Adductor canal block in outpatient clinic for pain control after knee arthroplasty: A randomized controlled, clinical trial

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Abstract

Background: Successful total knee replacement surgery is influenced by surgery and rehabilitation program. We hypothesized the adductor canal block (ACB) in the outpatient clinic is safe, effective for pain relief and decreases analgesic consumption compared with controls.

Methods: a paired, randomized controlled trial. The intervention group received ACB with 15 mL mixture of ropivacaine 0.2% with isotonic saline and steroids on post-operative day 14 (POD-14) at the outpatient clinic, the control group received daily consumption of analgesic. We evaluated Visual Analog Score (VAS) pain score, and analgesic consumption.

Results: 35 subjects for each group. In the ACB group, mean of age was 66.42 years old, mean of BMI was 25.87. The control group, mean of age was 64.11 years old, mean of BMI was 25.95. There were significantly different mean VAS scores of both groups and analgesic consumption of both groups on POD 15th, 17th and 19th (p = 0.00, 0.000 and 0.001, respectively). Two patients complained about hematoma in their thigh (insertion needle) and recovered.

Conclusions: Single-shot ACB in the outpatient clinic is safe, significantly decreased pain and analgesic consumption and may enhance the rehabilitation program.

Keywords
adductor canal block, knee surgery, outpatient clinic, randomized controlled trials

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Introduction

Total knee arthroplasty (TKA) is one of the most common musculoskeletal procedures in the United States, with approximately 719,000 procedures performed each year. The incidence of TKA is expected to grow in the future, reaching an estimated 3.48 million by 2030, due to the predicted rises in population size and longevity. As a result, perfecting the surgical technique for TKA is essential.1

Following knee procedures such as arthroplasty, quadriceps weakness is common. The cause of muscle weakness is still unclear, but it may be related to the distal quadriceps’ incision made during knee joint opening. This disability can be avoided with early rehabilitation and quadriceps strengthening. Previously, femoral nerve block was the most common knee surgery procedure. Femoral nerve blocks can help with postoperative pain, but they can also decrease quadriceps muscle strength leading to delays in mobilization and recovery. Since it retains muscle strength, allows for early ambulation and mobilization, and requires a shorter hospital stay, the adductor canal block (ACB), a novel nerve block, has recently become more common for pain relief after knee surgery.2,3

Many recent studies have found that ACB is effective at controlling pain while causing minimal muscle weakness. The saphenous nerve, which is the main sensory branch of the femoral nerve, as well as the medial femoral cutaneous nerve and articular branches of the obturator nerve, are all blocked in this procedure. As a consequence, the only motor nerve that ACB affects is the nerve that leads to the vastus medialis. This technique focuses on the sensory nerves while preserving muscle strength. The ACB substantially decreased postoperative pain, reduced opioid consumption, and increased rehabilitation program results in patients who underwent primary TKA.2,3

In general, ACB is conducted in the operating room following surgery, and there is limited literature on the procedure when performed in an outpatient clinic. We did ACB at 2 weeks post-operative for the following reasons: 1) The surgical wound had healed, and 2) the patient had begun an intensive rehabilitation program. In contrast to the controls, we hypothesized that the ACB in the outpatient clinic is safe and can minimize postoperative pain. The primary goal of this research was to see how ACB affected the Visual Analog Score (VAS) pain score during the rehabilitation as opposed to controls. The secondary goal was to determine how much analgesic (etoricoxibe) was consumed on a daily basis.

Methods

Ethics statement

This prospective, blinded, randomized controlled trial was approved by the local Regional Ethics Committee (KE/FK/0554EC/020) and registered in ClinicalTrials.gov with identifying number: ClinicalTrials.gov ID: NCT04883034. We enrolled patients scheduled for TKA between 1 August 2019 and 30 June 2020 after obtaining written informed consent. The Consolidated Standards of Reporting Trials (CONSORT) statement was used to present the data. Qualified patients were adults between the ages of 60 and 85 who were scheduled for TKA and had an American Society of Anesthesiologists physical status I–III and a body mass index (BMI) of 18–40 kg/m². Patients who declined to complete the study, were unable to cooperate, had an allergic reaction to any of the drugs used in the study, and/or were abusing alcohol or drugs were all excluded.

Randomization

Using computer software (Excel 2010; Microsoft, Redmond, WA), an independent operator who was not otherwise involved in the trial created randomized numbers ranging from 0 to 99. The generated randomized number was allocated to each patient who was included in the study. Patients who were assigned an even number were assigned to the ACB group, and those who were assigned an odd number were assigned to the control group.

Interventions. On postoperative day 14 (POD 14), the ACB was performed for group A (ACB). A curved ultrasound transducer (Philips Epic 7) was set on the medial aspect of the mid-thigh after skin disinfection. In the adductor canal, below the sartorius muscle, the femoral artery and vein were ensured using a short axis plane. From the lateral side of the transducer, a Sonoplex needle 21G x 100 mm (Pajunk Medical Systems LP, USA) was inserted in plane. The needle tip was positioned under the sartorius muscle, entering the fascia just lateral to the femoral artery and vein, and 1–2 ml of saline was used to confirm the correct location (confirmed by the enlarged adductor canal), then local anesthesia agent (ropivacaine) was slowly injected, and the enlarged adductor canal was confirmed on the ultrasonography monitor once more.

In a 1:1:1 ratio, both participants received 15 mL of ropivacaine 0.2% combined with isotonic saline and steroid. All blocks were performed by one orthopedic surgeon (RTM), who had prior experience in pain intervention guided by ultrasonography, with the aid of orthopedic residents and nurses. Patients who took analgesic drugs (etoricoxibe) on a daily basis continued to take them throughout the study and were allowed to increase their dosage if they still had pain until they hit the maximum prescribed dose. Patients in group B (the control group) were given analgesic (etoricoxibe) on a daily basis, with the option to increase the dose if pain persisted, up to a maximum of 120 mg per day.
**Outcomes**

On POD 5, we measured the VAS of pain during the knee rehabilitation program, at every 2 days until POD 29. Regular analgesic (etoricoxibe) intake doses were used as a secondary endpoint.

**Assessment of outcomes**

From POD 5 to POD 29, we analyzed the findings every 2 days. A VAS scale was used to assess pain severity, with 0 indicating no pain and 10 indicating extreme pain. During the study period, analgesics (etoricoxibe) were continued as usual and allowed to be increased until the maximum prescribed dose was reached.

**Statistical analysis**

SPSS 18 (SPSS, Chicago, IL, USA) was used to conduct statistical analysis based on the intention to treat principle. The mean and standard deviation (SD) were used to present the results. The Kolmogorov–Smirnov test was used to determine whether or not the distribution of data was normal. The area under the curve (AUC) was used to measure the pain scores from VAS during knee flexion and at rest. The independent samples t-test was used to assess overall analgesic intake and VAS-pain scores. The hypothesis testing was two-tailed, and \( p < 0.05 \) was considered statistically significant. All statistical work was done by the investigators.

**Results**

During the research period, 70 patients agreed to participate and signed informed consent documents. Table 1 displays the demographics and perioperative details of the patients. With 35 patients in the ACB group, the average age was 66.42 years old, the average BMI was 25.87, and the majority of the subjects were female (51.4%). The 35 patients in the control group had a mean age of 64.11 years, a mean BMI of 25.95, the majority of the participants were female, with 21 female patients in total (60%) (see CONSORT flow diagram, Figure 1).

**Mean VAS pain score**

On the 15th, 17th and 19th day, there were significant differences in mean of VAS scores between the two study groups (\( p \) values: 0.00, 0.00 and 0.009, respectively) (see Figure 2 and Table 2).

**Analgesics (Etoricoxibe) consumption**

There were significant differences of mean analgesic (etoricoxibe) consumption of both groups on days 15th, 17th and 19th (\( p \) values: 0.00, 0.00 and 0.001, respectively) (see Figure 3 and Table 3).

**Adverse events**

Two patients complained of a hematoma in their thigh (insertion site) but have since healed fully.

**Discussion**

The study’s most notable results were that ACB is safe to conduct in an outpatient clinic and can significantly reduce pain, making it useful in rehabilitation. According to our findings, injection of ropivacaine 0.1% (15 mL) was confirmed to fill in the distal of the adductor canal, raising the optimal effect of the ACB with blocking of the four nerves in the adductor canal. Since the total amount injected in our study was less than 20 mL, we were able to prevent spreading to the proximal canal and femoral triangle. According to a previous study, the spread to the proximal to femoral triangle requires more than 20 mL of injection volume.

Another study showed that volumes greater than 20 mL are not needed for an adductor canal block, as the success rate for the 15 mL dose was almost identical to the 20 mL dose injection (90.2%) (95.1%). Even though there was no statistically significant difference between volumes and the number of subjects with quadriceps weakening in another study, ACB over 20 mL was found to cause a decrease in muscle strength. With a dosage of less than 20 mL at mid-thigh, the ACB is almost entirely sensory blocked, with the vastus medialis being the only muscle that has its motor functions affected. Our findings indicate that the blockade can significantly reduce pain, promote early ambulation, and enhance rehabilitation program outcomes. According to other studies, one of the key benefits of the ACB technique over other procedures is the preservation of quadriceps muscle strength. Future research could provide a comparison of the quadriceps muscle’s strength and function to other pain intervention techniques. Since quadriceps strength is critical for maintaining a patient’s balance and gait, it has been suggested that weakness in this muscle increases the risk of falling.

| Table 1. Subjects’ characteristics. |
|-----------------------------------|
| No. Subjects | ACB group | Control group |
| Age, y | 66.42 (56–82) | 64.11 (58–75) |
| Body mass index, kg/m² | 25.87 (22–31) | 25.95 (22–30) |
| Sex, M/F | 17/18 | 14/21 |
This procedure is safe to perform in an outpatient clinic, and only two patients (5.7%) developed hematomas as a result of the procedure, which were resolved quickly. After ACB, Koniuch et al. confirmed a large thigh hematoma in a morbidly obese woman with a history of anticoagulation drug use (apixaban). According to the author, a conservative method of close supervision would have yielded a satisfactory result without the need for additional procedures.

Despite the fact that vascular injuries from peripheral nerve blocks are an uncommon complication, the risk of bleeding due to anticoagulation status was a concern. The American Society of Regional Anesthesia (ASRA) recommendations, which were recently revised (2018), suggest waiting 72 h after the last dose of anticoagulant before performing a block procedure. In our study, the patient was already taking anticoagulant drugs within the last 72 h in the case of a complication, and the hematoma was recovered within a few days with a cautious approach and stopping the anticoagulant drug intake.

Figure 2 indicates that the ACB group had significantly less pain on POD 15, 17, and 19 compared to the control group. The pain increased gradually after the operation and was almost equal in both groups by POD 19. A single shot
of ACB, according to Ludwigson et al., will improve postoperative ambulation and knee flexion. It also reduced the 2-day period of pain found in this study.\textsuperscript{13}

Figure 3 shows that after the treatment, analgesic drug (etoricoxibe) intake decreased, with significant differences between the two groups in POD 15, 17, and 19. After POD 19, analgesic drug intake gradually increased and remained nearly constant in both groups after POD 19. Jæger et al. compared ACB to placebo in terms of morphine intake and found no substantial difference between the two classes.

There were some limitations to our research. First, since the number of samples in this single-centered analysis was limited, the findings cannot be generalized. Second, the patients were aware of whether they received the ACB and oral analgesic or just the oral analgesic, which may cause bias to the results. Third, we only assessed VAS when in flexion, not at rest. The ambulation ability test and patient-reported outcomes were also not evaluated. Therefore, we could not evaluate whether VAS improved with the functional outcome. Still, we expected that pain improvement might improve the rehabilitation program outcomes. Fourth, there is no gold standard for single ACB dose. We used 15 mL of ropivacaine 0.2%, isotonic saline, and steroid in a 1:1:1 ratio in this study. According to our study, if the patient was still in pain after the first ACB block and needed improvements in the rehabilitation program, we may repeat the ACB block 1 week after. The strength of our study is that there are still very few studies that evaluate the effectiveness of ACB in an outpatient clinic setting. In the future, we plan to conduct a multi-centered prospective study and compare our findings to other pain intervention procedures.

Conclusions

Single-shot ACB in the outpatient clinic is safe, can reduce pain and analgesic use significantly, and may enhance rehabilitation.

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Author contributions

SR, FAR, MAR, ILG, and NCB concepted and designed this study, SR, FAR and MAR analysised and interpretated of the data; SR, ILG and NCB the drafted of the paper, SR, FAR, MAR and NCB revised it critically for intellectual content; SR, FAR, MAR, ILG, and NCB finalized approval of the version to be published; and that all authors agree to be accountable for all aspects of the work

Declaration of conflicting interests

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Ethical approval

The study was approved by the local Regional Ethics Committee (KE/FK/0554EC/020).

Guarantor

Sholahuddin Rhatomy is the guarantor and accepts full responsibility.

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| Day | ACB group | Control group | p Value |
|-----|-----------|---------------|---------|
| 5   | 114.86    | 113.14        | 0.071   |
| 7   | 91.71     | 93.42         | 0.065   |
| 9   | 85.71     | 88.28         | 0.165   |
| 15  | 28.20     | 83.14         | 0.000   |
| 17  | 53.14     | 80.57         | 0.000   |
| 19  | 54.00     | 79.71         | 0.001   |
| 21  | 81.42     | 81.42         | 1.000   |
| 23  | 80.57     | 82.28         | 0.072   |
| 25  | 77.14     | 78.00         | 0.329   |
| 27  | 64.28     | 65.14         | 0.277   |
| 29  | 63.42     | 64.28         | 0.395   |

Figure 3. Analgesics consumption.

Table 3. Analgesic dose consumption.
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