Original Article

Analgesic Effect of Intermittent Multiple IPACK Block Combined with ACB in Patients with Flexion Contracture Knee Arthritis Undergoing Total Knee Arthroplasty

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Abstract

We aimed to compare the analgesic effects of intermittent multiple infiltrations between the popliteal artery and capsule of the posterior knee (IPACK) combined with adductor canal block (ACB) and intermittent ACB alone in patients with flexion contracture knee arthritis undergoing total knee arthroplasty (TKA). Forty-six patients who underwent elective unilateral TKA were divided into two groups ($n = 23$ each): intermittent multiple IPACK combined with ACB (group IA) and intermittent multiple ACB (group A). ACB was performed with 20 mL of 0.375% ropivacaine in each group and IPACK with 20 mL of 0.25% ropivacaine in group IA. Intermittent multiple nerve blocks were used for postoperative analgesia (IPACK block combined with ACB in group IA and ACB in group A between 7:30 and 8:30 a.m. on postoperative day 1 [POD1] and postoperative day 2 [POD2]). Primary outcomes assessed were pain at rest, motion-evoked pain (MEP), and range of motion (ROM) on POD1 and POD2. Secondary outcomes included opioid consumption, first ambulation time, ambulation distance, and postoperative complications. We observed that compared with group A, MEP decreased, ROM became wider, ambulation distance was longer, and opioid consumption decreased in group IA. Other outcomes were either similar between the groups or showed clinically insignificant differences. We conclude that multiple intermittent IPACK therapy combined with ACB provides superior analgesia than multiple intermittent ACB therapy alone in patients with flexion contracture knee arthritis undergoing TKA.

Keywords
- IPACK
- adductor canal block
- total knee arthroplasty
- flexion contracture
- postoperative analgesia

Total knee arthroplasty (TKA) is considered an effective method for treating end-stage knee osteoarthritis[1] and can alleviate pain while enhancing patients' quality of life.[2] However, patients with flexion contracture knee arthritis, a condition where chronic inflammation and structural changes restrict knee extension, often experience greater challenges during rehabilitation and require tailored surgical and postoperative management to optimize outcomes.

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Postoperative pain remains a significant factor affecting the outcome of surgery and can make rehabilitation difficult and limit the joint's range of motion (ROM).[1] Traditional postoperative analgesia methods for TKA primarily include patient-controlled analgesia, nonsteroidal anti-inflammatory drugs (NSAIDs), femoral nerve block (FNB), sciatic nerve block (SNB), and periarticular local anesthetic injection.[3] Recently, with the introduction of ultrasound visualization technology, adductor canal block (ACB) has been proven to significantly reduce postoperative pain in patients and is gradually replacing FNB as the main analgesic method after TKA.[4] ACB has a marginal effect on quadriceps muscle strength, which reduces fall risks and facilitates early functional exercise.[3,5,6] However, ACB is less effective in relieving pain behind the knee.[3,6] The IPACK block, which has emerged in recent years, can block the sensory conduction of the sciatic nerve and the terminal branch of the obturator nerve.[6,7] Compared with SNB, the IPACK block has almost no risk of blocking the common peroneal nerve and tibial nerve,[8,9] and has almost the same analgesic effect.[10] Compared with proximal approaches, the distal approach can reduce the common peroneal nerve block rate and related complications.[10,11]

The duration of a single nerve block is approximately 8 hours, but severe pain usually occurs 2 to 3 days post-TKA.[12] Continuous nerve block has attracted considerable attention for prolonging the duration of analgesic effects. Studies[12] have demonstrated that continuous adductor canal block (CACB) provides superior analgesic effects compared with single adductor canal block (SACB).[13] However, CACB requires specialized nursing care for catheter placement, which increases the workload for nursing staff and inconveniences the patients. Moreover, complications such as catheter displacement, catheter obstruction, and difficulties in catheter removal can occur with CACB.[13] To explore a better analgesic method for TKA, we conducted this prospective, randomized controlled study to evaluate the efficacy and safety of the two different analgesic regimens intermittent multiple IPACK combined with ACB and ACB alone for patients undergoing TKA.

Materials and Methods

This study was approved by the medical ethics committee of the hospital and registered in the relevant clinical registry. Informed consent was obtained from the patients or their families prior to surgery. All experiments were performed in accordance with relevant guidelines and regulations.

Patient Selection and Exclusion Criteria

We recruited patients of both sexes, aged ≥18 years, with knee flexion contracture ranging from 5 to 30 degrees, and classified as American Society of Anesthesiologists (ASA) grade I to II, who were scheduled for primary unilateral from December 2021 to October 2022. Exclusion criteria included ASA grade III to V, operative time greater than 3 hours, revision procedure, blood loss greater than 40%, any contraindications to regional block, previous long-term history of opioid consumption, allergy to opioids or local anesthetics, inability to accurately comprehend the experimental procedure and pain scale, and refusal to participate in the study (►**Fig. 1**).

Study Design and Randomization

The patients were divided into two groups using a random number table method: the intermittent multiple IPACK block combined with the ACB group (group IA, $n = 23$) and the intermittent multiple ACB group (group A, $n = 23$). ACB was performed with 20 mL of 0.375% ropivacaine in both groups,

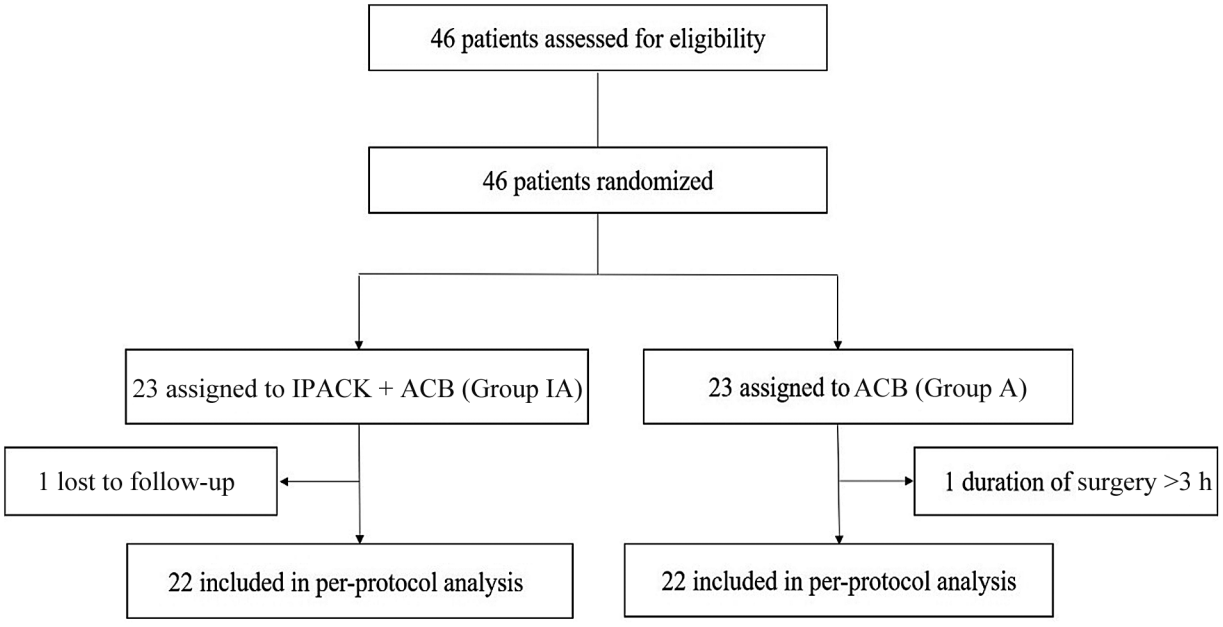

Fig. 1 Flow diagram of patient selection and exclusion. ACB, single-shot adductor canal block; IPACK, infiltration between the popliteal artery and capsule of the posterior knee block.

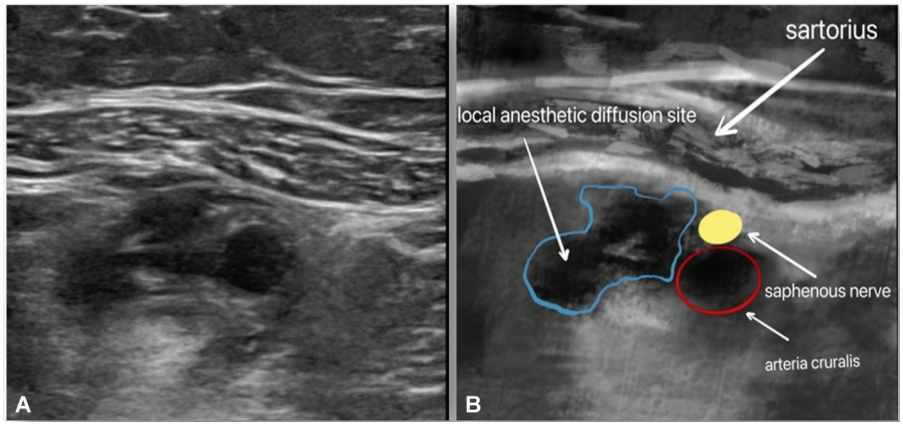

Fig. 2 (A, B) Local anesthetic diffusion after adductor canal block.

while IPACK was performed with 20 mL of 0.25% ropivacaine in group IA. Intermittent multiple nerve blocks were used for postoperative analgesia (IPACK block combined with ACB in group IA and ACB in group A between 7:30 and 8:30 a.m. on postoperative day 1 [POD1] and postoperative day 2 [POD2]).

Interventions

Adductor Canal Block

The patient was placed in the supine position with the thigh slightly extended. A high-frequency linear array probe was placed in the anteromedial and medial locations of the middle of the thigh, with the patient's thigh slightly abducted. The skin was disinfected and the in-plane injection method was adopted. After negative aspiration of blood, isotonic saline was injected to confirm the correct placement of the needle. Then 20 mL of 0.375% ropivacaine was injected as a local anesthetic into the adductor canal, and perivascular diffusion of the anesthetic was observed (►**Fig. 2**).

IPACK Block

The patient was placed in the supine position with the knees slightly extended. The probe was placed perpendicular to the femur at the fold of the popliteal fossa and moved to the head end to locate the femoral condyle and popliteal artery. The in-plane method was adopted, the needle was inserted from the inside to the outside. Twenty milliliters of 0.25% ropivacaine was injected as the local anesthetic into the lateral and medial condyles of the femur, as well as the area between them, as shown in ►**Fig. 3**.

Perioperative Management

Patients were encouraged to consume no more than 400 mL of mineral water for 2 hours preoperatively, starch for 4 hours, protein for 6 hours, and fatty food for more than 8 hours. Two hours prior to surgery, all patients were administered celecoxib (oral, 400 mg) and pregabalin (oral, 75 mg). An ultrasound-guided nerve block was performed in the preanesthesia room by an experienced anesthesiologist. Its effectiveness was confirmed based on temperature sensing.

Anesthesia was induced with propofol, sufentanil, and cisatracurium and maintained with propofol and remifentanil infusion. A laryngeal mask airway (LMA) was used to maintain airway patency during surgery. Patients who developed hypotension (systolic blood pressure >80% of baseline or >90 mm Hg) were treated with intravenous phenylephrine. When the heart rate (HR) decreased to greater than 40 beats/min, atropine (0.3–0.5 mg) was administered. Ondansetron (intravenous, 4 mg) and tramadol (intravenous, 1–2 mg/kg) were administered 15 minutes prior to the end of surgery. The local

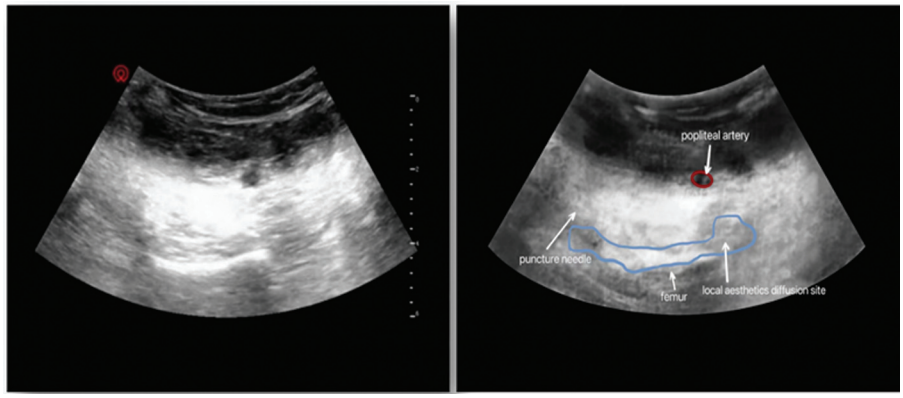

Fig. 3 Ultrasound image of infiltration between the popliteal artery and capsule of the posterior knee block.

infiltration analgesia (LIA) cocktail comprising ropivacaine 100 mg, betamethasone 7 mg, ketorolac 30 mg, epinephrine 0.3 mg, and dexamethasone 5 to 10 mg was administered to prevent postoperative nausea and vomiting, as well as to prolong the local anesthetic duration.[14] Extubation was performed when its criteria were met at the end of the operation, and the patient was transferred to the postanesthesia care unit (PACU) for further observation.

Another anesthesiologist who was blinded to the study conducted the postoperative assessment. Upon the patient's return to the ward, if their Visual Analog Scale (VAS) score was ≥4, intramuscular morphine was administered as rescue analgesia. The postoperative analgesic regimen included celecoxib (oral, 200 mg) and pregabalin (oral, 75 mg) every 12 hours until discharge, and ACB and IPACK were provided based on the presurgical grouping before 8 a.m. on both POD1 and POD2 after surgery.

Outcome Measures

Patients and anesthesiologists were aware of the study group allocation. However, the research staff who performed the assessments had no knowledge of the randomization. Baseline data included sex, age, weight, height, body mass index (BMI), ASA score, and preoperative knee deformity angle (the measurement method is shown in ►**Fig. 4**).

Primary outcomes included VAS scores for pain at rest (PAR) and movement-evoked pain (MEP), which included flexion exercise, extension exercise, and ambulation, which were all recorded. Furthermore, the maximum knee extension angle, flexion angle, straight leg–raising angle, and ambulation distance were recorded as primary outcomes. Secondary outcomes included length of hospital stay, postoperative complications (such as delirium, nausea, or vomiting), first ambulation time, and opioid consumption.

Sample Size

In this study, the sample size was calculated based on preliminary experimental results. The VAS score on POD1 was used as the primary outcome index, and the mean value and standard deviation (SD) in the experimental group were 4.4 and 1.07, respectively. The mean value and SD of the control group were 5.5 and 0.85, respectively. Significance level (α) of 0.05 (two-sided), power ($1-\beta$) of 90%, and anticipated dropout rate of 10% were taken into account.

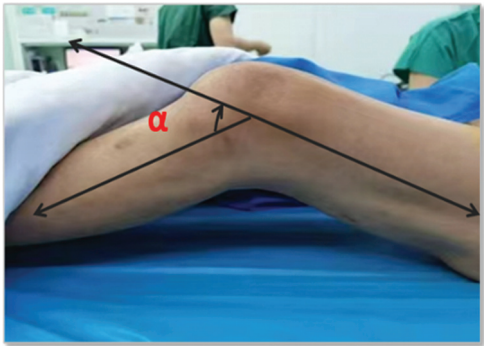

Fig. 4 Measurement of knee deformity angle.

Using these values, the minimum required sample size per group was determined to be 18. By taking into consideration of potential issues such as nerve block failure or loss to follow-up, we increased the sample size to 23 patients per group. We performed the calculation using the following standard formula for comparing two independent means:

$$N = 2 * \left(\frac{Z_{1-\frac{\alpha}{2}} + Z_{1-\beta}}{\frac{\Delta}{SD}} \right)^2,$$

where Δ is the expected mean difference between the groups, SD is the pooled SD, $Z_{1-\frac{\alpha}{2}}$ is the critical value for the significance level, and $Z_{1-\beta}$ is the critical value for the power.

Statistical Analysis

Data analysis was performed using SPSS version 25.0. All continuous data were evaluated for normality using the Shapiro–Wilk test, normally distributed variables were reported using mean ± SD and analyzed with independent-sample *t*-tests, and non-normally distributed variables were reported using mean and interquartile range and analyzed with Mann–Whitney *U* tests. Categorical data, expressed as numbers (percentages), were analyzed using the chi-squared test at a 95% confidence interval (CI).

Results

A total of 46 patients were included in this study, and 2 patients were excluded because of loss of follow-up and operation time ≥3 hours. Finally, 44 patients were included. No significant differences were observed in the general data between the two groups (►**Table 1**).

No statistically significant difference was observed in the PAR between the two groups (►**Table 2**). Compared with group A, the VAS scores for the flexion and extension exercises were significantly decreased on POD1 and POD2 ($p < 0.05$) in group IA (►**Table 3**). Furthermore, patients in group IA had a smaller knee extension angle on POD2 ($p < 0.05$) and longer distance ambulation on POD1 ($p < 0.05$); however, no significant differences were found in the other indicators (►**Table 4**). No statistically significant differences were observed in the length of hospital stay,

Table 1 Demographic and baseline variables ($n = 22$)

Indicators	Group IA	Group A
Sex, male/female	8/15	6/17
Age (y)	67.2 ± 6.5	65.3 ± 6.6
Height (cm)	161.9 ± 7.2	163.3 ± 7.9
Weight (kg)	67.4 ± 12.5	72.5 ± 12.3
BMI (kg/m^2)	25.9 ± 3.7	27.4 ± 3.3
ASA class (I/II)	3/19	1/21
Angle of knee deformity	14.8 ± 4.3	13.3 ± 3.3

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index;
Note: The data are presented as mean ± standard deviation or median (interquartile range).

Table 2 PAR VAS scores, $n = 22$, M (IQR)

Group	PACU	POD0	POD1		POD2	
		Evening	Morning	Evening	Morning	Evening
IA	1 (0–1)	1 (1–1)	1 (0–1)	1 (1–1)	1 (0–1)	1 (0–1)
A	1 (0–2)	1 (1–1)	0 (0–1)	1 (1–2)	1 (0–1)	1 (0–1)

Abbreviations: IQR, interquartile range; M, median; PACU, postanesthesia care unit; PAR, pain at rest; POD, postoperative day; VAS, Visual Analog Scale.

Table 3 MEP VAS scores, $n = 22$, point, M (IQR)

	Group	POD1	POD2
Flexion exercise	IA	3 (2–3)[a]	2 (1–2)[a]
	A	3 (3–4)	2 (2–3)
Extension exercise	IA	4 (4–5)[a]	3 (3–4)[a]
	A	5 (5–6)	4 (4–5)
Ambulation	IA	1 (1–2)	1 (1–1)
	A	2 (1–2)	1 (1–1)

Abbreviations: IQR, interquartile range; M, mean; MEP: movement-evoked pain; POD, postoperative day; VAS, Visual Analog Scale.
Note: Compared with group A.
[a]$p < 0.05$.

Table 4 ROM, $n = 22$, M (IQR)]

	Group	POD1	POD2
Extension angle (degrees)	IA	7 (5–8)	2 (1–3)[a]
	A	8 (5–10)	4 (2–6)
Flexion angle (degrees)	IA	60 (50–70)	80 (70–90)
	A	65 (55–70)	90 (60–90)
Straight leg raising angle (degrees)	IA	60 (40–70)	80 (70–90)
	A	60 (40–70)	70 (60–90)
Distance ambulation (m)	IA	60 (50–75)[a]	150 (120–200)
	A	40 (35–60)	120 (80–160)

Abbreviations: IQR, interquartile range; M, mean; POD, postoperative day; ROM, range of motion.
Note: Compared with group A.
[a]$p < 0.05$.

postoperative complications, and first ambulation time between the two groups (►**Table 5**). Opioid consumption was lower in group IA on POD1 and POD2 ($p < 0.05$; ►**Table 6**).

Both groups did not experience any adverse events, such as local anesthetic toxicity, infection at the puncture site, hematoma formation, or hospital falls. One patient exhibited mild postoperative delirium on the night following surgery but returned to normal without discomfort the next morning.

Discussion

Despite the significant benefits of TKA to patients with end-stage knee osteoarthritis, including long-term improvements in the quality of life, pain relief, and joint function,[15] effective postoperative pain management remains a major challenge. Approximately 20% of TKA patients report dissatisfaction with their outcomes, primarily due to inadequate pain control postsurgery,[16] especially pain behind the knee during extension exercises.

Our study demonstrated a significant decrease in VAS scores for group IA during postoperative extension and flexion exercises, suggesting that the addition of an IPACK block to the ACB leads to an improved analgesic effect after TKA. However, some studies have suggested that the combination of ACB and IPACK has no effect on postoperative pain scores in TKA patients,[6,17] which may be due to differences in patient inclusion criteria. In our study, we specifically included patients with preoperative knee flexion ranging from 5 to 30 degrees, as they often present with mild to moderate knee flexion contractures that are commonly observed in clinical practice and are more likely to benefit from regional anesthesia. This inclusion criterion may have contributed to the observed beneficial effects of the IPACK block in improving pain control and function postsurgery. This range of knee flexion was selected to focus on patients with noticeable pain during extension exercises, which is a common concern in TKA patients and may have influenced the generalizability of the findings to patients with more severe knee deformities. Furthermore, our study shows that the addition of IPACK block to ACB leads to improved knee ROM and distance ambulation, which is consistent with Kim et al's study.[18]

The addition of an IPACK block to the ACB leads to an improved analgesic effect after TKA. The IPACK block likely improves analgesic effects for patients with preoperative

Table 5 Duration of hospital stay, postoperative complications, and first ambulation time ($n = 22$)

Group	Length of stay (d)	Nausea and vomiting (%)	Postoperative delirium (%)	First ambulation time (h)
IA	7 (7–9)	6 (26.1)	0 (0.0)	4.7 ± 0.6
A	8 (7–11)	7 (30.4)	1 (4.3)	5.1 ± 0.8

Table 6 Opioid consumption (rescue analgesia), $n = 22$, M (IQR)

Group	POD0 (%)	POD1 (%)	POD2 (%)
IA	1 (4.3)	11 (47.8)[a]	2 (8.7)[a]
A	1 (4.3)	21 (91.3)	11 (47.8)

Abbreviations: IQR, interquartile range; M, mean; POD, postoperative day.
Note: Compared with group A.
[a]$p < 0.05$.

flexion deformity by targeting the posterior capsule of the knee, which is often a primary source of pain during extension exercises. Patients with flexion deformity often experience increased discomfort due to tension on the posterior knee structures during extension, and the IPACK block helps alleviate this pain. This selective analgesia can be especially beneficial for such patients, as it directly addresses the pain mechanisms associated with flexion contractures.

A study[19] comparing CACB combined with IPACK with CACB block found no significant difference in postoperative VAS scores. We hypothesize that this may be because the ACB block site is relatively low, and a larger volume of local anesthetic is given, resulting in the diffusion of local anesthetic from the adductor canal to the capsule of the posterior knee.[20,21] For the management of perioperative pain in elderly patients, it is recommended to minimize opioid use.[22] In this trial, small doses of opioids were administered for anesthesia induction and maintenance to reduce opioid-related adverse reactions. Additionally, our study results demonstrate that the inclusion of the IPACK block can effectively decrease perioperative opioid consumption, which is consistent with the findings of Li et al.[23] Strategies to minimize opioid use in perioperative pain management include the use of regional anesthesia techniques, such as the IPACK block, and multimodal analgesia. By combining local anesthetics, NSAIDs, and nonopioid analgesics, it is possible to reduce opioid exposure, while long-acting local anesthetics and early mobilization further enhance pain management without increasing opioid use.

The limitations of this study are as follows. First, the optimal effective dose and concentration of local anesthetics have not been studied. The dosage of local anesthetics in this study was set based on relevant literature and clinical experience. Second, this was a single-center, small-sample study with a short duration, necessitating further confirmation through multicenter, large-sample, randomized controlled studies. Similar studies using long-acting local anesthetics should be conducted in the future to further improve patient comfort.

In conclusion, multiple intermittent IPACK blocks combined with ACB can provide better clinical analgesia for patients after TKA, facilitate early functional exercise, and improve their quality of life.

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Conflict of Interest
None declared.

References

1 Karkhur Y, Mahajan R, Kakralia A, Pandey AP, Kapoor MC. A comparative analysis of femoral nerve block with adductor canal block following total knee arthroplasty: a systematic literature review. J Anaesthesiol Clin Pharmacol 2018;34(04):433–438
2 Chua JL, Goh GS, Liow MHL, Tay DK, Lo NN, Yeo SJ. Modern TKA implants are equivalent to traditional TKA implants in functional and patellofemoral joint-related outcomes. Knee Surg Sports Traumatol Arthrosc 2019;27(04):1116–1123
3 Koh IJ, Choi YJ, Kim MS, Koh HJ, Kang MS, In Y. Femoral nerve block versus adductor canal block for analgesia after total knee arthroplasty. Knee Surg Relat Res 2017;29(02):87–95
4 Zhao Y, Huang Z, Ma W. Comparison of adductor canal block with local infiltration analgesia in primary total knee arthroplasty: a meta-analysis of randomized controlled trials. Int J Surg 2019; 69:89–97
5 Sankineani SR, Reddy ARC, Eachempati KK, Jangale A, Gurava Reddy AV. Comparison of adductor canal block and IPACK block (interspace between the popliteal artery and the capsule of the posterior knee) with adductor canal block alone after total knee arthroplasty: a prospective control trial on pain and knee function in immediate postoperative period. Eur J Orthop Surg Traumatol 2018;28(07):1391–1395
6 Kertkiatkachorn W, Kampitak W, Tanavalee A, Ngarmukos S. Adductor canal block combined with ipack (interspace between the popliteal artery and the capsule of the posterior knee) block vs periarticular injection for analgesia after total knee arthroplasty: a randomized noninferiority trial. J Arthroplasty 2021;36(01): 122–129.e1
7 Kampitak W, Tansatit T, Tanavalee A, Ngarmukos S. Optimal location of local anesthetic injection in the interspace between the popliteal artery and posterior capsule of the knee (iPACK) for posterior knee pain after total knee arthroplasty: an anatomical and clinical study. Korean J Anesthesiol 2019;72(05):486–494
8 Tang X, Jiang X, Lei L, et al. IPACK (interspace between the popliteal artery and the capsule of the posterior knee) block combined with SACB (single adductor canal block) versus SACB for Analgesia after Total Knee Arthroplasty. Orthop Surg 2022;14 (11):2809–2821
9 Tran J, Giron Arango L, Peng P, Sinha SK, Agur A, Chan V. Evaluation of the iPACK block injectate spread: a cadaveric study. Reg Anesth Pain Med 2019;44:689–694
10 D'Souza RS, Langford BJ, Olsen DA, Johnson RL. Ultrasound-guided local anesthetic infiltration between the popliteal artery and the capsule of the posterior knee (IPACK) block for primary total knee arthroplasty: a systematic review of randomized controlled trials. Local Reg Anesth 2021;14:85–98
11 Mou P, Wang D, Tang XM, et al. Adductor canal block combined with IPACK block for postoperative analgesia and function recovery following total knee arthroplasty: a prospective, double-blind, randomized controlled study. J Arthroplasty 2022;37 (02):259–266
12 Wang C, Chen Z, Ma X. Continuous adductor canal block is a better choice compared to single shot after primary total knee arthroplasty: a meta-analysis of randomized controlled trials. Int J Surg 2019;72:16–24
13 Lee S, Rooban N, Vaghadia H, Sawka AN, Tang R. A randomized non-inferiority trial of adductor canal block for analgesia after total knee arthroplasty: single injection versus catheter technique. J Arthroplasty 2018;33(04):1045–1051
14 Rahangdale R, Kendall MC, McCarthy RJ, et al. The effects of perineural versus intravenous dexamethasone on sciatic nerve

blockade outcomes: a randomized, double-blind, placebo-controlled study. Anesth Analg 2014;118(05):1113–1119
15 Canovas F, Dagneaux L. Quality of life after total knee arthroplasty. Orthop Traumatol Surg Res 2018;104(1S):S41–S46
16 Kim K, Elbuluk A, Yu S, Iorio R. Cost-effective peri-operative pain management: assuring a happy patient after total knee arthroplasty. Bone Joint J 2018;100-B(1, Supple A):55–61
17 Patterson ME, Vitter J, Bland K, Nossaman BD, Thomas LC, Chimento GF. The effect of the ipack block on pain after primary tka: a double-blinded, prospective, randomized trial. J Arthroplasty 2020;35(6S):S173–S177
18 Kim DH, Beathe JC, Lin Y, et al. Addition of infiltration between the popliteal artery and the capsule of the posterior knee and adductor canal block to periarticular injection enhances postoperative pain control in total knee arthroplasty: a randomized controlled trial. Anesth Analg 2019;129(02):526–535
19 Tak R, Gurava Reddy AV, Jhakotia K, Karumuri K, Sankineani SR. Continuous adductor canal block is superior to adductor canal block alone or adductor canal block combined with IPACK block (interspace between the popliteal artery and the posterior capsule of knee) in postoperative analgesia and ambulation following total knee arthroplasty: randomized control trial. Musculoskelet Surg 2022;106(02):155–162
20 Runge C, Moriggl B, Børglum J, Bendtsen TF. The spread of ultrasound-guided injectate from the adductor canal to the genicular branch of the posterior obturator nerve and the popliteal plexus: a cadaveric study. Reg Anesth Pain Med 2017;42(06):725–730
21 Raddaoui K, Radhouani M, Bargaoui A, et al. Adductor canal block: effect of volume of injectate on sciatic extension. Saudi J Anaesth 2020;14(01):33–37
22 Urvoy B, Aveline C, Belot N, Catier C, Beloeil H. Opioid-free anaesthesia for anterior total hip replacement under general anaesthesia: the observational prospective study of opiate-free anesthesia for anterior total hip replacement trial. Br J Anaesth 2021;126(04):e136–e139
23 Li D, Alqwbani M, Wang Q, Liao R, Yang J, Kang P. Efficacy of adductor canal block combined with additional analgesic methods for postoperative analgesia in total knee arthroplasty: a prospective, double-blind, randomized controlled study. J Arthroplasty 2020;35(12):3554–3562