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Original Article

The impact of ropivacaine local infiltration in multimodal analgesia on early functional recovery and safety in elderly patients undergoing total knee arthroplasty

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Abstract: Objective: To investigate whether adding ropivacaine local infiltration (RLI) to standard analgesia can improve functional recovery outcomes and safety in elderly patients undergoing total knee arthroplasty (TKA). Methods: This retrospective study included 227 elderly patients who underwent unilateral TKA under spinal anesthesia between January 2023 and January 2025. According to different analgesic regimens, patients were divided into two groups: the conventional multimodal analgesia (CMA) group (n=105) and the RLI group (n=122). The cumulative use of morphine within 48 hours after surgery, visual analog scale (VAS) pain levels during activity, range of motion (ROM) of the knee joint, 6-minute walking distance, functional independence measurement (FIM) score, and incidence of adverse events were compared between the two groups. Results: At 24 and 48 hours postoperatively, cumulative morphine use was significantly lower in the RLI group compared with the CMA groups (all P<0.05). Activity-related VAS pain scores were significantly lower in the RLI group at all evaluation time points (all P<0.05). In addition, the RLI group demonstrated greater knee ROM (48-hours: 95.84 vs. 92.16, P<0.001), longer six-minute walk distances (48-hours: 213.29 vs. 204.85, P=0.007), and higher FIM motor scores (57.05 vs. 54.49, P=0.008), compared with the CMA group. Patients in the RLI group had a lower incidence of itching and a relatively shorter hospital stay. Conclusion: In elderly patients undergoing TKA, local infiltration analgesia (LIA) can alleviate early postoperative pain, reduce the use of opioid drugs, and promote faster functional recovery.

Keywords: Total knee arthroplasty, elderly patients, ropivacaine, local infiltration analgesia, functional recovery

Introduction

Osteoarthritis (OA) is a degenerative joint disease characterized by the gradual loss of joint cartilage, leading to pain, stiffness, and functional limitations [1]. Total knee arthroplasty (TKA) is a primary surgical option for advanced knee OA. With the aging global population, the incidence of knee OA continues to rise, resulting in an increasing number of patients receiving TKA [2]. Although TKA effectively relieves pain and improves joint function, postoperative pain management remains a challenge [3]. Inadequate pain control may hinder early mobilization, delay postoperative recovery, and increase the risk of complications [4].

In recent years, improvements in perioperative care and clinical outcomes have largely relied on multimodal analgesia and intensive rehabilitation programs [5]. However, many patients still report insufficient pain relief and slower-than-expected functional recovery [6]. Therefore, multimodal analgesia with a variety of non-opioid agents has become a key approach to provide effective pain control while minimizing the side effects of opioids [7]. Nevertheless, achieving optimal pain control in clinical practice remains challenging, underscoring the need for continued exploration of more effective pain management strategies.

Peripheral interventions, such as local infiltration analgesia (LIA), can regulate both periph-

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eral and central sensitization processes involved in postoperative pain [8]. Surgery can provoke the release of various mediators, resulting in local inflammation and sensitize peripheral pain receptors [9]. If left uncontrolled, these signals can overexcite the central nervous system and amplify pain perception [10]. Incorporating ropivacaine into a multimodal analgesia regimen to block peripheral nerve sodium channels can directly target the source of pain and reduce the cascade of events that trigger central sensitization [11]. This facilitates earlier mobilization and is of great significance in postoperative recovery [12, 13].

This study aims to investigate the effects of adding LIA with ropivacaine to standard multimodal pain management for early functional recovery and safety in elderly patients undergoing TKA. Special attention was placed on early postoperative functional recovery, as it directly influences discharge time and subsequent rehabilitation outcomes. Through this research, we hope to provide robust clinical evidence for pain management in elderly TKA patients, promote faster recovery, and improve overall prognosis.

Methods

Ethical statement

This retrospective study was approved by the Institutional Review Board of The Affiliated Hospital of Qingdao University and conducted in strict accordance with the Declaration of Helsinki. Due to the retrospective design, all data used were anonymized, and individual patient consent was waived.

Research design and patient grouping

This study included a total of 227 elderly patients who underwent TKA at the Affiliated Hospital of Qingdao University from January 2023 to January 2025. According to the analgesic regimen, the patients were divided into two groups: the conventional multimodal analgesia (CMA) group (n=105; standard multimodal analgesia, without local infiltration with ropivacaine), and the ropivacaine local infiltration (RLI) group (n=122; local infiltration of ropivacaine on the basis of multimodal analgesia).

Inclusion and exclusion criteria

Inclusion criteria: age ≥65 years; diagnosis of primary knee osteoarthritis; First-time unilateral TKA under spinal anesthesia; complete medical records available.

Exclusion criteria: simultaneous bilateral TKA or knee revision surgery; TKA performed for reasons other than osteoarthritis (e.g., rheumatoid arthritis, traumatic arthritis); chronic opioid use (more than three months) before surgery; severe neurological disorders (e.g., dementia, post-stroke sequelae); psychiatric disorders that may interfere with postoperative functional assessments; severe liver or kidney dysfunction (estimated glomerular filtration rate <30 ml/min/1.73 m^2) that may affect drug metabolism; known allergy to ropivacaine or other amide-type local anesthetics; receipt of additional regional analgesic techniques during surgery (e.g., adductor canal block, femoral nerve block) as the primary analgesic method; contraindications to peripheral nerve blocks (e.g., coagulopathy, infection at the injection site).

Details of analgesic protocol

All patients received a multimodal analgesia protocol based on the standard TKA practices of the Affiliated Hospital of Qingdao University. The basic protocol included preoperative administration of acetaminophen and/or nonsteroidal anti-inflammatory drugs (NSAIDs), with celecoxib 400 mg given the night before surgery and the morning of surgery, otherwise weak opioids were administered for preemptive analgesia based on patient conditions. Intraoperatively, dexamethasone 10 mg was administered intravenously before skin incision to reduce postoperative nausea and vomiting, and parecoxib sodium 40 mg was given intravenously to provide additional intraoperative and early postoperative analgesia. Postoperatively, patient-controlled intravenous analgesia (PCIA) with morphine (1 mg/mL) was used, with pump settings at no continuous background infusion, with a 1-mg single bolus dose, and a 15-minute lockout interval. Additionally, patients started regular oral NSAIDs (celecoxib 200 mg twice daily) and acetaminophen 500 mg (every 6 hours) after returning to the ward to maintain adequate analgesia.

For patients in the RLI group, an additional step was performed at the end of surgery. The surgical team administered a total of 150 mg of 0.5% ropivacaine solution (30 mL) slowly and in layers into specific anatomical sites, including

the posterior joint capsule, the medial and lateral collateral ligaments, the attachment point of the quadriceps tendon, and the periarticular soft tissues and subcutaneous tissues.

Outcome measurements

Patient demographics: Patient demographic information, including age and gender, was retrieved from the medical record system. According to the American Society of Anesthesiologists (ASA), patients were evaluated based on their overall health status and the severity of systemic disease [14]. The duration of surgery and specific surgical details were extracted from surgical records.

Postoperative morphine consumption measurement: At 12, 24, and 48 hours postoperatively, the cumulative dose of morphine was automatically recorded by a PCIA pump (MP-PCA-01, Mindray, China).

Pain assessment using visual analog scale: The Visual Analogue Score (VAS) is a validated tool for measuring pain intensity [15]. The score ranges from 0 to 10, with 0 indicating no pain and 10 representing the most severe pain. Pain assessments were conducted at 6, 12, 24 and 48 hours after surgery. Resting pain was measured with patient lying supine and the affected limbs at rest. Active pain was assessed after passive knee joint flexion and extension.

Knee Range of Motion (ROM) measurement: The ROM of the knee joint was measured preoperatively and 24 and 48 h postoperatively. Measurements were taken by a specially trained physical therapist using a standard goniometer. Preoperative ROM was recorded during the first evaluation. For postoperative measurements, the patient was placed in a supine position and actively stretched the knee to record the maximum extension angle.

Postoperative functional recovery: Postoperative functional recovery and muscle strength were assessed at post-operative 24 hours and 48 hours. A manual muscle testing scale was used to measure the strength of the quadriceps muscle, with levels ranging from grade 1-5 [16]. Grade 1 indicates visible muscle contraction without joint movement. Grade 2 refers to the ability to complete a full range of motion in a horizontal or lateral position. Grade 3 represents the ability to overcome gravity and complete a full range of activities. Grade 4 indicates the ability to complete full-range motion under certain resistance. Grade 5 indicates the ability to complete full-range motion even in full resistance state.

When measuring the 6-minute walking distance (6MWD), participants were asked to walk on a straight and flat corridor for as long as possible for 6 minutes, and then the total walking distance was recorded [17]. The longer the walking distance, the better the patient's physical strength and endurance.

When conducting the Timed Up and Go (TUG) test, the patients were instructed to complete a series of actions, including standing up from a chair, walking a distance of 3 meters, turning around, retreating to the chair, and finally sitting down, and the time required for these actions were recorded [18].

Functional independence measure: The patient underwent a Functional Independence Measure (FIM) assessment at both 24 and 48 hours after the procedure [19]. The FIM consists of a motor subscale and a cognitive subscale. The motor subscale assesses patient's physical independence in daily life, including self-care, sphincter control, transfers, and mobility. The cognitive subscale evaluates patients' cognitive function through assessments of comprehension, expression, social interaction, problem-solving, and memory. Both subscales are scored on a 7-point scale, with 1 point indicating complete dependence and 7 points indicating complete independence. Trained physical therapists observe patients performing these tasks for evaluation. Each task was scored separately, and the scores were summed to obtain the total FIM score. Higher scores indicate greater independence and better functional status.

Postoperative adverse reactions: The incidence of adverse reactions, including nausea, vomiting, dizziness, pruritus, infection and abnormal cold sensation, was recorded based on patient self-reports and clinical observations. Additionally, the following safety events were monitored. Respiratory depression was defined as postoperative blood oxygen saturation persistently below 90% for more than 30 seconds in a non-oxygen-supplemented state, or the need for medical intervention due to excessive drowsi-

Table 1. Comparison of demographics and operative parameters between the two groups

Variable	CMA group (n=105)	RLI group (n=122)	t/χ^2	P
Gender			0.087	0.768
Female	58 (55.24%)	65 (53.28%)		
Male	47 (44.76%)	57 (46.72%)		
Age (years)	77.3 ± 4.26	76.85 ± 4.21	0.794	0.428
Body Mass Index (kg/m^2)	23.37 ± 2.49	23.71 ± 2.52	1.032	0.303
Smoking History (Yes/No)	22 (20.95%)/83 (79.05%)	25 (20.49%)/97 (79.51%)	0.007	0.932
Alcohol Consumption (Yes/No)	19 (18.10%)/86 (81.90%)	23 (18.85%)/99 (81.15%)	0.021	0.884
Hypertension (Yes/No)	28 (26.67%)/77 (73.33%)	33 (27.05%)/89 (72.95%)	0.004	0.948
Diabetes (Yes/No)	17 (16.19%)/88 (83.81%)	15 (12.30%)/107 (87.70%)	0.707	0.400
ASA Grade			0.048	0.976
Grade I	4 (3.81%)	4 (3.28%)		
Grade II	67 (63.81%)	78 (63.93%)		
Grade III	34 (32.38%)	40 (32.79%)		
Surgery Duration (minutes)	69.28 ± 5.66	70.04 ± 6.73	0.919	0.359
Tourniquet Duration (minutes)	65.85 ± 7.11	65.37 ± 6.41	0.525	0.600
Preoperative Medication			0.257	0.612
Paracetamol and/or NSAIDs	83 (79.05%)	93 (76.23%)		
Weak opioids	22 (20.95%)	29 (23.77%)		
Side of Surgery			1.538	0.215
Right Knee	56 (53.33%)	55 (45.08%)		
Left Knee	49 (46.67%)	67 (54.92%)		

CMA: conventional multimodal analgesia; RLI: ropivacaine local infiltration; ASA Grade: American Society of Anesthesiologists Physical Status Classification; NSAIDs: Non-Steroidal Anti-Inflammatory Drugs.

ness or shallow, slow breathing. Delayed wound healing was defined as the presence of exudate, redness, skin margin separation exceeding 1 cm, or the need for additional dressing changes or surgical management. Local anesthetic toxicity symptoms included new onset perioral numbness, tinnitus, blurred vision, muscle tremors, restlessness, or altered consciousness within 48 hours after anesthesia. Length of hospital stay was automatically recorded by the electronic medical record system based on the admission and discharge dates.

Statistical analysis

All data were analyzed using SPSS software (version 26.0, USA). Continuous data were first tested for normality using the Shapiro-Wilk test. Data that followed a normal distribution were presented as means ± standard deviations and compared between groups using independent samples t-tests. For continuous data that did not follow a normal distribution, the Mann-Whitney U test was used for comparisons. Categorical variables were expressed as frequencies (n) and percentages (%), and group comparisons were performed using chi-square (χ^2) tests. The significance level was set at $P<0.05$.

Results

Patient demographics and surgery-related parameters

No significant differences were observed between the CMA group and the RLI group in terms of sex, age, body mass index (BMI), smoking history, alcohol consumption, hypertension, diabetes, ASA grade, surgery duration, tourniquet duration, preoperative medication, or side of surgery (both $P>0.05$; **Table 1**), indicating good comparability between the two groups.

Postoperative analgesic efficacy

No significant difference was observed in morphine consumption during postoperative 12 hours between the two groups ($P>0.05$; **Figure 1**). However, the postoperative 24 h- and 48 h-consumption of morphine in the CMA group

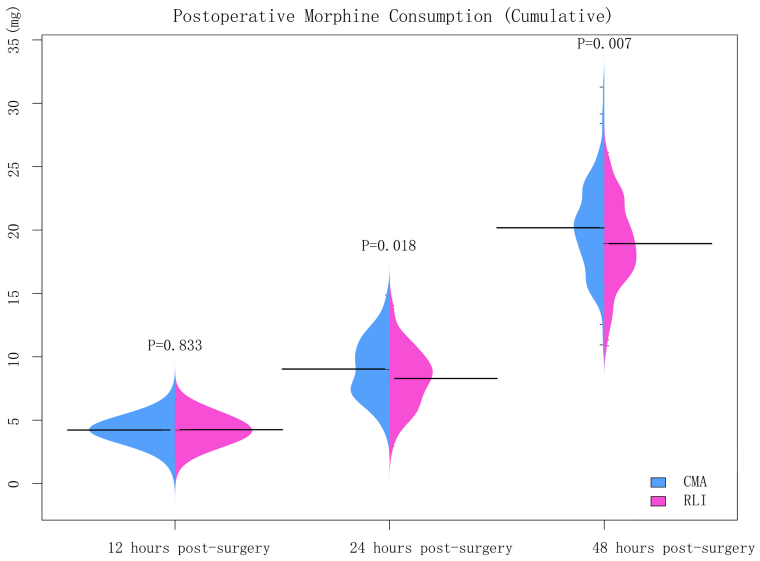

Figure 1. Postoperative morphine consumption (cumulative). CMA: conventional multimodal analgesia; RLI: ropivacaine local infiltration.

Table 2. Comparison of visual analog scale scores between the two groups

Variable	CMA group (n=105)	RLI group (n=122)	t	P
Resting Pain				
6 hours post-surgery	0.27 ± 0.11	0.25 ± 0.09	1.823	0.070
12 hours post-surgery	1.07 ± 0.28	0.99 ± 0.21	2.118	0.035
24 hours post-surgery	2.01 ± 0.39	1.85 ± 0.36	3.068	0.002
48 hours post-surgery	1.67 ± 0.31	1.61 ± 0.34	1.460	0.146
Activity Pain				
6 hours post-surgery	0.32 ± 0.09	0.29 ± 0.07	2.561	0.011
12 hours post-surgery	2.01 ± 0.29	1.86 ± 0.25	4.282	<0.001
24 hours post-surgery	4.35 ± 0.65	4.12 ± 0.53	2.930	0.004
48 hours post-surgery	5.22 ± 0.72	4.97 ± 0.58	2.852	0.005

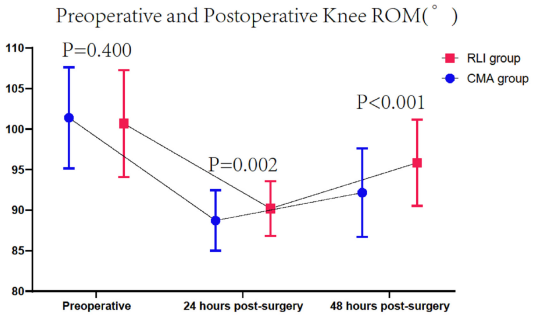

Figure 2. Comparison of knee ROM between the two groups before and after surgery. ROM: Range of Motion.

was significantly higher than that in the RLI group (P=0.018, 0.007). These results indicate that, over time, the CMA group required more morphine to achieve adequate analgesia, suggesting inferior sustained pain control.

Significant differences in resting VAS pain scores were observed between the CMA group and RLI group at several postoperative time points (**Table 2**). At both postoperative 12 hours and 24 hours, the CMA group reported higher VAS scores than the RLI group (P=0.035, 0.002). However, at 6 hours and 48 hours postoperatively, no significant differences were observed between the two groups (both P>0.05). These results indicate that while resting pain were comparable in the early and late postoperative periods, patients in the CMA group experienced significantly higher pain during the intermediate period. At all measured time points, the CMA group demonstrated significantly higher activity-related VAS scores compared with the RLI group (P=0.011, P< 0.001, P=0.004, and P=0.005 for postoperative 6, 12, 24, and 48 hours, respectively). These results indicate that patients in the CMA group experienced greater activity-related pain throughout the entire postoperative period.

Postoperative functional recovery

Preoperative ROM measurements showed no significant differences between the two groups (P>0.05; **Figure 2**). However, at 24 hours and 48 hours postoperatively, although both groups experienced a decrease in ROM, the RLI group demonstrated significantly higher ROM than the CMA group (P=0.002, P<0.001). These results indicate that while the preoperative knee joint mobility was similar between the two groups, the RLI group demonstrated faster recovery of knee joint ROM at different postoperative time points.

Table 3. Comparison of postoperative functional recovery and muscle strength between the two groups

Variable	CMA group (n=105)	RLI group (n=122)	t/χ^2	P
24 hours post-surgery				
Quadriceps Strength			0.079	0.778
Grade 2	10 (9.52%)	13 (10.66%)		
Grade 3	95 (90.48%)	109 (89.34%)		
6-Minute Walk Distance	174.12 ± 17.84	179.64 ± 16.21	2.441	0.015
Timed Up and Go Test	26.31 ± 2.91	25.29 ± 2.74	2.712	0.007
48 hours post-surgery				
Quadriceps Strength			0.743	0.389
Grade 2	7 (6.67%)	5 (4.10%)		
Grade 3	98 (93.33%)	117 (95.90%)		
6-Minute Walk Distance	204.85 ± 24.74	213.29 ± 21.63	2.743	0.007
Timed Up and Go Test	25.76 ± 2.51	24.85 ± 2.46	2.750	0.006

Table 4. Comparison of FIM scores between the two groups

Variable	CMA group (n=105)	RLI group (n=122)	t	P
Baseline				
Motor Subscale	61.71 ± 6.17	62.04 ± 6.85	0.374	0.709
Cognitive Subscale	31.37 ± 3.81	31.25 ± 3.59	0.236	0.814
48 hours post-surgery				
Motor Subscale	54.49 ± 7.58	57.05 ± 6.89	2.665	0.008
Cognitive Subscale	31.26 ± 3.76	31.33 ± 3.39	0.150	0.881

FIM: Functional Independence Measure.

No significant differences were observed in quadriceps strength between the CMA and RLI groups at 24 and 48 hours postoperatively (both P>0.05) (**Table 3**). However, significant differences were observed in the 6-minute walk distance and TUG test at multiple time points. At 24 hours postoperatively, the RLI group had a longer 6-MWD (P=0.015) and a shorter TUG test time (P=0.007) compared with the CMA group. Similarly, at 48 hours postoperatively, the RLI group also performed better in 6-MWD (P=0.007) and TUG test (P=0.006). These results indicate that although the quadriceps strength of the two groups was similar, patients in the RLI group showed better functional recovery at 48 hours postoperatively.

No significant difference was found in preoperative FIM scores, both motor and cognitive subscales, between the CMA and RLI groups (both P>0.05; **Table 4**). However, at 48 hours postoperatively, the RLI group reported significantly higher motor scores (P=0.008). These results indicate that although the baseline functional independence levels were similar between the two groups, the RLI group showed better motor function recovery at 48 hours postoperatively.

Adverse reactions and length of hospital stay

The CMA group and RLI groups showed no significant differences in adverse reactions, including nausea and vomiting, dizziness, infection, abnormal cold sensation, respiratory depression, and delayed wound healing (all P>0.05; **Table 5**). Local anesthetic toxicity did not occur in either group (P=1.000). However, the CMA group had a higher incidence of itching (P=0.047) and a longer hospital stays (P=0.010).

Discussion

The results of this study indicate that adding ropivacaine local infiltration to the multimodal analgesia regimen for elderly TKA patients can alleviate early postoperative pain and accelerate limb functional recovery, without increasing the incidence of adverse events.

In this study, the RLI group consumed less morphine in the first 48 hours after surgery compared with the CMA group. This discovery has important clinical value as it aligns with the modern perioperative goal of minimizing opioid use whenever possible [20]. Notably, this differ-

Table 5. Comparison of post-operative adverse reactions between the two groups

Variable	CMA group (n=105)	RLI group (n=122)	t/χ^2	P
Nausea and Vomiting (Yes/No)	4 (3.81%)/101 (96.19%)	6 (4.92%)/116 (95.08%)	0.007	0.935
Dizziness (Yes/No)	6 (5.71%)/99 (94.29%)	11 (9.02%)/111 (90.98%)	0.888	0.346
Itching (Yes/No)	20 (19.05%)/85 (80.95%)	12 (9.84%)/110 (90.16%)	3.954	0.047
Infection (Yes/No)	2 (1.90%)/103 (98.10%)	3 (2.46%)/119 (97.54%)	0.000	1.000
Cold Sensation Abnormality (Yes/No)	12 (11.43%)/93 (88.57%)	15 (12.30%)/107 (87.70%)	0.040	0.841
Respiratory Depression (Yes/No)	2 (1.90%)/103 (98.10%)	1 (0.82%)/121 (99.18%)	0.017	0.896
Delayed Wound Healing (Yes/No)	3 (2.86%)/102 (97.14%)	2 (1.64%)/120 (98.36%)	0.029	0.865
Local Anesthetic Toxicity (Yes/No)	0 (0.00%)/105 (100.00%)	0 (0.00%)/122 (100.00%)	None	1.000
Length of Hospital Stay	6.26 ± 0.52	6.07 ± 0.53	2.606	0.010

ence became apparent only after 12 hours, which may be due to the pharmacological properties of a single injection of LIA. Surgical trauma triggers local inflammation, leading to the release of inflammatory mediators such as prostaglandins, bradykinin, and cytokines [21]. These mediators not only directly stimulate peripheral nociceptors but also sensitize them, amplifying nociceptive transmission and contributing to hyperalgesia. Ropivacaine, an amide-type local anesthetic, reversibly blocks voltage-gated sodium channels, inhibiting the initiation and conduction of nerve impulses, thereby providing effective analgesia at the surgical site [22]. Early and adequate peripheral blockade reduces acute postoperative pain and, more importantly, prevents or mitigates central sensitization by decreasing the total amount of nociceptive stimuli reaching the central nervous system. Central sensitization involves increased excitability and enhanced responsiveness of spinal and supraspinal neurons [23]. Thus, using ropivacaine for local infiltration at the onset of pain not only provides immediate analgesia but also exerts a "preemptive analgesic" effect, curbing the initial burst of pain signals and preventing subsequent complex and persistent central remodeling [24]. This explains why patients in the RLI group showed lower pain scores and reduced opioid requirements over 24 to 48 hours, even after the initial drug effect diminished, further supporting the clinical value of local infiltration anesthesia in reducing opioid use by modulating peripheral and central sensitization. These results are consistent with previous studies indicating that LIA has can reduce the use of opioid drugs [25].

Our research results indicate that the RLI group performed well in pain control, further confirming its opioid-saving effects, especially during patient activity. From 6 to 48 hours after surgery, the activity-related VAS scores were consistently lower in the RLI group. Pain during activity is the major obstacle to early mobilization and physical therapy after TKA [26]. Ropivacaine LIA can effectively alleviate this pain, which is consistent with previous studies [27]. By reducing intense pain signals at the surgical site during knee joint movement, LIA improves the patient's tolerance to early physical therapy [28]. The functional outcomes observed in this study are consistent with this conclusion [29]. This indicates that the current multimodal analgesia regimens already provide adequate control of resting pain, and the primary advantage of LIA lies in its ability to manage dynamic pain more effectively.

Patients who experience pain relief during activities often achieve faster functional recovery. In our study, patients in the LIA group demonstrated greater postoperative ROM, which is a key determinant of long-term functional outcomes and patient satisfaction [30]. In addition, patients in the RLI group perform better on objective functional assessments. They walked longer in the 6-MWD test and completed the TUG test in shorter times at all evaluation points. These findings indicate that patients in the RLI group not only experienced better pain relief but also demonstrated safer and more efficient mobility. Previous studies have also shown that, compared to femoral nerve block, LIA enables earlier mobilization, thereby achieving better functional recovery [31]. This advantage may be attributable to better pain management, which enhances patients' confidence and motivation to participate in rehabilitation [31].

Patients in the RLI group showed an improvement in the postoperative FIM motor subscale scores, indicating that patients rely less on caregivers during transfer, activity and self-care. This result is consistent with previous studies, which have reported that LIA enables TKA patients to perform basic self-care activities within hours after surgery [32]. The improvement in functionality is reflected not only in reduced pain or increased walking distance but also in meeting the need for immediate postoperative functional independence. This patient-centered care philosophy could potentially become an important factor in facilitating earlier patient discharge from the hospital [33].

Manual muscle testing showed that quadricep strength was similar in both groups. Although concerns have been raised that local anesthetics may induce muscle toxicity or residual motor block, thereby weakening strength [34]. However, our results indicate that ropivacaine effectively blocks pain without causing motor block, a key advantage over bupivacaine [35]. With LIA, patients can activate their quadriceps like the CMA group, but with less pain. Therefore, patients can actively participate in functional activities, resulting in better overall performance.

In terms of safety, the two groups demonstrated comparable incidence in most adverse reactions. However, the incidence of itching was notably higher in the CMA group, likely due to the higher cumulative morphine use in this group [36]. Meanwhile, the hospitalization time of the RLI group was slightly shorter. Although the difference was small, it remains clinically meaningful, as shortened hospitalization can reduce the risk of hospital-acquired complications and lower medical costs. A shorter stay also reflects successful surgery and smoother recovery, which is consistent with the goals of the ERAS protocol [37].

Despite encouraging results, some limitations of this study should still be recognized. First, although the baseline features of each group matched well, retrospective and single center designs still bring inevitable risks of selection bias and unmeasured confounding factors. The lack of randomization means that unknown factors may affect the selection of analgesic regimens and the final outcome. Second, the follow-up period was limited to the first 48 hours after surgery. Although this timeframe is crucial for early recovery, it does not provide information about long-term outcomes such as persistent pain, long-term functional status, or whether the initial benefits persist over time. In addition, subjective indicators such as pain scores may lead to bias in the evaluation process.

Future research should prioritize prospective, randomized, double-blinded, and multi-center collaborative designs. Further exploration is needed to determine the optimal ropivacaine dose for LIA. Meanwhile, extending follow-up time is crucial for clarifying whether early functional improvement of ropivacaine LIA can translate into long-term outcomes.

Conclusion

Adding ropivacaine local infiltration to multimodal analgesia regimens in elderly patients undergoing TKA can help reduce opioid demand, improve dynamic pain relief, accelerate early functional recovery, without increasing the risk of adverse events.

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Disclosure of conflict of interest

None.

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