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Systematic Review

Analgesic benefits of single-shot versus continuous adductor canal block for total knee arthroplasty; systematic review

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Abstract

Background: Postoperative pain after total knee arthroplasty (TKA) delay mobilization and rehabilitation. Adductor canal block (ACB) is widely used because it provides analgesia while preserving quadriceps strength, but it's uncertain whether single-shot Adductor canal block (SACB) or continuous Adductor canal block (CACB) had the better postoperative outcomes. This review evaluated their effects on pain, opioid consumption, and early functional recovery after TKA. **Methods:** This systematic review followed PRISMA guidance. MEDLINE, Scopus, Web of Science, Embase, and the Cochrane Central Register of Controlled Trials were searched from inception to 2025 for original studies comparing SACB with CACB in TKA. Two reviewers screened studies, and assessed full texts. We found heterogeneity in study design, block protocols, and outcome reporting, so the findings were analyzed qualitatively rather and meta-analysis not done. **Results:** We initially identified 172 records, 106 were screened, 28 full texts were assessed, and 9 studies

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involving 1,307 patients were included. CACB provided more steady analgesic benefit than SACB, especially after 12 to 24 hours, with several studies showing lower pain scores at 24 and 48 hours, and reduced opioid use. Some trials found equivalent early analgesia, mainly when SACB was combined with adjuvants or multimodal analgesia. Functional outcomes were mixed, with some studies favoring CACB for ambulation or range of motion and others showing no significant differences. **Conclusion:** CACB provide more sustained analgesia and opioid-sparing benefit after TKA, whereas functional advantage over SACB still not confirmed and context dependent.

Keywords: total knee arthroplasty; adductor canal block; single-shot adductor canal block; continuous adductor canal block; postoperative analgesia

Introduction

Total knee arthroplasty (TKA) is one of the most common procedures for advanced knee osteoarthritis, and postoperative pain is a major barrier to early mobilization and rehabilitation. Recovery after TKA depends on preservation of quadriceps function and pain relief and regional anesthesia has become a central component of multimodal analgesia. The adductor canal block (ACB) gained wide acceptance because it provides effective sensory analgesia while without affecting motor function better than femoral nerve block, so its better in fast-track arthroplasty pathways (Jaeger et al. 2013; Kim et al. 2014; Jiang et al. 2016; Schnabel et al. 2019).

A SACB is simpler, avoids catheter care, and is well suited to perioperative practice, and its analgesic duration is limited to the early postoperative period. CACB prolong sensory blockade and reduce rebound pain, but it requires catheter placement, infusion management, and affected by catheter dislodgement or protocol variability. This clinical ambiguity has been reflected in the literature, where previous studies reported mixed conclusions regarding CACB offers clinical advantages over SACB techniques, mainly for opioid use, pain scores beyond 24 hours, and functional recovery (Zhang et al. 2019; Sercia et al. 2022; Hussain et al. 2023).

Direct comparative studies produced heterogeneous findings, some randomized studies found better analgesia with CACB after the first postoperative day, whereas others found equivalence of SACB, when combined with adjunctive analgesic strategies (Canbek et al. 2019; Lee et al. 2018; Turner et al. 2018). The analgesic and functional benefits of SACB versus CACB in TKA remain uncertain. Therefore, our systematic review aimed to analyzes the available data from original studies on SACB and CACB in adult TKA patients, with focus on postoperative pain, opioid consumption, and early functional recovery.

Method

Our systematic review study follow PRISMA guidelines. A literature search was conducted to identify original studies comparing SACB with CACB in TKA patients. The following electronic databases were searched from database inception to 2025: MEDLINE, Scopus, WOS, Embase, and the Cochrane Central Register of Controlled Trials. PubMed terms were developed using free text keywords and MeSH terms, and the Embase strategy was adapted using Emtree terms. CENTRAL searched to improve identification of randomized and quasi-randomized trials.

Our search strategy combined controlled vocabulary and text words related to the population, intervention, comparator, and

procedure. Core concepts included: “total knee arthroplasty,” “total knee replacement,” “adductor canal block,” “saphenous nerve block,” “single-shot,” “single injection,” “continuous,” “catheter,” and related synonyms. Reference lists of eligible studies were also screened to identify additional eligible articles not captured by the electronic search.

A representative PubMed search strategy was as follows: ("Arthroplasty, Replacement, Knee"[MeSH] OR "total knee arthroplasty" OR "total knee replacement" OR TKA OR TKR) AND ("adductor canal block" OR "saphenous nerve block") AND ("single shot" OR "single-shot" OR "single injection" OR bolus) AND (continuous OR catheter OR infusion OR perineural catheter).

Study selection and screening

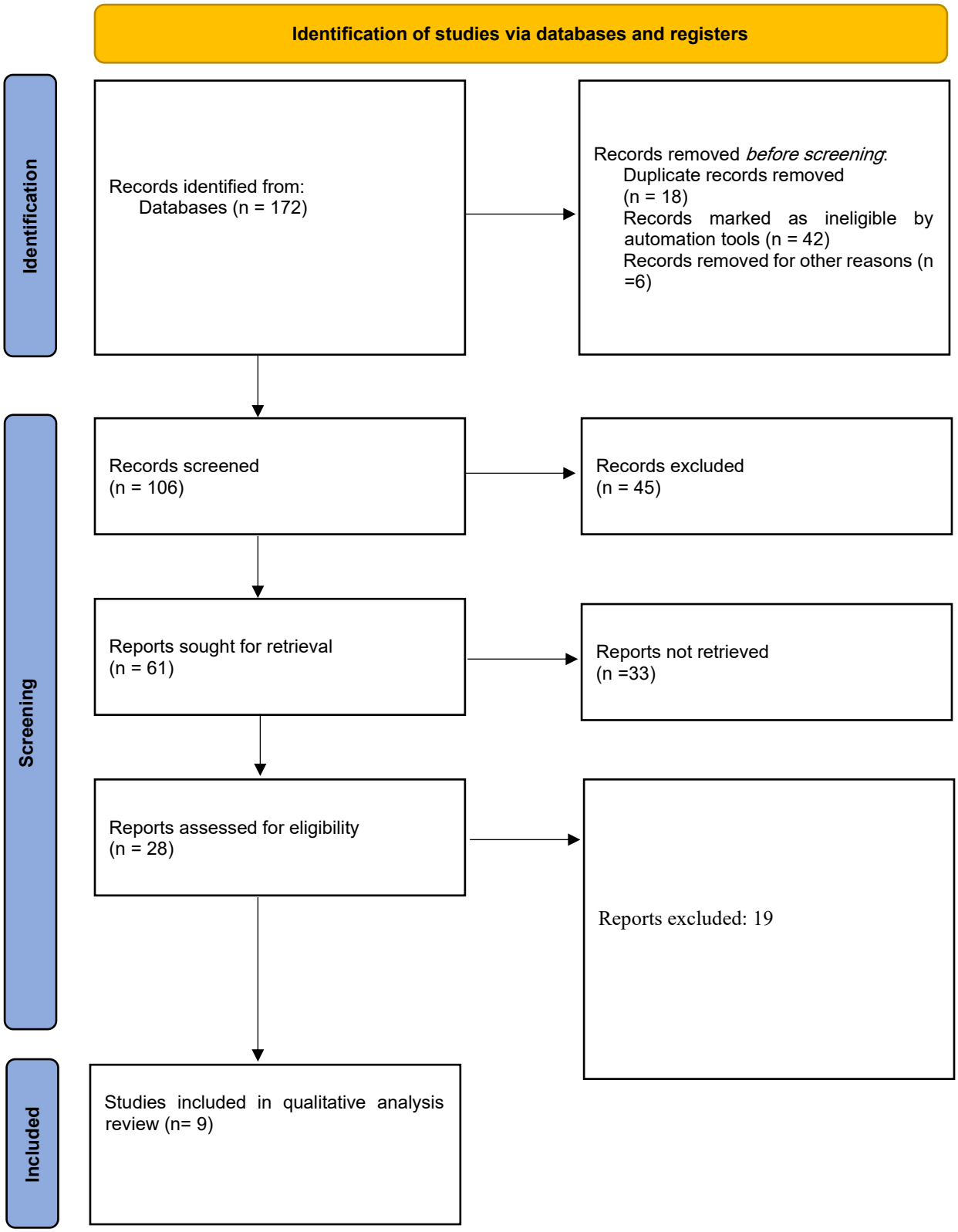
All records retrieved from the database search were exported to a reference management software Endnote and Mendeley, and duplicate citations were removed automatically before manual check. After removal of duplication, two reviewers screened titles and abstracts for eligibility criteria. Studies judged to be relevant by either reviewer were retrieved in full text for detailed assessment. Full-text articles then reviewed by the same two reviewers to determine final inclusion. Disagreement at either stage was resolved through discussion and, when necessary, consultation with a third reviewer. The study selection process documented in a PRISMA 2020 flow diagram, including numbers of records identified, screened, assessed for eligibility, excluded, and finally included, with reasons for full-text exclusion reported explicitly (Fig 1).

Studies were considered eligible if they met the were original human research; adult patients undergoing primary total knee arthroplasty; comparison between SACB and CACB; and reporting at least one postoperative outcome (pain scores, opioid consumption, functional recovery, ambulation, quadriceps strength, length of stay, complications). We exclude review articles, systematic reviews, meta-analyses, editorials, letters, conference abstracts without full data, case reports, cadaveric or technical studies, non-comparative studies, and studies not evaluating SACB versus CACB in TKA. When multiple publications reported overlapping populations, the most complete or most recent dataset was retained.

Data analysis

We found some heterogeneity in study design, analgesic protocols, intervention characteristics, and reported outcome measures, so quantitative pooling was not considered. Data were synthesized using a narrative qualitative approach. Study characteristics were summarized descriptively (Table 1), and the findings of the included studies were organized by outcome domain, including postoperative pain, opioid consumption, and ambulation or functional recovery (Table 2). Comparisons were then made in studies to identify patterns favoring either CACB or CACB.

Fig 1: PRISMA flow chart



Result

The efficacy of CACB versus SACB blocks in reducing postoperative pain scores varied in the literature. Several studies found that CACB provided better analgesia compared to SACB, mainly after the initial 12 to 24 hours postoperatively. Significant reductions in pain scores at 24 and 48 hours were reported in the CACB groups. CACB associated with lower incidences of breakthrough pain compared to SACB techniques.

Other investigations found that SACB provide equivalent analgesia to CACB during the first postoperative day. One equivalency trial found that when SACB was supplemented with multiple adjuvants, it provided pain control equivalent to that of a CACB. Reductions in postoperative opioid requirements were a consistent finding in several trials which support the CACB. Multiple studies reported lower cumulative opioid consumption in patients receiving CACB compared to those receiving SACB. Rescue opioid use was found to be lower in CACB during the first 24 to 48 hours following surgery. Some researchers observed no significant difference in total opioid consumption between the two techniques during the first 24 hours.

The impact of the block technique on functional recovery and mobility showed mixed results. Some studies suggests that CACB facilitate better early functional recovery, improved range of motion, and longer ambulation distances compared to SACB. Several randomized trials reported no significant differences between SACB and CACB regarding mobility measures, such as the Timed Up and Go (TUG) test or the total distance walked by the patient. There was no significant difference found in the range of motion in some studies.

Table 1: characteristics of the included studies

Study	Country	Study design	Participants (n)	Intervention groups
Lyngeraa et al. (2019)	Denmark	Randomized, blinded, controlled study	105 patients	Suture-method catheter ACB Standard catheter ACB SACB
Canbek et al. (2019)	Turkey	Prospective randomized controlled trial	123 patients	SACB (n=60) CACB (n=63)
Shah et al. (2015)	India/South Korea	Prospective randomized controlled trial	90 patients	CACB SACB
Tak et al. (2020)	India	Randomized controlled trial	171 patients	CACB SACB ACB + IPACK block

Study	Country	Study design	Participants (n)	Intervention groups
Turner et al. (2018)	USA	Double-blinded, randomized, equivalency trial	60 patients	SACB (with adjuvants) CACB
Kim et al. (2022)	South Korea	Retrospective record analysis	482 patients	IV-PCA alone CACB PCA + SACB
Elkassabany et al. (2019)	USA	Prospective randomized open-label study	114 patients	SACB CACB
Kim et al. (2019)	South Korea	Randomized controlled trial	62 patients	CACB IV-PCA + SACB (Group IVACB)
Lee et al. (2018)	Canada	Randomized non-inferiority trial	100 patients	SACB SACB

Table 2: main findings of the included studies

Study	Primary pain findings	Opioid consumption	Ambulation and functional recovery
Lyngeraa (2019)	No significant difference in pain scores between catheter and SACB during the first 24h.	No significant difference in total opioid consumption among the three groups.	No difference found in the TUG test or mobility.
Canbek (2019)	CACB group showed lower VAS scores at 24 and 48 hours compared to SACB.	Significantly lower in the CACB group.	CACB had better range of motion and faster functional recovery.
Shah (2015)	VAS scores were significantly better at all recorded times in the CACB than the SACB.	Morphine consumption was significantly less in the CACB.	CACB showed better ambulation ability and early functional recovery.
Tak (2020)	CACB was superior in controlling pain at rest and after ambulation compared to SACB.	CACB group had significantly lower opioid consumption in morphine equivalents.	CACB resulted in longer ambulation distances compared to CACB.
Turner (2018)	SACB provided equivalent analgesia to CACB.	No significant difference in opioid use between groups.	No difference in TUG test or physical therapy performance.

Study	Primary pain findings	Opioid consumption	Ambulation and functional recovery
Kim (2022)	Breakthrough pain was significantly lower in the C-ACB group compared to the PCA+ SACB group.	Rescue opioid consumption was significantly less in the CACB group.	CACB group showed higher satisfaction and less breakthrough pain.
Elkassabany (2019)	CACB provided superior analgesia compared with a SACB on POD 1.	Significantly less opioid consumption in the CACB group on the day of surgery and POD 1.	No significant difference in the distance walked or TUG test.
Kim (2019)	Pain scores at 24h and 48h were significantly lower in the CACB group.	Total fentanyl consumption was lower in the CACB group than the IV-PCA+SACB group.	No significant difference in the range of motion between groups.
Lee (2018)	SACB was non-inferior to catheter for pain control on POD 1.	Morphine consumption at 12 and 24 hours was higher in the SACB group.	No significant difference in TUG test times at 24 or 48 hours.

Discussion

In this study we found that CACB provided more analgesic benefit than SACB, mainly after the immediate postoperative period. According to the included studies SACB and CACB were comparable during the earliest postoperative hours, whereas CACB show lower pain scores at 24 to 48 hours and reduced breakthrough pain. Some studies favor CACB and others found little or no difference in standardized mobility outcomes. Our findings suggest that the main advantage of CACB is the prolongation of analgesia rather than in producing a better rehabilitation profile.

Several included studies reported better postoperative analgesia with CACB, mainly at 24 and 48 hours after surgery. Canbek et al. found lower pain scores and better functional results in the CACB group, while Shah et al., Elkassabany et al., Kim et al., and Tak et al. reported better pain control or lower breakthrough pain with CACB techniques. These results are biologically reasonable because a catheter-based infusion extend the sensory blockade after the limited duration of a SACB. On the other hand, Turner et al. showed that SACB supplemented with multiple adjuvants provided equivalent analgesia for the early postoperative course, and Lee et al. reported the same of SACB for early opioid outcomes. Lyngeraa et al. did not identify a major early analgesic difference between catheter-based and SACB approaches. These data indicate that the analgesic advantage of CACB is apparent when the comparison is made after the first postoperative day or when SACB is not prolonged by adjuncts (Canbek et al. 2019; Shah et al. 2015; Elkassabany et al. 2019; Kim et al. 2019; Tak et al. 2022; Turner et al. 2018; Lee et al. 2018; Lyngeraa et al. 2019).

In our review, several studies favored CACB for lower rescue or cumulative opioid use, which is consistent with more sustained regional analgesia reliance on systemic opioids. This was evident in the trials by Canbek et al., Shah et al., Elkassabany et al., Kim et al., and Tak et al. Opioid outcomes were not uniform in the studies. Turner et al. suggested that when multimodal analgesia is optimized or when SACB is potentiated with adjuvants, differences in

opioid use narrow, this explain why narrative synthesis favor CACB, while pooled meta-analyses found statistically nonsignificant differences for opioid consumption. Our findings support an opioid-sparing potential of CACB, but this benefit depend on the surrounding analgesic regimen and the timing of measurement rather than on the block technique alone (Canbek et al. 2019; Shah et al. 2015; Elkassabany et al. 2019; Kim et al. 2019; Tak et al. 2022; Turner et al. 2018).

The effect of block technique on functional recovery was more heterogeneous than its effect on pain. Some studies in our review indicate that CACB improved ambulation distance, range of motion, or early rehabilitation markers, and others found no significant difference in Timed Up and Go performance or related mobility outcomes. Postoperative mobility after TKA is multifactorial and affected by surgical technique, physiotherapy protocols, baseline functional status, concomitant analgesic methods, and discharge pathways. Once adequate analgesia is achieved with either technique, mobility gains become harder to show using short-term functional tests. This interpretation is consistent with the meta-analysis by Sercia et al., which found better 48-hour pain scores and improved quadriceps strength with CACB but no significant advantage in Timed Up and Go performance, and Hussain et al., did not support routine CACB for all patients despite the theoretical benefit of prolonged analgesia (Sercia et al. 2022; Hussain et al. 2023).

The studies differed in catheter regimen, infusion duration, local anesthetic concentration, use of adjuvants, comparator protocols, and associated multimodal analgesia, intravenous patient-controlled analgesia or IPACK block. Turner et al. used a CACB enhanced by multiple adjuvants, which prolonged analgesic duration and reduced the contrast with CACB infusion. Kim et al. 2022 compared CACB with PCA plus SACB within a retrospective setting, while Lyngeraa et al. studied repeated catheter boluses using different catheter systems rather than a simple SACB versus CACB design (Turner et al. 2018; Kim et al. 2022; Lyngeraa et al. 2019; Sercia et al. 2022; Hussain et al. 2023).

According to our findings CACB is useful when prolonged analgesia and early opioid reduction are targeted, especially in patients experience postoperative pain or in settings where 24 to 48 hour pain control is critical. SACB is a pragmatic option in fast-track programs, mainly when combined with optimized multimodal analgesia or enhanced SACB. This interpretation is more appropriate than routine preference for one technique in all TKA patients. The recent review by Hussain et al. reported fewer block related complications with SACB, which is weighed against the analgesic advantages of catheter based strategies. The choice between SACB and CACB should be individualized according to institutional workflow, catheter expertise, analgesic goals, and the enhanced recovery pathway (Hussain et al. 2023; Lee et al. 2018; Turner et al. 2018; Canbek et al. 2019).

The included original studies were heterogeneous, some had small sample sizes, outcome timing was inconsistent, and at least one included study used a retrospective design. Not all studies compared pure SACB and CACB under identical multimodal protocols, which complicates attribution of differences to the block technique. These limitations reduce indicate that future trials should standardize rescue analgesia, functional outcome

definitions, catheter protocols, and follow-up time points. The present review provides a clinically useful synthesis founding that CACB confer a more reliable advantage for pain control after the first postoperative day, whereas functional superiority is less certain and context dependent.

Conclusion

CACB provide sustained postoperative analgesia than SACB after TKA, mainly after the first 12–24 hours. In the nine included studies, CACB were more associated with lower pain scores, less breakthrough pain, and reduced opioid consumption. Functional outcomes were inconsistent, with some studies showing better ambulation or recovery and others showing no difference. CACB is good option when supported by multimodal analgesia or adjuvants. CACB offers analgesic benefit, while functional dominance still uncertain in current studies.

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