Comparison between adductor canal block and femoral nerve block for different knee surgical procedures. A meta-analysis of randomized trials

Enas Wageh Mahdy	extsuperscript{a}, Ahmed Mostafa Abd El-Hamid	extsuperscript{b} and Dina Hosny Elbarbary	extsuperscript{a}

	extsuperscript{a}Faculty of Medicine, Benha University, Benha; 	extsuperscript{b}Faculty of Medicine, Benha University, Elharam, Giza, Egypt

ABSTRACT

Background: Femoral nerve block (FNB) is a prevalent technique for analgesia following knee surgeries, but it also results in quadriceps weakness and greater chances of falling. Adductor canal block (ACB) is advertised as a motor nervesparing alternative to FNB.

Objectives: The aim of the study was to compare adductor canal block with femoral nerve block as regard different surgical procedures of the knee.

Study design: Meta-analysis was used to address this concern.

Sittings: Meta-analysis-based study following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Methods: The database MEDLINE, EMBASE, PubMed, and Cochrane were systematically searched to detect all published randomized and prospective clinical trials comparing adductor canal block with femoral nerve block as regard different surgical procedures of the knee in the last five years.

Results: Eighteen studies were identified for inclusion in this study, involving a total of 1457 patients. The risk of bias was low. Meta-analysis revealed that groups receiving femoral nerve blocks experience a significant decrease in pain scores and analgesic medication usage. However, adductor canal block groups have a significantly lower rate of quadriceps muscle weakness than FNB groups.

Conclusion: Femoral nerve block provides more analgesia and reduces analgesic consumption. On the other hand, adductor canal block, in the early postoperative period, preserves quadriceps function.

The diversity of surgical procedures available for the knee results in postoperative pain ranging from mild to severe. Numerous techniques for determining the best analgesics for these procedures have been used. The type and duration of surgical intervention, as well as the patient’s age, all influence the postoperative pain response. Thus, the anesthesiologist can select the most appropriate analgesic regimen for each patient during and after surgery [1]. Postoperative pain can impair early ambulation and length of stay in the hospital following knee surgeries. Postoperative pain that is not relieved can result in psychological and clinical changes that impair one’s quality of life [2]. Adequate analgesia with preservation of motor function became the primary goal following knee surgery. Numerous options, including regional analgesics (i.e., neuraxial and peripheral) and systemic analgesics (i.e., opioid and non-opioid), are present for postoperative pain management. Multimodal analgesia is achieved through the combination of several painkillers acting at various sites in the nervous system and via distinct mechanisms [3]. Numerous regional analgesic techniques were used to provide analgesia during and following knee surgery, particularly femoral nerve blockade (FNB). As regards postoperative pain management, FNB is a good choice [4,5]. However, FNB frequently results in quadriceps muscle motor blockade, which may postpone postoperative mobilization and increases the chances of falling [6]. The addition of an adductor canal block (ACB) is a relatively recent procedure. When compared to FNB, it causes a lesser reduction in quadriceps muscle strength [7,8]. ACB has been shown to be effective in clinical trials investigating its effectiveness in knee operations [9,10]. Additionally, several meta-analyses on the use of ACB in knee surgeries have been published [11–13]. Taking into account the anatomical evidence, we can suggest that ACB might be more advantageous than FNB. However, the results of previous studies that compared FNB and ACB did not entirely verify the previously mentioned evidence. Thus, the present study aimed to compare the clinical efficacy of ACB and FNB for analgesia following knee surgeries and comparing quadriceps muscular strength between two groups from the perspective of a systematic review with meta-analysis, which pooled outcomes with a small sample size into a larger sample size.
1. Methods
This study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [14].

2. Search strategy and selection criteria
MEDLINE, EMBASE, PubMed, and Cochrane were used to identify all published randomized and prospective clinical studies (between 2015 and 2020) comparing femoral nerve block and adductor canal block as regard various surgical procedures of the knee. The following search terms were used to identify relevant articles: “Femoral nerve block” and “Adductor canal block.” Studies were limited to human and English language studies. Reference lists of related articles were also reviewed. Institutional Review Board approval was not necessary for this study.

3. Exclusion criteria
Studies were excluded when their data were missing or inadequate, or if their authors were unavailable or did not respond when more data from their trials were requested, or if their results were considered unnecessary.

4. Data extraction
The first author, the year of publication, the study design, sample size, and setting of each included randomized trial, as well as any outcomes of interest, were extracted from the included trials. Pain score at 6, 12, 24, and 48 hours was the primary outcome of this research. Secondary outcomes included analgesia consumption and quadriceps muscle strength.

5. Quality assessment and bias risk
Using the Cochrane Collaboration’s approved risk of bias method, the quality of trials was assessed [15]. We estimated the following elements as high, unclear, or low: inadequate outcome data, selective reporting, random sequence generation, blinding, allocation concealment, and other bias. Disagreements were identified and handled by discussion.

6. Statistical analysis
We used Review Manager (RevMan), Version 5.3, Copenhagen (The Nordic Cochrane Centre, The Cochrane Collaboration, 2014) to aggregate the findings of studies comparing adductor canal block versus femoral nerve block for various knee surgery procedures. Pain scores at 6, 12, 24, and 48-hours post-operative were the primary comparison themes. Secondary comparison themes included analgesia consumption and quadriceps muscle strength. We assumed that the mean and median were equal in studies that reported only the interquartile range (IQR) for continuous measure outcomes. By dividing the IQR by 1.35, we obtained the standard deviation (SD) [16].

For studies reporting only the mean and the confidence interval (CI) to measure outcomes, we calculated the standard deviation from CI and sample size (N) according to the following equation described in Cochrane Handbook for Systematic Reviews of Interventions:

$$SD = \sqrt{N} \times (upper\ CI - lower\ CI) / (tinv .2t(1-\ CI,\ N-1) \times 2$$

Using the I2 statistic, heterogeneity was determined. Pooling findings were accomplished using random-effects models. For continuous outcomes, the mean difference (MD) and associated 95% confidence intervals were computed (CIs). Statistical significance was defined as a two-sided value α of 0.05, while clinical significance was interpreted with an emphasis on confidence intervals (CIs).

7. Results
7.1. Search results
Our search identified 153 studies through database searching and other sources. Of these articles, 57 were excluded after duplicates removal. There were 96 articles screened. After screening, 72 articles were eliminated, and 24 were judged for eligibility. Finally, 18 randomized controlled trials were included in the analysis, with the remaining being eliminated according to the PRISMA flow diagram (Figure 1).

8. Quality and characteristics of clinical studies included in the meta-analysis
Table 1 summarizes the studies involved in the analysis. Eighteen studies were identified for inclusion in this study, involving a total of 1457 patients. Of which 11 were RCTs [17–27]. All papers were published between 2015 and 2019 – the data extraction process was agreed upon by all reviewers.

Bias risk in the eighteen trials was assessed to be generally low (Figure 2a, b)).
9. Pain scores at 6, 12, 24, and 48 hours

The forest plot diagrams (Figure 3) showed that the FNB result in a significant decrease in pain scores. (Mean difference = −0.46 [0.37, 0.55]; 95% CI; I² = 90.9%; P = 0.00001)

10. Analgesia consumption

The forest plot demonstrates the significant decrease in consumption of analgesic drugs in FNB group (Mean difference = 0.84 [0.28, 1.41]; 95% CI; I² = 84%; P = 0.004) (Figure 4)
| Study ID et al. 2015 | Study design | N. of participants | Patients characteristics | Outcomes | Level of evidence |
|---------------------|--------------|---------------------|--------------------------|----------|------------------|
| Grevestad et al.    | Single center randomized, blinded, placebo-controlled study | Group ACB: N = 25 Group FNB: N = 25 | Unilateral TKA, VAS>60 mm, age: 30–85, ASA: I–III, BMI: 18–40 Kg/m² | Quadriceps MVC VAS | L1 |
| El Ahl et al. 2015  | Randomized, controlled, double-blind study | Group ACB: N = 64 Group FNB: N = 64 | ASA I or II, aged 18–45, body mass index >35 | VAS scale Muscle weakness Total morphine requirements | L1 |
| Memtsoudis et al.   | Randomized, controlled, double-blind study | Group ACB: N = 59 Group FNB: N = 59 | Muscle weakness Total morphine requirements | L1 |
| Tan et al. 2015     | Randomized controlled, blind trial | ACB: N = 40 Group FNB: N = 40 | Quadriceps muscle strength Timed Up and Go (TUG) test The quality of recovery | L1 |
| Abdallah et al. 2016 | A randomized, double-blind study | Group ACB: N = 52 Group FNB: N = 48 | Adult patients aged 18 to 50 yr., with ASA I to II and body mass index <35 kg/m² | Morphine requirement VAS score Muscle strength | L2 |
| Nabil M et al. 2016  | Randomized Controlled, double-blind trial | Group ACB: N = 31 Group FNB: N = 31 | Patients undergoing primary unilateral total knee arthroplasty | Pain scores sensory recovery Motor strength Opioids consumption | L1 |
| Wesmann et al. 2016 | a blinded and randomized trial | Group ACB: N = 21 Group FNB: N = 21 | Age: 50–80 yrs., ASA I–III | Time to 1st analgesic request | L2 |
| Rahimzadeh et al. 2017 | Prospective, randomized, double-blinded clinical trial | Group ACB: N = 46 Group FNB: N = 46 | Ages 15–70 years old and with the ASA I and II were | The quality of recovery | L2 |
| Thobhani et al. 2017 | Randomized, blind | Group ACB: N = 22 Group FNB: N = 23 | Patients scheduled for total knee arthroplasty | Pain scores Opioid consumption Performance during physical therapy Hospital length of stay | L2 |
| Ghodki et al. 2018 | Randomized, Blind | Group ACB: N = 30 Group FNB: N = 30 | ASA I and II, Age 25–35 yrs. Body mass index between18 and 35 | Quadriceps muscle strength Numeric rating scale Patient satisfaction score Time of rescue analgesia Total analgesic consumption | L2 |
| Runner et al. 2018 | Prospective, Single-Blinded, Randomized Trial | Group ACB: N = 38 Group FNB: N = 35 | Patients were <18 years of age undergoing ACL reconstruction | MS Strength Complications | L1 |
### Table 1. (Continued).

| Study ID         | Study design                                                                 | N0. of participants | Patients characteristics                                                                 | Outcomes                                                                                     | Level of evidence |
|------------------|------------------------------------------------------------------------------|---------------------|------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|-------------------|
| Tan et al. 2018  | Double-blind, prospective, randomized, and controlled trial.                | Group ACB: N = 100  | Primary unilateral TKA for OA or RA                                                        | VAS score Total opioid consumption Length of stay Patient satisfaction score PONV              | L1                |
|                  |                                                                               | Group FNB: N = 100  |                                                                          |                                                                                               |                   |
| Borys et al. 2019| A randomized, double-blind, controlled trial.                               | Group ACB: N = 50   | Age >18 and <75 years                                                                   | Morphone consumption Visual analogue scale Degree of knee extension Quadriceps muscle strength | L1                |
|                  |                                                                               | Group FNB: N = 50   |                                                                          |                                                                                               |                   |
| Kukreja et al. 2019| Randomized Controlled Trial                                                    | Group ACB: N = 43   | Age > 18 No existing neurologic or anatomic deficit in the operative limb                 | Visual analogue pain scores Morphone Consumption Post-operative ambulation Patient satisfaction | L1                |
|                  |                                                                               | Group FCB: N = 41   |                                                                          |                                                                                               |                   |
| Lim et al. 2019  | A prospective, double-blinded, randomized controlled trial.                 | Group ACB: N = 15   | 45: 85 years old                                                                       | Morphine consumption Numeric rating scale Quadriceps strength                                  | L1                |
|                  |                                                                               | Group FNB: N = 15   |                                                                          |                                                                                               |                   |
| Lynch et al. 2019| A prospective, double-blinded, randomized controlled trial.                 | Group ACB: N = 29   | Age > 16 years Undergoing primary or revision ACL reconstruction                         | Visual analogue scale Narcotic requirements Ability to perform a straight leg raise Circumference between the operative and nonoperative leg | L1                |
|                  |                                                                               | Group FNB: N = 30   |                                                                          |                                                                                               |                   |
| Bailey et al. 2019| Randomized controlled trial                                                  | Group ACB: N = 40   |                                                                                         | Opioid consumption MS strength Range of movement Complications                                | L1                |
|                  |                                                                               | Group FNB: N = 38   |                                                                          |                                                                                               |                   |
| Seangleular et al. 2019 [37] | A blinded, randomized, non-inferiority trial                            | Group ACB: N = 28   | Patients undergoing ACLR with the hamstring graft                                        | VAS/opioid/ strength/complications                                                            | L1                |
|                  |                                                                               | Group FNB: N = 28   |                                                                          |                                                                                               |                   |

ACB; adductor canal block  
FNB; femoral nerve block  
TKA; Total knee Arthroplasty  
VAS; Visual analogue scale  
ASA; physical status classification of American Society of Anesthesiologists  
ACL; Anterior cruciate ligament  
ACLR; Anterior cruciate ligament reconstruction  
MIVC; Maximum voluntary isometric contraction  
PONV; Post-operative nausea and vomiting  
NRS; Numeric rating scale  
SAS Modified sedation-agitation scale
Figure 2. (a) Risk of bias graph, (b) Risk of bias summary.
Figure 2. Continued.

Figure 3. Pain scores.
11. Quadriceps muscle strength

Although most of the included studies favor significantly less quadriceps muscle weakness in ACB groups than those in FNB groups, the meta-analysis was unable to be conducted since the majority of these research employed different techniques for comparing muscular strength between groups. This heterogeneity of data impedes the analysis of this outcome.

12. Discussion

Almost all knee surgeries result in moderate-to-severe postoperative pain, making sufficient analgesia critical for postoperative analgesia and early mobility while preserving motor function, which is required for fast recovery. FNB offers adequate postoperative analgesia but decreases the quadriceps muscle strength and raises the chances of falling following surgery. ACB is better due to its ability to preserve motor function while providing sufficient analgesia. So, this research was conducted to determine if ACB was superior to FNB in terms of muscular strength, pain management, and side effects. ACB is an excellent alternative to FNB in post-knee surgeries, as demonstrated by the meta-analysis of RCTs. This meta-analysis assessed pain VAS scores throughout a broader range of follow-up times (e.g., post-anesthesia, 2, 4, 6–8, 12, 24, 48, and 72 h). Comparisons of pain scores between ACB and FNB indicate that ACB has a substantially same analgesic effect as FNB. In this analysis, we included RCTs that assessed pain scores at various time periods. Based on the results of 18 trials, ACB and FNB showed no significant difference in pain scores at 6 hours and 12 hours. At 24 and 48 hours, the FNB resulted in a significant decrease in pain scores. In this study, we found that five studies showed that FNB is better than ACB in pain control as there is a decrease in VAS at 8,24,48 h in FNB than ACB [18,22,23,28,29]. Other studies included in this meta-analysis suggest that no significant difference in analgesic effect between FNB&ACB in postoperative 24,48 h or at knee flexion [20,24,25,30]. The two groups showed no significant difference in pain scores in a meta-analysis done by Min et al. [31].

On the other hand, a trial done by Lynch et al. [26] showed that the ACB had less VAS at 4 hours postoperative and less opioid consumption than FNB. We found in our meta-analysis that there is a decrease in consumption of analgesic drugs in the FNB group than ACB group. Still, there is no significant difference in opioid associated adverse effects, but [26,31] found that, between the two groups, no significant differences in opioid consumption or side effect was found. The present debate over quadriceps strength recovery focuses on whether ACB may generate results that are superior to or comparable to those obtained with FNB. After evaluating the included research, we concluded that this disagreement most likely arises from the fact that separate studies used different scales or assessment systems. We just reported the outcomes due to the fact that the data were not accessible for meta-analysis.

Mobility ability is an indicator for muscular strength recovery, and the majority of the trials included in this meta-analysis found that patients who received ACB showed superior results in terms of mobilization abilities. Additionally, there is greater conservation of quadriceps muscular strength than with FNB. Early ambulation has been found to reduce deep venous thrombosis (DVT), improve muscular strength, and shorten hospital stays. The length of hospital stay has a direct correlation with postoperative problems. However, our meta-analysis revealed no statistically significant difference between the two groups regarding the length of hospital stay because multiple variables, including body mass index, age, and physiological state, might influence the length of stay in the hospital.

Regarding ACB &FNB, no significant difference in the Quadriceps strength or functional recovery was found by Lim et al. [25], Wiesmann et al. [32], and Xin et al. [33].
Edwards et al. [34] meta-analysis which done by eight randomized controlled trials on and gets data from 655 patient suggest that ACB preserve the quadriceps muscle function only in the early postoperative period.

13. Limitations

There are several limitations of this study due to limited long-term follow-up and using different functional measures. We reasoned that this disagreement might have been triggered by the use of various time points for evaluation. The number of trials included and the sample size of these trials were limited, which may have introduced bias. Also, heterogeneity among studies in reporting quadriceps muscle strength variable made uniform comparison difficult. To decide whether ACB provides superior functional recovery compared with FNB, further studies are required.

14. Conclusion

FNB results in better analgesia and less analgesic consumption than

Disclosure statement

The authors declare that they have no conflicts of interest. This work was not subject to ethical review. The findings provided in this paper have not been previously published in their entirety or in part.

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