Arthroplasty Today 27 (2024) 101366

Contents lists available at ScienceDirect

Arthroplasty Today

journal homepage: http://www.arthroplastytoday.org/

Original Research

The Effect of Postoperative Single-Injection Adductor Canal Block in Total Knee Arthroplasty Under Spinal Anesthesia With Intraoperative Dexmedetomidine Infusion

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ARTICLE INFO

Article history:
Received 20 February 2023
Received in revised form
20 February 2024
Accepted 27 February 2024
Available online xxx

Keywords:
Adductor canal block
Single injection
Total knee arthroplasty

ABSTRACT

Background: Single-injection adductor canal block (SACB) is one of the multimodal pain managements in total knee arthroplasty. The effect of an intrathecal local anesthetic is prolonged with an intraoperative dexmedetomidine infusion. Currently, SACB's effect along with the prolonged spinal anesthesia effect by dexmedetomidine has not been studied elsewhere.

Methods: Seventy-eight patients were randomized to either the SACB group (n = 39) or the control group (n = 39). Spinal anesthesia and continuous infusion of dexmedetomidine were performed intraoperatively. The SACB was performed using 15 mL of either 0.5% ropivacaine or normal saline in post-anesthesia care unit postoperatively. Primary endpoint examined the average numerical rating scale (NRS) pain scores at 2, 6, 12, and 24 hours after SACB while resting or moving. The secondary outcomes were the morphine equivalent, postoperative nausea and vomiting score, quadriceps strength, and overall satisfaction score.

Results: The SACB group showed a lower average NRS pain score until 24 hours than the control group (2.4 vs 3.3 resting, 3.4 vs 4.1 moving). Resting and moving NRS scores at 6 and 12 hours were significantly lower in the SACB group, whereas no difference was found at 2, 24, and 48 hours, regardless of movement. The satisfaction score was higher in the SACB group than in the control group (9 [7.3-10.0] vs 7 [5.3-8.8]), and morphine equivalent at 2 hours was lower in the SACB group (2 [1-3]) than in the control group (2.9 [1.6-4]).

Conclusions: SACB provided an additional analgesic effect in patients undergoing total knee arthroplasty under spinal anesthesia with continuous dexmedetomidine intravenous infusion.

Introduction

Total knee arthroplasty (TKA) results in considerable postoperative pain. If not successfully managed, postoperative pain can cause dissatisfaction, delayed recovery, and chronic pain. Therefore, multimodal analgesic protocols are crucial in TKA [1]. Multimodal protocols include perioperative analgesics, patient-controlled analgesia (PCA), local anesthetic injection in periarticular space or interspace between the popliteal artery and the capsule of the posterior knee, and nerve blocks, such as femoral nerve block or adductor canal block (ACB).

Unlike femoral nerve block, ACB targets the pure sensory saphenous nerve and spares motor nerves to the quadriceps muscle. Therefore, ACB reduces the risk of falling while increasing the possibility of early ambulation. The application of ACB can either be a single injection or a continuous infusion using a catheter. [2] Continuous ACB enables prolonged drug administration, whereas single-injection adductor canal block (SACB) has advantages over

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https://doi.org/10.1016/j.artd.2024.101366

time-saving, cost-effectiveness, and less possibility of infection. [3,4] Some studies have reported that SACB reduces postoperative pain and opioid consumption significantly. [5,6] However, the Cochrane review argued that the analgesic effect of SACB at 24-hour pain reduction remains uncertain. [7] The reason for such inconsistency lies in different anesthetic methods (spinal, general analgesia), nerve block methods (timing, dose, position), and diverse multimodal analgesic compositions.

Spinal anesthesia is widely used in TKA. After spinal anesthesia, patients do not experience immediate postoperative pain due to the residual effects of intrathecal local anesthetics. Under spinal anesthesia, sedation with dexmedetomidine is widely reported to prolong the duration of the local anesthetic effect. [8,9] Considering the residual spinal anesthesia effect and dexmedetomidine enhancement, the effectiveness of SACB remains unclear.

This study aimed to compare the postoperative analgesic effect of SACB vs placebo in TKA under spinal anesthesia with intraoperative dexmedetomidine continuous infusion. We hypothesized that single-injection ACB would decrease the postoperative pain compared to those not receiving the nerve block.

Material and methods

Patient recruitment

A double-blinded randomized controlled study was conducted between May 2020 and July 2021 at a single tertiary medical center (Seoul National University Hospital, Seoul, Korea). Ethical approval was obtained on May 27, 2020, by the Seoul National University Hospital Institutional Review Board (H-2004-253-1122). The trial was registered prior to patient enrollment at clinicaltrials.gov (NCT 04400708, https://clinicaltrials.gov/ct2/show/NCT04400708, date of registration: May 22, 2020). A full verbal explanation was provided, and written informed consent was obtained from all participants.

Eighty patients scheduled for elective, unilateral, primary TKA under spinal anesthesia were enrolled. The inclusion criteria were patients with American Society of Anesthesiologists physical status class I-III and aged 19-80 years. The exclusion criteria were as follows: previous operation of ipsilateral knee, local infection at the site of nerve block, contraindication to spinal or regional anesthesia, allergic to local anesthetics, insufficient cooperation in pain evaluation (due to dementia), previous diagnosis of complex regional pain syndrome, chronic opioid users (prescribed with 10 or more opioid analgesics or required opioids for more than 120 days [10]).

Randomization was performed using a web-based computer-generated sequence (Research Randomizer [https://www.randomizer.org/]). Participants were divided into 2 groups: single-injection ACB group vs control group. Group allocation was concealed by sequentially numbered, sealed opaque envelopes, which were only opened by the blinded researcher immediately before the ACB. Patients, the orthopaedic surgeon, and the anesthesiologists were blinded to the group allocation.

Anesthesia

After initial measurement of vital signs, spinal anesthesia was inducted by a 25-gauge Quincke needle (TaeChang Industrial Co., Ltd., Gongju-si, South Korea). Intrathecal opioids or any adjuvant other than bupivacaine, such as clonidine, or epinephrine were not allowed. After assessing clear flow of cerebrospinal fluid and gentle aspiration of cerebrospinal fluid (0.1-0.2 mL), 0.5% hyperbaric bupivacaine (Marcaine Spinal 0.5% Heavy; AstraZeneca, Cambridge, UK) (1.1-1.5 mL) was intrathecally injected at the attending anesthetist's discretion. The block level was assessed at multiple time points using cold sensation, including immediately after spinal anesthesia (T0), 5 minutes after spinal anesthesia (T1), before the end of surgery (T2), and before discharge at the postanesthesia care unit (PACU) (T3).

Sedation was provided by continuous intravenous (IV) infusion of 4 mcg/mL dexmedetomidine with a loading dose of 1 mcg • kg^{-1} • hr^{-1} over 10 min, followed by continuous infusion at 0.1 mcg • kg^{-1} • hr^{-1}. A half-loading dose (0.5 mcg • kg^{-1} • hr^{-1}) of dexmedetomidine was administered to geriatric patients (aged >70 years) with preexisting bradycardia defined as a baseline heart rate of 40-50 beats per minute. Dexmedetomidine infusion was discontinued once the final dressing had begun.

Surgery

All surgeries were performed by a single skilled surgeon (M.C.L.) to minimize operator bias. An anterior midline skin incision and medial parapatellar arthrotomy with resection of both cruciate ligaments were performed. A uniform knee prosthesis bearing (NexGen LPS-Flex, Zimmer, Warsaw, IN) was implanted. After knee prosthesis fixation with cement, the posterior knee was infiltrated with a drug combination of ropivacaine 180 mg (24 mL) and ketorolac 30 mg (1 mL) mixed with normal saline to a total volume of 30 mL. This composite was injected into the posterior capsule (10 mL), quadriceps tendon (5 mL), lateral capsule/synovium (5 mL), and subcutaneous tissue along the midline incision site (10 mL). Intra-articular closed-suction drainage tube with BAROVAC (400 mL, Sewoon Medical, Seoul, Republic of Korea) was inserted in all patients until postoperative day (POD) 2.

Nerve block

Upon arrival in the PACU, SACB was provided in the supine position with the operative leg externally rotated and abducted. Ultrasonography with a high-frequency linear array transducer (6-14 MHz frequency range, UMT-400 Mindray, Szechuan, China) was used. One anesthesiologist trained for ACB performed every block. Tracing from the femoral nerve in the inguinal ligament to the adductor canal, the apex of the femoral triangle and entrance of the adductor canal were visualized, where the medial border of the sartorius muscle and adductor longus meet. The level at which the medial border of the sartorius muscle crossed the medial border of the adductor longus muscle was targeted. To ensure safety, nerve stimulator (Stimuplex HNS 12, Stockert, Freiburg, Germany) was applied with the electrode at the distal foot. Stimulation started with 1 mA, and after quadriceps twitched, stimulus was downgraded to 0.3-0.5 mA to prevent intraneuronal injection. Under full aseptic cleansing with 2% chlorhexidine, a 100-mm 21-gauge needle (SonoPlex STIM; PAJUNK; Germany) was introduced in-plane from the lateral to medial direction. After confirmation of the needle tip and shaft location, 15 mL of either 0.5% ropivacaine or normal saline was injected. The study drugs were prepared by another attending nurse, and all other investigators were blinded.

Multimodal pain control

Preoperatively, all patients received oral celecoxib 200 mg, pregabalin 75 mg, and cetamadol (tramadol 37.5 mg/acetaminophen 325 mg) as preemptive analgesics. An intraoperative periarticular injection was performed, as described above. Postoperatively, IV PCA composed of fentanyl 1000 mcg, nefopam 80 mg, and ramosetron 0.3 mg in a total volume of 100 ml was applied. PCA's lockout period of 15 minutes was present with a basal flow of 1 mL and bolus dose of 1 mL. Oral celecoxib 200 mg

was administered every 12 hours, and 1 tablet of cetamadol was administered every 8 hours from POD 1 until discharge. Breakthrough pain with a pain score exceeding the numerical rating scale (NRS) score of 4 was treated with either oral oxycodone (5 mg) or IV morphine (5 mg).

To prevent postoperative nausea and vomiting (PONV), 10 mg of IV dexamethasone and 0.075 mg of palonosetron were injected on the morning of the operation day. Ramosetron 0.3 mg was mixed at IV PCA, and an additional 0.3 mg of IV ramosetron was administered on the morning of POD 1.

Standard rehabilitation began with continuous passive motion within 24 hours from the end of surgery. Mild ambulation and continuous passive motion were permitted on POD 1. Active walking with isometric quadriceps strengthening exercises was performed on POD 2 after removing the closed-suction drain. Two sessions of active and passive range of motion exercise per day were maintained throughout the first week of hospitalization.

Outcome variables and data recruitment

NRS pain scale was used for pain assessment (NRS: 0, no pain; 10, the most severe pain imaginable). The primary outcome was the difference in the average pain scores at the 4 different time points: 2, 6, 12, and 24 hours after ACB. Individual NRS scores at each time point were also evaluated. The secondary endpoints were the amount of PCA used, any rescue analgesic other than routine analgesic modality, total morphine equivalent calculated by oral morphine equivalent daily dose (oMEDD), quadriceps strength at 24 hours after the block, and overall patient satisfaction score of pain control (0, very unsatisfied; 10, completely satisfied). PONV was also assessed by scoring (PONV: 0, no nausea, no vomit; 1, nausea but no vomit; 2, vomiting once with nausea; 3, vomiting more than twice within 30 min). Opioid consumption was converted to oMEDD by using the Australian and New Zealand College of Anaesthetists Faculty of Pain Medicine opioid equivalence dose (Appendix A).

Preoperatively, the patient's usual knee pain score was recorded. After the block, patients were required to fill out a "pain diary" to record the NRS score at resting/movement and the PONV score at 2, 6, 12, 24, and 48 hours after the block. The resting pain was measured with the operated leg lying on bed with the patient in supine position. No additional strain force was allowed in the lower extremity muscle. Movement pain was recorded with the patient in sitting position with the hip joint flexed. Patients were requested to record the score while extending the knee, where the quadriceps muscle contracts. Additionally, patients were requested to complete the time they first felt any pain at the operative knee. At 24 hours after the block, a blinded investigator evaluated the quadriceps muscle strength using a digital push-pull gauge (FGPX-50, SHIMPO, Osaka, Japan). Overall patient satisfaction score on pain control was obtained immediately after the 48-hour point.

Statistical analyses

The sample size was calculated based on a preliminary investigation performed by Canbek *et al.* [2] The results were a visual analogue scale (VAS) pain score of mean (standard deviation) such as the following: 5.68 (3.53), 6.78 (2.30), 4.95 (2.70), and 3.90 (1.67) at 2, 6, 12, and 24 hours, respectively. Based on these results, we hypothesized a mean NRS score of 5.3 and assumed a reliable decrement of NRS of 20%, thereby calculating the reduction of NRS score of 1.1 (1.8) as significant. Based on a one-way t-test with an effect size of 0.6, an α error of 5%, and a minimum power of 0.80, 36 patients were required for each group. Assuming a dropout rate of 10%, we planned to enroll 40 participants in each group, for a total of 80 patients.

Statistical analyses were performed using the Statistical Package for the Social Sciences version 23.0 (IBM Corp., Armonk, NY) for Windows (Microsoft Corporation, Redmond, WA). The SACB and control groups' variables were assessed for normality using the Shapiro-Wilk test. Normally distributed variables were analyzed using Student's *t*-test, whereas categorical variables were analyzed using Pearson's chi-squared test (or Fisher's exact test if the expected count was <5). If the data were not normally distributed, we conducted the Mann-Whitney U test for continuous variables and the chi-squared test for categorical variables. The results are expressed as the mean ± standard deviation with corresponding 95% confidence interval or median (interquartile range). Statistical significance was set at $P < .05$.

Results

Patient characteristics

Of the 80 patients who were screened for eligibility between May 2020 and July 2021, 78 were enrolled (one refused to participate, and one did not meet the inclusion criteria because of a newly found previous history of knee surgery). Patients were randomly assigned to either the SACB (n = 39) or control group (n = 39). One patient did not receive the intervention because of failed spinal anesthesia. Another patient was provided the wrong intervention due to faulty preparation of the allocated drug. Three patients requested early removal of PCA, and the pain management was replaced with an unconventional method, including intermittent bolus of painkillers or fentanyl patch. One patient's PCA data were lost due to technical problems with the device. Patient recruitment and flow are described in the Consolidated Standards of Reporting Trials diagram (Fig. 1). The final analysis included 36 patients in each group. The demographics are presented in Table 1. Baseline characteristics did not differ between the 2 groups.

Primary outcomes

The average NRS pain scores at 2, 6, 12, and 24 hours were lower in the SACB group in both resting and movement states (ACB 2.4 [2.0-2.8] vs control 3.3 [2.8-3.8] while resting, $P = .005$; 3.4 [2.9-3.9] vs 4.1 [3.6-4.7] while moving, $P = .042$). At 6 and 12 hours after ACB, the SACB group had significantly lower NRS pain scores both in the resting and movement states than the control group (ACB 1.5 [0-3] vs control 3 [1.25-5] at 6 hours while resting, $P = .024$; ACB 3 [1-5] vs control 4 [2-7] at 6 hours while moving, $P = .040$; ACB 3 [1.25-5] vs control 4 [3-5.75] at 12 hours while resting, $P = .007$; ACB 5 [3-6] vs control 6 [4.25-7] at 12 hours while moving, $P = .027$). However, NRS pain scores at 2, 24, and 48 hours after ACB showed no difference (Table 2).

Secondary outcomes

Time to first pain showed no difference, but the NRS of first pain was lower in the SACB group (1 [1-2]) than in the control group (1.5 [1-3], $P = .03$). The amount of PCA drug and any rescue analgesic at 2, 6, 12, 24, and 48 hours showed no difference. The oMEDD at 2 hours was lower in the SACB group (ACB, 2 [1-3]; control, 2.9 [1.6-4], $P = .035$). The quadriceps strength at 24 hours after ACB was higher in the SACB group than in the control group (ACB, 49.8 ± 13.6; control, 42.8 ± 10.74; $P = .028$). Finally, the patient satisfaction score was significantly higher in the SACB group (ACB, 9 [7.25-10]) than in the control group (7 [5.25-8.75], $P = .009$) Table 2).

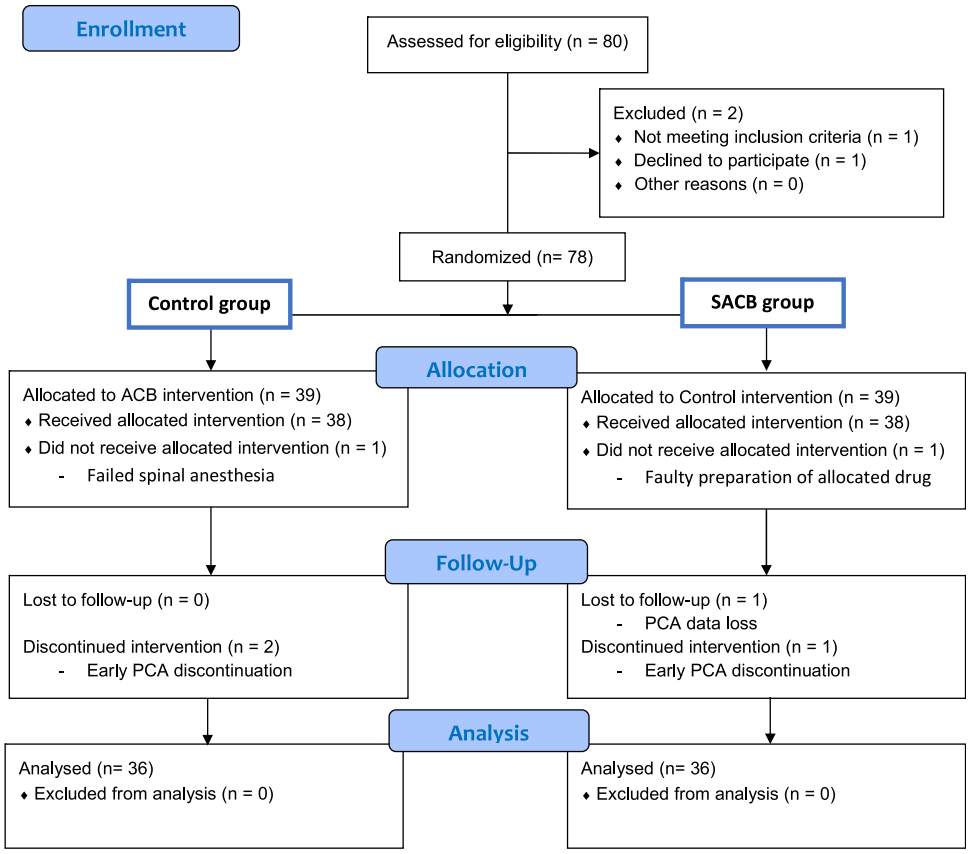

Figure 1. Consolidated Standards of Reporting Trials diagram.

Other outcomes

The intraoperative and PACU data between the 2 groups were comparable (Table 3). At the PACU, 4 cases of desaturation (oxygen saturation ≤94%) for each group were found, all of which were recovered by applying an oxygen supplement via nasal prong (2 to 4 L/min).

Discussion

This study demonstrates that SACB reduces pain at 6 and 12 hours, but not after 24 hours after ACB. This implies that the effect of SACB may be effective for at least 12 hours under spinal anesthesia. However, the reduced pain score does not sufficiently exceed the minimal clinically important difference (MCID), and

Table 1
Demographics and preoperative measures.

Variables	SACB group (n = 36)	Control group (n = 36)	Mean difference	*P* value
Age (y)	69 ± 5	71 ± 4	2.0 (−0.3 to 4.3)	.081
Male gender (n)	4 (11.11)	6 (16.67)		.496
Height (cm)	155.8 (149.9-157.9)	153.7 (150.3-156.7)	−1.4 (−3.6 to 1.3)	.371
Weight (kg)	65.5 (58.9-69.6)	61.1 (56.0-69.1)	−2.8 (−7.8 to 1.7)	.201
Body mass index (kg/m^2)	27.3 ± 3.5	26.7 ± 4.2	−0.6 (−2.4 to 1.2)	.529
Comorbidity (n)				
Hypertension	21 (58.33)	26 (72.22)		.216
Diabetes mellitus	5 (13.89)	9 (25.00)		.234
Chronic kidney disease	0 (0.00)	2 (5.56)		.493
Hepatic disease	0 (0.00)	3 (8.33)		.239
Thyroid disease	3 (8.33)	4 (11.11)		1.000
Preoperative medication				
Antihypertensive	24 (66.67)	25 (69.44)		.800
Oral hypoglycemic agents	3 (8.33)	8 (22.22)		.101
Aspirin	11 (30.56)	5 (13.89)		.089
Synthyroids	2 (5.56)	5 (13.89)		.429
Preoperative NRS (0-10)	3 (3-5)	4 (3-6)	0.0 (0.0-1.0)	.207
Kellgren-Lawrence Grade (1-4)	4 (4-4)	4 (3-4)	0.0 (0.0-0.0)	.426

NA, not applicable.
Continuous variables are presented as mean ± standard deviation or median (Q1-Q3) and tested using the t-test or Wilcoxon rank-sum test, and categorical variables are presented as N (%) and tested using the chi-squared test or Fisher's exact test.
Data are expressed as number (%), mean (standard deviation), or median (interquartile range).

Table 2
Postoperative pain scores.

Variables	SACB group (n = 36)	Control group (n = 36)	Mean difference	*P* value
Average NRS at rest till 24 h	2.4 (2.0-2.8)	3.3 (2.8-3.8)	3.6 (1.1-6.2)	.005
Average NRS at movement till 24 h	3.4 (2.9-3.9)	4.1 (3.6-4.7)	2.89 (0.1-5.7)	.042
Time to first pain (min)	270 (158-435)	258 (126-311)	−30 (−115 to 30)	.457
NRS of first pain	1 (1-2)	1.5 (1-3)	0.0 (0.0-1.0)	.030
NRS at rest				
2 h	0 (0-0)	0 (0-2)	0.0 (0.0-0.0)	.089
6 h	1.5 (0-3)	3 (1.25-5)	1.0 (0.0-2.0)	.024
12 h	3 (1.3-5)	4 (3-5.8)	1.0 (0.0-2.0)	.007
24 h	4 (3-5)	4 (3-6)	0.0 (−1.0 to 1.0)	.476
NRS at movement				
2 h	0 (0-0)	0 (0-2)	0.0 (0.0-0.0)	.263
6 h	3 (1-5)	4 (2-7)	1.0 (0.0-3.0)	.040
12 h	5 (3-6)	6 (4.3-7)	1.0 (0.0-2.0)	.027
24 h	6 (4-7)	5 (5-7.5)	0.0 (−1.0 to 1.0)	.837
PONV severity				
2 h	0 (0-0)	0 (0-0)	0.0 (0.0-0.0)	.558
6 h	0 (0-0)	0 (0-0)	0.0 (0.0-0.0)	.307
12 h	0 (0-0)	0 (0-0)	0.0 (0.0-0.0)	.088
24 h	0 (0-0)	0 (0-0)	0.0 (0.0-0.0)	.011
Morphine equivalent				
2 h	2 (1-3)	2.9 (1.6-4)	1.0 (0.0-1.8)	.035
6 h	10 (5.2-12)	11 (8-13.9)	2.0 (−0.2 to 5.0)	.083
12 h	23.5 (13.1-29.5)	24.5 (16.2-34.6)	3.6 (−2.5 to 9.8)	.285
24 h	56.5 (45.0-77.0)	65.5 (53.3-88.6)	10.1 (−1.6 to 21.0)	.084
Rescue analgesic				
2 h	0 (0-0)	0 (0-0)	0.0 (0.0-0.0)	.984
6 h	0 (0-0)	0 (0-0)	0.0 (0.0-0.0)	.154
12 h	0 (0-0)	0 (0-5)	0.0 (0.0-0.0)	.173
24 h	0 (0-0)	0 (0-9.25)	0.0 (0.0-0.0)	.128
Total oMEDD				
oMEDD till 24 h	56.5 (45.0-77.0)	65.5 (53.3-88.6)	10.1 (−1.6 to 21.0)	.085
oMEDD till 48 h	118.5 (100.1-152.9)	136.5 (115.1-158.0)	14.6 (−2.0 to 32.0)	.078
Satisfaction score	9 (7.3-10.0)	7 (5.3-8.8)	−1.0 (−2.0 to 0.0)	.009
Quadriceps strength (N) at 24 h	49.8 ± 13.6	42.8 ± 10.7	−7.0 (−12.7 to −1.2)	.028

NA, not applicable; oMEDD, oral morphine equivalent daily dose.
Continuous variables are presented as mean ± standard deviation or median (Q1-Q3) and tested using the t-test or Wilcoxon rank-sum test.
Data are expressed as number (%), mean (standard deviation), or median (interquartile range).

SACB did not effectively reduce the total amount of opioid used. Previous studies demonstrated acceptable MCID after TKA to be approximately 1-2 points on VAS score [11,12] with median MCID being 15 mm at rest and 19mm during movement on a 0-100 mm VAS scale [13]. Interestingly, quadriceps muscle strength at the 24-hour time point and overall satisfaction score were both significantly higher in the SACB group than in the control group. The decreased pain might have facilitated quadriceps activation.

To date, many meta-analyses comparing SACB with continuous ACB have shown that continuous ACB provides better pain relief, lower opioid consumption, and shorter length of hospital stay. [4,14] However, the practical superiority of continuous ACB remains controversial because of the displacement and infection risks of continuous ACB. [8,15] The displacement rate has been reported to be as high as 26%. [16] Postoperative physiotherapy of leg movement was reported to change distance from the skin to the adductor canal, which may contribute to catheter tip dislodgement. [16] Previous meta-analyses included TKA performed under spinal anesthesia and general anesthesia. The effect of SACB under spinal anesthesia was investigated in 6 studies until recently. [2,15,17-20] However, to the best of our knowledge, there is no randomized controlled trial comparing SACB with sham block in the setting of extended spinal anesthetic duration by IV dexmedetomidine.

The duration of SACB has not been well reported. Previously, presumed block resolution of SACB was between 36 and 42 hours. [3] The SACB in our study was revealed to be effective for more than 12-hour time point but less than 24 hours. Meanwhile, prolonged spinal anesthetic duration under IV dexmedetomidine infusion has been widely reported. [21,22] Regarding the spinal block duration, the meta-analysis by Abdallah *et al*. showed that the sensory block was prolonged by at least 34%. [21] The duration of sensory blockade in the dexmedetomidine group was reported to range from 208 ± 44 minutes [23] to 270 ± 21 minutes [24]. The time to first analgesic request was extended by at least 60%, resulting in a mean of 278 min. [21] Based on these previous results, most dexmedetomidine-extended spinal anesthetic durations last less than 300 minutes. Therefore, based on our study, the duration effect of SACB can be evaluated to exceed the duration of spinal anesthesia with an IV dexmedetomidine infusion.

At 2 hours after SACB, the NRS score did not differ between the 2 groups. However, 2 hours of oMEDD showed a lower amount in the SACB group. This may be due to the significantly lower NRS score for first pain in the SACB group. The lower intensity of the first pain may have contributed to less demand to push the button of the IV PCA. Nonetheless, at 6-48 hours, oMEDD did not differ between the 2 groups.

The current study has some limitations. First, motor strength was measured using a digital push-pull gauge dynamometer. The digital push-pull gauge dynamometer only measures the maximal voluntary contraction force of the quadriceps, not the complex muscle power required for ambulation. Precise evaluation requires functional evaluation of mobility, such as the 100-foot walking test, 6-minute walking test, and timed-up-and-go test. Second, a relatively short-term comparison until 48 hours was evaluated without a long-term comparison. We did not collect longitudinal outcome data, so the effect on longer-term recovery is unknown,

Table 3
Intraoperative data between the single-injection adductor canal block and control groups.

Variables	SACB group (n = 36)	Control group (n = 36)	Mean difference	*P* value
Bupivacaine dose (mg)	12 (12.0-12.8)	12 (12.0-12.8)	0.0 (0.0-0.0)	.905
Dexmedetomidine dose (mcg)	60 (52-89)	62 (44-80)	−4.0 (−14.0 to 8.0)	.557
Spinal anesthesia level				
Initial level	2.5 (2-4)	3 (2-4)	0 (−1 to 1)	.835
5 minutes after initial	7 (5-8)	6 (5-8)	0 (−1 to 1)	.732
End of operation	7 (4-8)	6 (5-8)	0 (−1 to 1)	.565
Exitting PACU	3 (2-6)	4 (3-6)	1 (0-2)	.157
Intraoperative findings				
Crystalloid input (mL)	375 (250-600)	425 (300-638)	50 (−50 to 150)	.387
Estimated blood loss (mL)	225 (150-300)	200 (105-200)	−50 (−100 to 0)	.047
Urine output (mL)	190 (100-345)	225 (100-350)	20 (−50 to 100)	.549
Total anesthesia time (min)	125 (111-130)	115 (110-130)	−5 (−10 to 5)	.236
Total operation time (min)	80 (71-85)	75 (70-89)	0 (−5 to 5)	.613
PACU				
Painkillers in PACU	0 (0)	0 (0)		-
Complication in PACU				
Desaturation event (n)	4 (11.1)	4 (11.1)		1.000
Dizziness event (n)	0 (0)	2 (5.6)		.493
Headache event (n)	0 (0)	1 (2.8)		1.000

NA, not applicable.
Continuous variables are presented as mean ± standard deviation or median (Q1-Q3) and tested using the t-test or Wilcoxon rank-sum test, and categorical variables are presented as N (%) and tested using Fisher's exact test.
Spinal anesthesia level is expressed by setting level L2 through C2 as 0-20.
Data are expressed as number (%), mean (standard deviation), or median (interquartile range).

though prior studies suggest that better earlier pain control facilitates faster recovery. [25] Future studies with multiple evaluation time points and long-term comparisons until discharge are warranted.

Conclusions

SACB demonstrated superior analgesia in both resting and movement states up to 12 hours, although this effect was not sustained beyond 24 hours. However, the analgesic efficacy of SACB did not surpass the MCID. Nonetheless, SACB resulted in higher overall patient satisfaction and preserved motor strength, particularly in the context of the extended residual effect of spinal anesthesia facilitated by dexmedetomidine infusion.

Acknowledgments

We would like to thank the operative room and PACU assisting nurses, and orthopaedic surgeon for their support in running this trial.

Conflicts of interest

The authors declare there are no conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2024.101366.

CRediT authorship contribution statement

Hyung-Been Yhim: Writing – review & editing, Writing – original draft, Project administration, Methodology. **Seokha Yoo:** Data curation. **Sun-Kyung Park:** Data curation. **Youngwon Kim:** Data curation. **Young-Jin Lim:** Data curation, Conceptualization. **Jin-Tae Kim:** Writing – review & editing, Supervision, Project administration, Methodology, Data curation, Conceptualization.

Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.artd.2024.101366.

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