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The Effect of Femoral Nerve Block and Adductor Canal Block Methods on Patient Satisfaction in Unilateral Knee Arthroplasty: Randomized Non-Inferiority Trial

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Abstract

Introduction: Femoral Nerve Block (FNB) and Adductor Canal Block (ACB) methods, which are regional analgesic techniques, are successfully used in postoperative pain control after total knee arthroplasty. This study aimed to compare adductor canal block method that was preoperatively used and femoral nerve block method in total knee arthroplasty (TKA) patients who underwent spinal anesthesia in terms of factors effecting patient satisfaction and determine whether these methods were equally effective or not. **Methods:** A total of 80 patients between the ages of 60 and 75 who were in the American Society of Anesthesia (ASA) physical status of I-III were prospectively included in this randomized study. Patients ($n = 40$) who received FNB were called Group FNB and patients ($n = 40$) who received Adductor Canal Block were called Group ACB. **Results:** Although mean postoperative VAS values were lower in FNB group only in the first hour ($p = 0.02$) there was no significant difference between the groups in the third, fifth, seventh, ninth, 12th and 24th hours ($p \geq 0.05$). Although Bromage scores were lower in FNB group in the first, second, third, fourth and fifth hours there was no statistically significant difference between the groups ($p \geq 0.05$). When mobilization time, patient satisfaction level, time of first analgesia, intraoperative sedation need, and recovery time of sensorial block were compared no statistically significant difference was found ($p \geq 0.05$). **Discussion:** When ACB and FNB that are used for postoperative analgesia in patients who undergo total knee arthroplasty are compared in terms of factors affecting patient satisfaction it is observed that they result in the same level (non-inferiority) of patient satisfaction. **Conclusion:** We recommend the routine use of ACB method with FNB in total knee arthroplasty. More studies focusing especially on measuring patient satisfaction are needed.

Keywords

femoral nerve block, adductor canal block, KNEE ARTHROPLASTY, postoperative pain, patient satisfaction

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Introduction

Control of postoperative pain in total knee arthroplasty involves problems that are still discussed. A sufficient time of pain control after TKA is a must for early mobilization, postoperative functional improvement and an optimal rehabilitation in patients.[1,2]

Not relieving the postoperative pain enough after TKA can delay the processes necessary for recovery of the patient.[3] Not being able to relieve the postoperative pain negatively affects patient satisfaction, reduces quality of life and may cause increase in the risk of permanent chronic pain.[4]

Recently, several postoperative pain control strategies including peripheral nerve blocks, epidural analgesia, local infiltration analgesia (LIA) and systemic opioids have been used to control pain after TKA.[5]

Generally, femoral nerve block (FNB) that is used as one of the preferred methods nowadays blocks femoral nerve, lateral

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femoral cutaneous nerve and obturator nerve and reduces postoperative pain. However, it should be kept in mind that FNB may not be effective enough in control of pain on popliteal area.[6] Adductor canal block (ACB) blocks the saphenous nerve which is a component of adductor canal and the largest sensory branch of femoral nerve in the knee.[7]

In the management of postoperative pain in TKA patients, multimodal analgesic methods combining the neural and peripheral nerve blockade techniques such as femoral nerve blocks have recently become important as the leading contemporary strategies.[8,9] Although femoral nerve blocks have high analgesic and opioid protective effects they are also associated with quadriceps injury that may cause delayed functional mobilization and increase in the risk of falling.[10]

Adductor canal block (ACB) which is a regional analgesic technique is successfully used in postoperative pain control after knee surgery.[11] It has been asserted that a similar postoperative analgesic effect can be obtained with adductor canal block and femoral nerve block, but rehabilitation can be started earlier in patients who receive ACB compared to the patients who receive FNB.[12]

Similarly, when ACB and FNB were compared in 93 patients who underwent TKA it was revealed that quadriceps strength was relatively preserved in 6-8-hour postanesthetic period.[13]

When compared with FNB, ACB has been asserted to have the same pain control and early ambulation after TKA and reduces postoperative nausea. Therefore, ACB may have the potential to change the gold standard of FNB in pain management for patients who undergo TKA.[14]

Although femoral nerve block and adductor canal block methods have been compared in various studies in terms of some features studies comparing these methods in terms of many factors are needed.

Primary aim of our study was to compare adductor canal block and femoral nerve block that were used for postoperative analgesia after total knee arthroplasty in terms of pain scores and first analgesic need and secondary aim was to assess them in terms of the recovery times of motor block and sensory block and mobilization time and determine whether they had similar effects on patient satisfaction.

Methods

After approval of the study by Clinical Research Ethics Committee (2019/44), a total of 90 patients between the ages of 60 and 65 who were in American Society of Anesthesia physical status (ASA) I-III and who were hospitalized in the Orthopedics and Traumatology Clinic for total knee arthroplasty were prospectively included in this randomized study. Four patients were excluded from the study due to various reasons and the study was performed with 86 patients. The whole study was performed in accordance with the principles of Helsinki Declaration. Patients were selected with single-blind and closed-envelope methods the day before, all the patients were informed about the study design in detail and their informed consents were obtained. Patients were assigned to the groups by the anesthesia technician in charge in the preoperative preparation room and the orthopedist, traumatologist and patients did not know anything about the groups and assignments until the end of the study. The anesthesiologist and reanimation specialist learned the details during application. During the study, 6 patients were excluded from the study due to the other reasons and data of 80 patients were statistically analyzed (Figure 1).

The orthopedists who performed TKA were not included in postoperative follow-ups of the patients. Midazolam (0.02 mg/kg) (Roche, Switzerland) was injected to all patients 30 minutes before block administration. Electrocardiogram (ECG), pulse rate and peripheral oxygen saturation (SpO2) of the patients were monitored in pre-anesthesia preparation room. Hydration was nasally administered with 2 lit/min of O2 and 5 ml/h of 0.9% NaCl. Patients who received Femoral Nerve Block (FNB) were called Group FNB and patients who received Adductor Canal Block (ACB) were called Group ACB.

Patients in whom peripheral nerve block was contraindicated (coagulopathy, infection), pregnant women, patients with a neuropathic disorder including the surgical area, patients with diabetes mellitus and morbid obesity (body mass index > 40 kg/m2) and patients who were hypersensitive to local anesthetic agents were not included in the study.

In FNB group, anterior skin surface was aseptically sterilized and skin anesthesia was performed with 1% lidocaine. The inguinal region was scanned by a high-resolution transducer frequency linear probe of 5-10 MHz (Sonosite, probe), the femoral nerve was screened in the lateral where femoral artery/vein would be localized and the nerve stimulator needle was placed between the 2 layers of fascia iliaca with in-plane technique. As a secondary target, ipsilateral quadriceps contraction (patellar motion) was obtained by a stimulation at 0.5 mA with nerve stimulator. Then, the stimulation was decreased to 0.3 mA and it was observed that there was no muscle contraction. Ideal position of the needle was assured and after negative aspiration, local anesthetic solution involving 10 ml of 0.5% Bupivacaine, 10 ml of 2% Lidocaine and 2.5 mcg/ml adrenaline was administered with an immobilized stimulator needle. The spread of local anesthesia was visualized during injection and screened by ultrasound. In ACB group, the region was scanned by a high-resolution transducer frequency linear probe of 5-10 MHz (Sonosite, probe), the saphenous nerve between vastus medialis and sartorius muscle in the lateral superficial femoral artery was detected in the medial compartment of the thigh and after ultrasound probe was detected in in-plane position and anterior skin surface was aseptically sterilized skin anesthesia was performed with 1% lidocaine. Then, the ideal position of the nerve stimulator needle was assured with ultrasound probe and local anesthetic solution involving 10 ml of 0.5% Bupivacaine, 10 ml of 2% Lidocaine and 2.5 mcg/ml adrenaline was injected around saphenous nerve (Figure 2).

After administration, patients were brought to the operating room and placed in sitting position on the operating table.

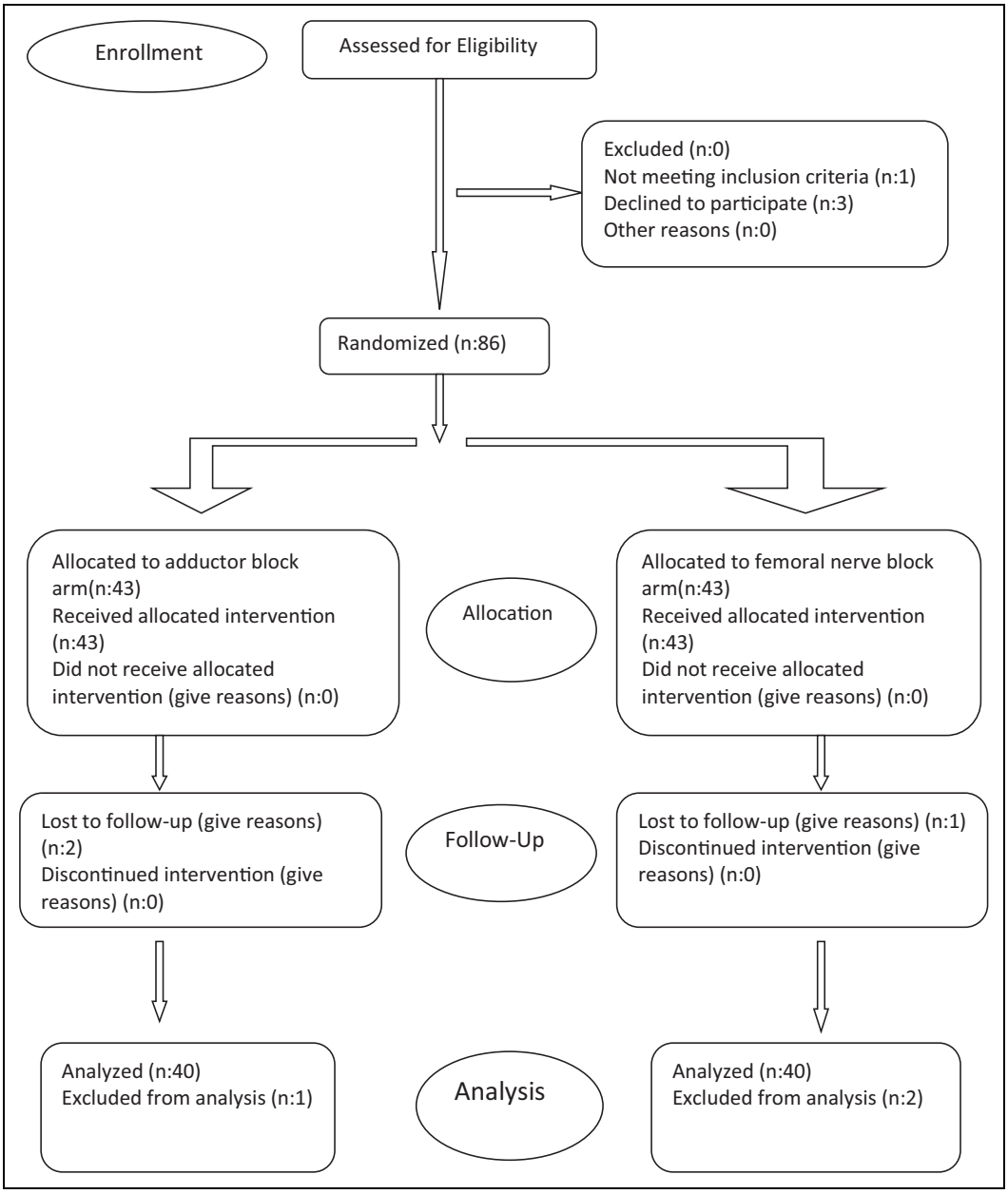

Figure 1. CONSORT 2010 flow diagram.

Then, 4 mL of 0.5% levobupivacaine was injected in 30 seconds to the subarachnoid space by a 25-gauge spinal needle (Egemen, Turkey) under sterile conditions. The patient was placed in spine position just after the spinal block and after it was assured by pin-prick test that the sensory block reached T10 dermatome level the intervention was initiated. Patients who did not have sufficient sensory block for the intervention after 10 minutes were recorded and excluded from the study and received an additional anesthesia method. Patients were brought to the recovery room in postoperative period and then, they were transferred to the ward.

Recovery time of sensory block (the feeling of being able to differentiate cold and hot on patella in 30-minute periods) and recovery time of motor block (Bromage score measured in time) were measured in all the patients during postoperative follow-ups. Bromage scores were scored as follows: 1 = unable to move feet or knee, 2 = able to move feet only, 3 = able to move feet and knee and 4 = full flexion of knee and feet.[15] It was aimed to assess the effect of femoral and adductor nerve block on recovery of motor block after spinal anesthesia. Postoperative analgesia need, time of first analgesia, mobilization time (standing up and walking for at least 5 meters starting from the postoperative 16th hour), patient satisfaction score and complications were recorded. When patients had VAS score of 4 and above in postoperative period 75 mg of diclofenac was administered for rescue

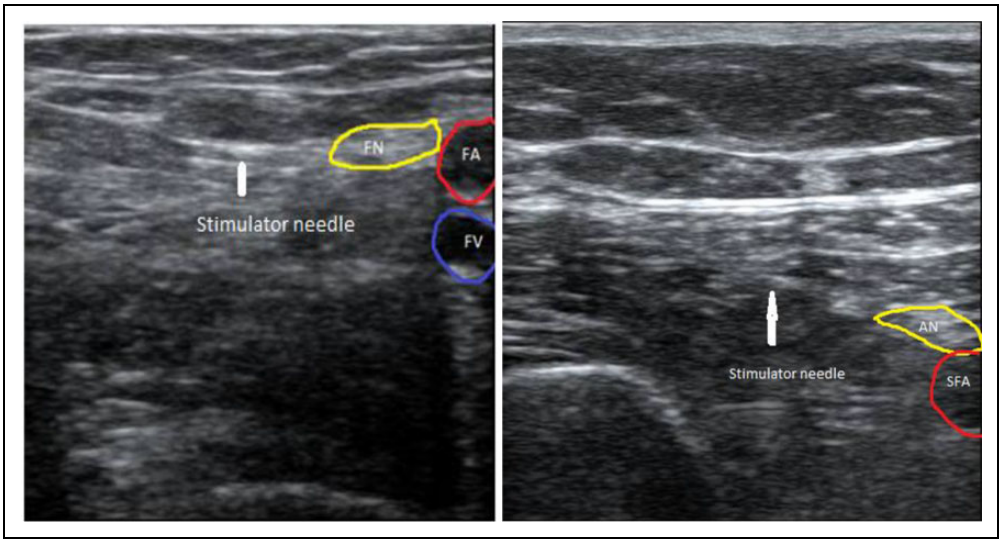

Figure 2. Femoral nerve and adductor nerve—ultrasound image.

analgesia. For patients who still had pain, 5 mg of morphine was administered.

In order to measure patient satisfaction: During discharge, patients were questioned about their satisfaction levels on the procedure performed for analgesia. The assessment was as follows: I am very satisfied:4; I am satisfied:3; I am not satisfied:2; I am not satisfied at all:1

Statistical Analysis

Statistical analyses were performed on "SPSS for Windows version 22.0" software program. Numerical variables were expressed as mean ± standard values. Whether numerical variables were normally distributed or not was assessed with Kolmogorov Smirnov test. T test was used in comparison of normally distributed variables in independent groups. Mann-Whitney U-test was used for non-normally distributed variables. Changes in blood pressure, pulse rate and SpO2 values among the groups were assessed with variance analysis in repeated measurements. Chi-square test and Fisher's exact test were used in the assessment of statistical significance between categorical variables. Significance level was accepted as $p < 0.05$.

G power test was used in determining the sample size. Based on the study "Rehabilitation Outcomes for Total Knee Arthroplasties: Continuous Adductor Canal Block Versus Continuous Femoral Nerve Block" by Patrick Brennan et al., while probability of Type 1 error was calculated as 0.05, statistical power of the test as 0.95 and effect size as 0.8 the required minimum sample size in both groups was calculated as 82 in equal groups.

Results

There was no statistically significant difference between the groups in terms of demographic data. No statistically significant difference was found between the groups in terms of ASA scores. No statistically significant difference was found between the groups in terms of intraoperative mean blood pressure, pulse rate and SpO2 values in either group ($p \geq 0.05$) (Table 1).

Table 1. Distribution of Demographic Features of the Groups.

	GROUP (FNB)	GROUP (ACB)	p
Age[a]	66.0 ± 1.4	64.4 ± 1.7	0.492
Height[a](cm)	158.9 ± 1.1	159.4 ± 1.1	0.758
Male/female[c]	8/32	10/30	0.592
Weight[a](kg)	83,4 ± 2.4	85.8 ± 2.2	0.383
MAP[b](mm/hg)	100.0 ± 2.4	106.9 ± 2.3	0.457
PULSE[a]	74.7 ± 1.8	80.4 ± 2.1	0.432
ASA[c](I/II/III)	8/21/12	7/22/11	0.590
SPO2[b](%)	94.4 ± 0	94.2 ± 0	0,907

Data presented as mean SD or number of patients (%). [a]Student-T test. [b]Mann–Whitney U-test. [c]Pearson's 2–test. [d]Fisher's exact test.
Statistically significant between-group differences ($P < 0.05$) *.
ASA, American Society of Anesthesiologists.
f = female, m = male.

Although postoperative mean VAS values were statistically significantly lower in FNB group only in the first hour ($p = 0.02$) (Figure 3) there was no significant difference between the groups in the third, fifth, seventh, ninth, 12th and 24th hours ($p \geq 0.05$) (Table 2).

Although postoperative Bromage scores were lower in FNB group in the first, second, third, fourth and fifth hours (Figure 4) this difference was not statistically significant between the groups ($p \geq 0.05$) (Table 3).

There was no statistically significant difference between the groups in terms of mobilization time, patient satisfaction levels, duration of the first analgesic need, intraoperative sedation need, and recovery time of sensory block ($p \geq 0.05$) (Table 4).

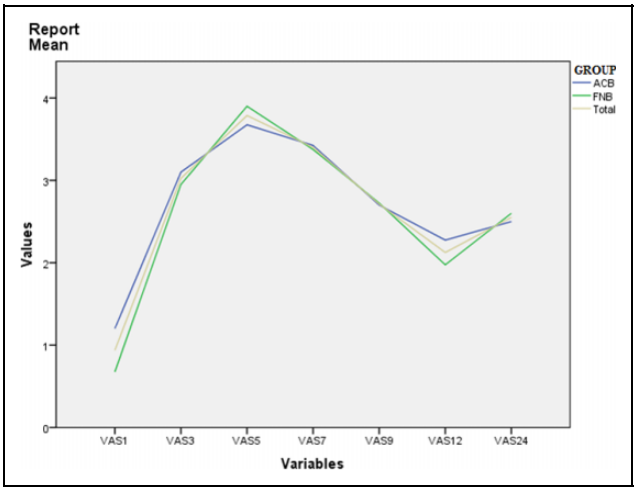

Figure 3. VAS values of the groups in the first hour ($p < 0.005$) and in the third, fifth, seventh, ninth, 12th and 24th hours ($p \geq 0.05$).

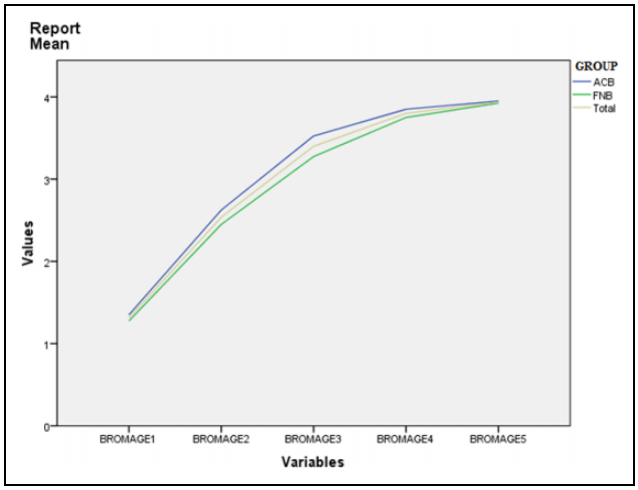

Figure 4. Bromage motor block scores of the groups in the first, second, third, fourth and fifth hours ($p \geq 0.05$).

Table 2. Postoperative Visual Analogue Scale Values Among Groups.

	Group ACB (n = 40) Mean ± SD	Group FNB (n = 40) Mean ± SD	p
First hour	1.20 ± 0.16	0.68 ± 0.14	0.020
Third hour	3.10 ± 0.23	2.95 ± 0.22	0.446
Fifth hour	3.68 ± 0.19	3.90 ± 0.22	0.372
Seventh hour	3.43 ± 0.17	3.38 ± 0.20	0.865
Ninth hour	2.70 ± 0.19	2.73 ± 0.18	0.984
12th hour	2.28 ± 0.17	1.98 ± 0.15	0.198
24th hour	2.50 ± 0.14	2.60 ± 0.14	0.803

Group ACB: Adductor Canal Block.
Group FNB: Femoral nerve Block.
Mann–Whitney U-test.

Table 3. Postoperative Bromage Score Values Among Groups.

	Group ACB(n = 40) Mean ± SD	Group FNB (n = 40) Mean ± SD	p
First hour	1.35 ± 0.76	1.28 ± 0.71	0.472
Second hour	2.63 ± 0.09	2.45 ± 0.12	0.221
Third hour	3.53 ± 0.08	3.28 ± 0.11	0.158
Fourth hour	3.85 ± 0.06	3.75 ± 0.07	0.255
Fifth hour	3.95 ± 0.03	3.93 ± 0.04	0.646

Group ACB: Adductor Canal Block.
Group FNB: Femoral nerve Block.
Mann–Whitney U-test.

Discussion

FNB has an effective postoperative analgesia in pain control after TKA and is an analgesic method that is now commonly used. However, FNB can cause weakness in quadriceps muscle and clinical result of this is delayed mobilization and increase in the risk of falling.[16]

G. Fanelli et al.[17] revealed in their study comparing spinal anesthesia and the combination of sciatic and femoral nerve block that peripheral nerve block did not cause a significant change in hemodynamic parameters. In our study, there was no significant difference in FNB and ACB groups in terms of intraoperative hemodynamic data.

The most important problem that must be solved in patients who receive FNB or ACB is postoperative pain. Ozal Adiyeke et al.[18] compared patient groups who received ACB due to postoperative analgesia and who didn't receive ACB and observed that while VAS values in postoperative hours 0 and 4 were lower in the group who received ACB there was no significant difference between the groups in terms of VAS value in postoperative 24th hour. In our study, we assessed VAS in the first 12 hours when pain complaint was the highest and in the 24th hour. There was no significant difference in measurements except for the first hour and both methods were similar in terms of analgesic efficacy. VAS score was the highest between the fifth and seventh hours in both groups and analgesia was required in these time periods.

Although Timed Up and Go test have commonly been used in similar studies to measure the strength of quadriceps muscle[19] we used Bromage motor block scale and mobilization time because mean age was above 60 in our study and Bromage score is one of the objective tests in measuring the gradual recovery of motor block, commonly used in clinical practice and directly related to patient satisfaction although it was not commonly used for that purpose in previous studies.

In the study by Jyoti Sandeep Magar et al., full recovery time of motor bock was measured as mean 2.5 hours in patients who underwent lower leg surgery under spinal anesthesia.[20] In our study, mean full recovery time of motor bock was measured above 3.5 hours and motor block recovered when the knee and feet had the strength to perform full flexion. This result suggests that peripheral nerve block added to spinal anesthesia may cause extension in motor block duration. In addition, there was no significant difference between the groups in this study in terms of motor functions measured in every 1 hour throughout 5 hours and mobilization time.

Table 4. Duration of Mobilization, Morphine Consumption, Duration of Motor Block, Satisfaction Level, Duration of Additional Analgesia Needed, Duration of Sensory Block, and Sedation Among Groups.

	Group ACB (n = 40) Mean ± SD	Group FNB(n = 40) Mean ± SD	
Duration of Mobilization[b]	20.45 ± 0.65	21.55 ± 0.62	0.162
Duration of motor block (hour)[b]	3.42 ± 0.12	3.57 ± 0.15	0.413
Satisfaction level[b]	3.25 ± 0.11	3.20 ± 0.10	0.720
Duration of additional analgesia Needed[b]	4.73 ± 0.28	4.54 ± 0.19	0.965
Morphine Consumption (mg)[b]	23.75 ± 7.82	21.50 ± 7.61	0.207
Duration of sensory block (hour)[b]	4.80 ± 2.28	5.35 ± 0.24	0.477
Sedation[a]	21/19	23/17	0.653

Group ACB: Adductor Canal Block.
Group FNB: Femoral Nerve Block.
[a]Pearson's 2–test, [b]Mann–Whitney U-test.

A.S. Ibrahim et al. reported that sensorial block in cruciate ligament reconstruction extended until mean 12th hour in adductor canal block in which they used 20 ml of Bupivacaine to which dexamethasone was added and inserted needle into the lower leg.[21] This may be due to the use of long-effect anesthetic agent and measurement method. In our study, we used a mixed anesthetic agent and performed the measurement on patella as the feeling of being able to differentiate cold and hot, which may have caused the duration of our sensorial block to be shorter. Sensorial block duration of mean 5 hours that we obtained was a desired result in terms of extending the time of first analgesia. We think this result contributed to the patient satisfaction level.

Although there was no difference between the groups in terms of first mobilization time of patients in our study it was later than the mobilization time of the patients who underwent lower abdominal and lower extremity surgery under only spinal anesthesia in the study by Watanabe M et al.[22] This is may be because mean age of the patients in our study was relatively higher, the surgery had an effect of retarding the mobilization, peripheral nerve blocks used caused motor block to extend and we assessed the mobilization as standing up and walking for at least 5 meters.

Intraoperative sedation need is an expectable condition in patients who undergo TKA under spinal anesthesia.[23] Sedation need is determined by more than 1 factor. In our study, no additional sedation need occurred in ACB or FNB methods apart from the one needed under spinal anesthesia.

There are quite high number of studies measuring postoperative opioid consumption in ACB and FNB.[14,24] In our study, we used 75 mg of diclofenac as the first analgesia and recorded that as the first analgesia application time. We used additional intramuscular morphine in doses of 5 mg for patients when needed and there was no difference between the groups in terms of total morphine consumption. This result was consistent with those in previous studies.

In the study by Faraj W. Abdallah et al.,[25] the duration needed for analgesia was mean 100 minutes in adductor canal block and 83 minutes in femoral nerve block among the blocks in which they used 20 ml of ropivacaine in anterior cruciate ligament reconstructions. We used the first analgesia in patients in condition that they had VAS score of 4 and above. We used diclofenac 100 mg for that purpose. In our study, although this duration was not statistically significantly different in adductor canal block group it was measured longer and first analgesic need occurred in longer duration. This result may be associated with the nature of the surgery.

The most important factors affecting patient satisfaction in TKA patients are considered to be factors such as postoperative pain level, mobilization time and analgesic need.[26] In our study, there was no significant difference in terms of these values and patient satisfaction levels were not statistically significantly different.

The rate of complications that can develop due to the technique in patients who receive ACB and FNB is quite low. These can be listed as nerve damage, infection in needle entry region, bleeding and local anesthetic toxicity.[27] In our study, we did not assess the complications caused by spinal anesthesia and no complication that could occur due to ACB and FNB such as infection, bleeding and local anesthetic toxicity developed in any of our patients included in the study.

Conclusion

When ACB and FNB that are used for postoperative analgesia in patients who undergo total knee arthroplasty are compared in terms of factors affecting patient satisfaction it is observed that they result in the same level (non-inferiority) of patient satisfaction. Therefore, we recommend the routine use of ACB method with FNB in total knee arthroplasty. More studies focusing especially on measuring patient satisfaction are needed.

Declaration of Conflicting Interests

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