentage) or median (q1, q3).
Abbreviations: CI, confidence interval; ONB, obturator nerve block.
[a] Obtained from the Fisher's exact test, with effect size presented as relative risk (95% CI).
[b] Obtained from the Mann–Whitney U test, with effect size presented as median difference (95% CI).
[c] Obtained from the chi-square test.

score of 0 (0–20% decrease from baseline) was considered indicative of no ONB, [15] the obturator nerve appeared to be spared in 55% (23/42) of patients in the placebo group. Collectively, these findings suggest that a 40-mL SFICB with 0.5% ropivacaine rarely anesthetizes the obturator nerve and therefore cannot be considered a true ONB, consistent with the anatomical considerations described by Bendtsen et al. [10] Future clinical trials may be required to investigate whether higher volumes of SFICB could increase the likelihood of ONB. [5] Notably, as 40 mL—a relatively large volume—failed to reliably anesthetize the obturator nerve, subsequent research should aim to determine the optimal, likely lower, volume of SFICB that consistently targets the femoral and lateral femoral cutaneous nerves. [1]

The consistently successful blockade of obturator nerve in the ONB group did not translate into improved postoperative analgesia, warranting further consideration. In contrast, Macalou et al. [11] reported that adding ONB to femoral nerve block improved early postoperative analgesia after total knee arthroplasty compared with femoral nerve block alone. The discrepant findings may be explained by differences in perioperative management in our study, including intraoperative administration of intravenous tranexamic acid, dexamethasone, and dexmedetomidine, which are known to enhance postoperative analgesia and may have attenuated any additional benefit of ONB. [12,23] Furthermore, the SD of morphine consumption in the ONB group was larger than anticipated from our pilot data (7.0 vs. 3.8 mg), reflecting increased inter-individual variability. This variability may stem from pain originating in the posterior knee compartment, which is innervated by both the obturator and sciatic nerves. [24] Neither local infiltration analgesia nor posterior-compartment–targeted regional blocks were performed, as local infiltration is not routine at our center and additional ropivacaine raises concerns regarding systemic toxicity. Consequently, a subset of patients may have experienced substantial posterior capsule pain, contributing to the large inter-individual variation in analgesic requirement and potentially reducing the statistical power to detect intergroup difference in morphine consumption.

The choice of a 40-mL SFICB with 0.5% ropivacaine in this study warrants further clarification. This volume was selected because it is commonly used in clinical practice. [2,13,15,25] Moreover, cadaveric and imaging studies have demonstrated that a 40-mL SFICB involved the obturator nerve in 75–83% of cases. [3–5] Therefore, it was important to evaluate whether this finding translates into a clinical setting. It should be noted that the total dose of local anesthetic is determined by both volume and concentration. The 200-mg dose corresponds to a 62.5-mL SFICB with 0.32% ropivacaine, which has been reported as the minimum effective volume required to stain the obturator nerve in 90% of cadaveric specimens. [5] At the time of study design, a higher concentration (0.5%) was deliberately chosen to ensure adequate motor blockade of the obturator nerve in the event that SFICB provided true obturator nerve coverage. Moreover, the additional 10 mL administered for the active ONB was intended to achieve a consistently high block success rate, thereby serving as a robust comparator for SFICB alone. Consequently, the total ropivacaine dose in the ONB group reached 250 mg, which, based on a mean patient body weight of approximately 70 kg, exceeded the customary maximum weight-based dose of 3 mg/kg. Although no signs or symptoms of local anesthetic systemic toxicity were observed, this dosing regimen was specific to the study design and should not be extrapolated to routine clinical practice.

This study has several limitations. First, SFICB with ropivacaine may not be motor-sparing in patients undergoing total knee arthroplasty; however, this population was selected pragmatically, as ambulation at our center usually begins on postoperative day 2, and preoperative adductor strength assessment is not feasible in hip fracture patients.

Second, postoperative pain and surgical trauma may have confounded adductor strength measurements, precluding evaluation of ONB success after surgery. Third, the specific contribution of the femoral nerve to adductor strength could not be isolated; administering ONB before SFICB with serial assessments might clarify this but would compromise feasibility and blinding. Fourth, the total ropivacaine dose used in the ONB group exceeded customary weight-based recommendations. Although no systemic toxicity was observed, this dosing strategy was specific to the study design and should not be extrapolated to routine clinical practice. Finally, the 62.5-mL minimum effective volume reported in a cadaveric study was not tested, [5] as it has limited clinical application and may be impractical when using higher local anesthetic concentrations. If ONB is required, selective blocks remain a more feasible option.

In conclusion, our findings suggest that a 40-mL SFICB with 0.5% ropivacaine rarely anesthetized the obturator nerve. Supplementing it with a selective ONB did not enhance postoperative analgesia or recovery within 48 h after total knee arthroplasty. Further studies are needed to define the minimum effective SFICB volume that reliably targets the femoral and lateral femoral cutaneous nerves.

CRediT authorship contribution statement

Yongsheng Miao: Writing – original draft, Project administration, Investigation, Data curation, Conceptualization. **Hongye Zhang:** Writing – review & editing, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Jinyu Wu:** Writing – review & editing, Investigation, Data curation. **Zongyang Qu:** Writing – review & editing, Methodology, Data curation. **Yuelun Zhang:** Writing – review & editing, Methodology, Formal analysis. **Yaonan Zhang:** Writing – review & editing, Resources, Project administration, Investigation. **Zhen Hua:** Writing – review & editing, Supervision, Methodology, Data curation.

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Declaration of competing interest

The authors declare no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jclinane.2026.112193.

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