Original Article/*Özgün Araştırma*

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Comparison of Epidural Anesthesia with the Combination Adductor Canal and IPACK Block in Knee Arthroplasty Patients

Diz Artroplasti Hastalarında Epidural Anestezi ile Adduktor Kanal ve IPACK Blok Kombinasyonunun Karşılaştırılması

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ABSTRACT

Objective: Motor function-preserving peripheral nerve blocks have begun to play an important role in multimodal analgesic approaches of the patients with total knee arthroplasty (TKA). The aim of this study is to compare the effects of anesthesia methods on postoperative analgesia and early rehabilitation of patients after total knee arthroplasty.

Methods: In this retrospective study, in which patients with unilateral TKA were screened, two groups were formed from selected patients. Group EA was administered 0.03 mg kg^{-1} of morphine with 10 cc saline through the epidural catheter in the postoperative period. In Group Adductor Canal Block (ACB)+ infiltration of local anesthetic between the popliteal artery and capsule of the knee block (IPACK), 10 mL 0.5% bupivacaine, 10 mL 2% lidocaine and 20 mL local anesthetic mixtures were made separately for ACB and IPACK blocks at one time. Primary postoperative outcome was Visual Analogue Scale (VAS), secondary outcomes were physical therapy ambulation test results.

Results: In this study, postoperative pain score rates as the primary outcome were measured as follows: VAS8: 5 / 4 (p=0.041); VAS12: 5 / 4 (p=0.004) and VAS24: 4 / 3 (p=0.001) and lower pain scores were obtained in the ACB + IPACK group. In timed up to go (TUG) tests, TUG24 was 36/34 (p=0.001), TUG48 32.5/30 (p=0.012) and TUG72 20/12. Better ROM measurements were recorded in group ACB+IPACK at both 24 and 48 hours.

Conclusion: In the ACB + IPACK group, better pain scores, more significant ambulation values, and less side-effect profile were obtained.

Keywords: Adductor canal block, analgesia, epidural analgesia, total knee arthroplasty

ÖZ

Amaç: Total diz artroplastisi (TDA) olan hastalarda motor fonksiyon koruyucu periferik sinir blokları multimodal analjezik yaklaşımda önemli rol oynamaya başlamıştır. Bu çalışmanın amacı, anestezi yöntemlerinin TDA sonrasında hastalarda postoperatif analjezi ve erken rehabilitasyon üzerindeki etkilerini karşılaştırmaktır.

Yöntem: Tek taraflı TDA hastalarının tarandığı bu retrospektif çalışmada, seçilmiş hastalardan iki grup oluşturuldu. Grup Epidural Anestezi (EA)'ye postoperatif dönemde epidural kateterden 0,03 mg kg^{-1} morfin, 10 cc salin uygulandı. Grup Adduktor Kanal Bloğu (ACB)+ popliteal arter ile arka diz kapsülü arasındaki boşluk bloğunda (IPACK) tek seferde ACB ve IPACK blokları için ayrı ayrı 10 mL %0,5 bupivakain, 10 mL %2 lidokain ve 20 mL lokal anestezik karışımları yapıldı. Ameliyat sonrası birincil sonuç Vizüel Analog Skala (VAS), ikincil sonuçlar fizik tedavi ambulasyon testi sonuçlarıydı.

Bulgular: Bu çalışmada primer sonuç olarak postoperatif ağrı skor oranları şu şekilde ölçüldü: VAS8: 5 / 4 (p=0,041); VAS12: 5 / 4 (p=0,004) ve VAS24: 4 / 3 (p=0,001) ve ACB + IPACK grubunda daha düşük ağrı skorları elde edildi. Timed up to go (TUG) testlerinde TUG24 36 / 34 (p=0,001), TUG48 32.5 / 30 (p=0,012) ve TUG72 20 / 12 olarak kaydedildi. Grup ACB + IPACK'de hem 24 hem de 48 saatte daha iyi ROM ölçümleri kaydedildi.

Sonuç: Grup ACB + IPACK'te daha iyi ağrı skorları, daha anlamlı ambulasyon değerleri ve daha az yan etki profili elde edildi.

Anahtar sözcükler: Adduktor kanal bloğu, analjezi, epidural analjezi, total diz artroplastisi

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INTRODUCTION

Total knee arthroplasty (TKA) has an increasing prevalence in older patients worldwide. Orthopaedic surgery can be associated with moderate to severe postoperative and early ambulatory pain. Despite the use of comprehensive multimodal analgesic regimens, these patients may experience varying degrees of pain. An improved method of analgesia is also important in terms of functional recovery, patient outcome and patient satisfaction (1,2). However, many studies have shown that there is a need for multimodal pain management which has minimal side effects and can be an aid to early rehabilitation (3,4). Postoperative pain control can be achieved by a variety of methods including intravenous (IV) opioid administration, periarticular infiltration, epidural analgesia (EA) and peripheral nerve blocks (PNBs) (5). Although effective analgesia can be achieved with epidural opioids used for TKA, more effective results can be achieved with peripheral nerve blocks (PNBs), in which an adductor canal block (ACB) and an infiltration block of the space between the popliteal artery and the knee capsule (IPACK) are performed in combination.

Both epidural and peripheral nerve blocks provide postoperative analgesia and contribute to effective rehabilitation. Compared with systemic opioid analgesia, epidural analgesia causes fewer opioid-related side effects by providing better pain control after TKA and sparing the opioids used (6). However, some studies have shown that EA has side effects such as urinary retention, hypotension, pruritus and motor block that delay mobilisation (7,8). One group of our study consists of the use of epidural analgesia in patients undergoing combined spinal epidural anaesthesia to achieve effective analgesia.

Femoral and sciatic nerve distributions are targeted for PNB after TKA. While providing superior analgesia, PNBs aim to reduce opioid consumption and opioid-related side effects. Femoral nerve block (FNB) has emerged as the traditional method in this sense, but ACB has come to the fore as an alternative because FNB reduces quatriceps muscle strength in the postoperative period and adversely affects early mobilisation. Sciatic nerve block with FNB also provides analgesia in the posterior knee region. However, there is generally low quality evidence for the effectiveness of sciatic nerve block (9). With regard to the possibility that sciatic nerve block may adversely affect physiotherapy and ambulation after TKA, further prospective studies of the risks and benefits of sciatic nerve block are needed (10). An alternative approach to posterior knee pain after total knee replacement (TKR) has recently been described. This block has been termed the IPACK block. This analgesic block of the space between the popliteal artery and the posterior capsule of the knee provides analgesia while preserving motor strength and providing anaesthesia in the posterior part of the knee. In this context, we used the combination of ACB and IPACK block in the other group of our study, one of the new peripheral nerve blocks that have come to the fore in recent years.

As patients experience severe pain after THA surgery, the primary aim of our study was to evaluate the efficacy of both these new block methods and epidural analgesia in postoperative analgesia. We also wanted to show, as secondary outcomes, the efficacy of these methods on postoperative walking and rehabilitation, and on postoperative complication rates in these patients.

MATERIAL and METHODS

This study is a retrospective study conducted at Dörtyol State Hospital, in which patients undergoing FFP were reviewed. Combined spinal epidural or USG-guided adductor canal block and IPACK block are routinely used for postoperative analgesia for knee surgery in our clinic. We reviewed the cases in which we used the combined epidural technique of traditional methods between April 2017 and March 2021, and the cases who underwent total knee arthroplasty with USG-guided adductor canal block and IPACK block, which we have used more frequently in recent years, between January 2019 and March 2021. During this period, cases undergoing unilateral total knee arthroplasty were identified. Hospital records, anesthesia and operation notes were used in this study. American Society of Anesthesiologists (ASA) class 1,2 and 3 without criteria, incomplete documentation to perform physical therapy sessions during ambulation tests, difficulty in coping, body mass index (BMI) >40, patients under the age of 18 years old or 80 years old, those who are will not be included in the study. A total of 158 patients underwent unilateral total knee arthroplasty during this period. Of these, 127 (82.4%) patients who met the inclusion criteria were included in the study. Approval to conduct the study was obtained from the administration of Dörtyol State Hospital on 16/04/2021 with protocol E-15913737-929. Ethical approval was obtained from the Ethics Committee of Hatay Mustafa Kemal University, dated 04/10/2021, with protocol number 04. Informed consent was not obtained from patients as the study was retrospective.

Group EA was selected from patients who underwent combined spinal anesthesia and received postoperative epidural morphine.

Group AKB+IPACK was selected from patients who underwent USG-guided adductor canal block and IPACK block after spinal anesthesia.

Perioperative data included age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) classification, and surgical time.

For DVT prophylaxis, all patients received preoperative enoxaparin sodium 0.6 sc once daily and prophylactic intravenous cefazolin 1 g 12 hours before surgery. After the patients were taken to the operating theatre, peripheral venous cannulation was performed and routine follow-up with electrocardiography, oxygen saturation and non-invasive blood pressure was performed in the prone position. Patients were given 2 mg midazolam for sedation. Sedation was continued with 1-2 mg of midazolam every 30 minutes. For combined spinal epidural anesthesia, the combined spinal epidural set (B. Braun Melsungen AG, Melsungen, Germany) was sterile opened. After administration of cutaneous and subcutaneous anesthesia in the L3/4 or L4/5 area in the sitting position, the epidural space was entered with a 17G Tuohy needle using the hanging drop method. Then a 27G Quincke spinal needle was passed through the Tuohy needle to access the spinal space. For spinal anesthesia, patients received 15 mg of 0.5% heavy bupivacaine. The epidural catheter was then passed through the Tuohy needle and placed 4-5 cm into the epidural space. In these patients, epidural protocol was established by administering 0.03 mg kg^{-1} morphine into the epidural catheter with a single dose of 10 cc saline after checking the epidural catheter placement at the end of the operation.

After cutaneous and subcutaneous anesthesia in the L3/4 or L4/5 area in the sitting position, patients scheduled for ACB and IPACK blocks received spinal anesthesia using a 27 G spinal needle (Braun Medical Inc, Melsungen, Germany). Patients received 15 mg of 0.5% heavy bupivacaine for spinal anesthesia. The operative limb was then sterilised from the inguinal ligament to the popliteal fossa, and the patient was guided in the supine position along the femoral artery using the inplane technique with a high-frequency linear ultrasound probe (10-12 Hz; SonoSite Turbo; SonoSiteInc, Bothell, WA) at the mid 1/3 thigh level. ACB was performed at the 9 o'clock position of the femoral artery. A total of 20ml of a mixture of 10 mL 0.5% bupivacaine and 10 mL 2% lidocaine was injected into the adductor canal using a 22G 2" Stimuplex needle (Braun MedicalInc, Melsungen, Germany). The convex probe of the same ultrasound (10-12Hz; SonoSite Turbo; SonoSiteInc, Bothell, WA) was placed on the medial condyle of the femur to visualise the popliteal artery and posterior aspect of the distal femur. The IPACK block was performed by injecting a total of 20 mL of a mixture of 10 mL of 0.5% bupivacaine and 10 mL of 2% lidocaine into the area between the popliteal artery and the femur using an out-of-plane technique with a 22G 2-inch Stimuplex needle (Braun MedicalInc, Melsungen, Germany). Patients underwent an ACB block followed by an IPACK block. An anesthetic mixture with the same content was administered.

The primary postoperative outcome measure was the visual analogue scale (VAS) and the secondary outcome measures were the results of the physiotherapy walking test and postoperative complications.

A visual analogue scale (0 = no pain, 10 = most severe pain) was used to monitor patients' postoperative pain. The assessment was made by the nursing staff. Recorded postoperative VAS scores at 4 hours, 8 hours, 12 hours, 24 hours, 36 hours and 48 hours were analysed.

Post-operative physiotherapy and assessment scales were performed by the same physiotherapists. Recorded quadriceps muscle strength (0 no movement, 5 full range of motion despite resistance) was assessed at 24 and 48 hours postoperatively. The timed get up and go test (TUG) (time taken to get up from a sitting position on a chair and walk 3 metres to the same sitting position) was also assessed at 24, 48 and 72 hours. Knee flexion range of motion (ROM) was assessed at 24 and 48 hours. Patients were assessed for side effects such as nausea, vomiting, urinary retention and pruritus. Additional postoperative analgesia was provided by paracetamol 500 mg intravenously every 6 hours and diclofenac sodium 75 mg intramuscularly for 12 and 24 hours. However, patients with pain received tramadol 100 mg as rescue analgesia. Patients receiving rescue analgesia were also examined.

There were 64 patients in the EA group and 63 patients in the AKB+IPACK group.

Statistical Analysis

Statistical analyses were performed using SPSS v22.0 software (IBM, Chicago, IL). The normality of data distribution was tested using the Kolmogorov-Smirnov test. Student t-test was used to compare two independent samples with normal distribution. The Mann-Whitney U test was used for non-normal continuous variables, and the chi-squared test was used to compare categorical variables. The confidence interval for all comparisons was set at 95% and $P < 0.05$ was considered statistically significant.

RESULTS

In this study, among 158 patients who underwent total knee arthroplasty between April 2017 and March 2021, inadequate documentation (n=10; 31. 25%), BMI>40 kg m^2 (n=8; 25%), difficulty cooperating (n=6; 18.75%), patients who could not perform a walking test (TUG) during physiotherapy sessions (n=4; 12.5%), patients undergoing revision TNP surgery (n=2; 6.25%), and 32 patients who received an additional dose of epidural analgesia because it would affect VAS scores (n=2; 6.25%) were not included in the study. The study population consisted of 127 patients (Figure 1). Demographic and preoperative characteristics, age, sex, BMI, ASA classification category and operative times were recorded. There

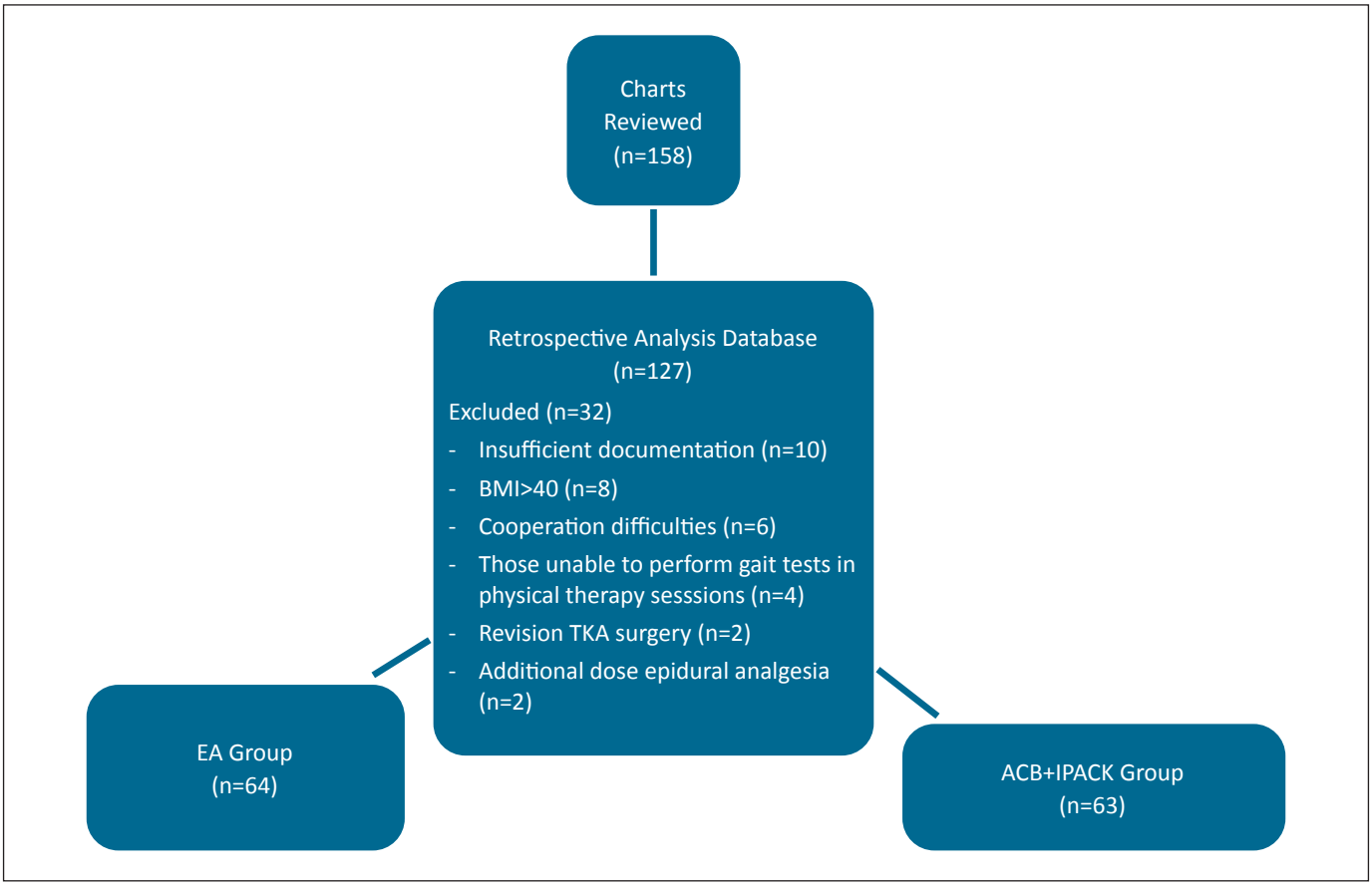

Figure 1: Flow chart showing data selection.

was no significant difference between the groups in terms of demographic data, and a good distribution of these data was observed between the groups (Table I).

The primary outcome of this study was post-operative VAS pain scores. VAS8 measured 5 vs. 4 (p=0.041), VAS12 5 vs. 4 (p=0.004) and VAS24, 4 vs. 3 (p=0.001), VAS36 3 vs. 2 (p=0.036) and there was a significant difference between these groups at 8, 12, 24 and 36hours. VAS4 3 vs. 3 (p=0.625) and VAS48 2 vs. 2 (p=0.705) pain scores there was no significant difference between the groups.

Secondary outcomes were walking distance, postoperative complications and length of hospital stay. When the patients were compared in terms of their quadriceps muscle strength, it was found to be 3 vs. 3. (p=0.690) at 24 hours and 5 vs. 5 (p=0.690) at 48 hours, with no statistically significant difference between the group.

Considering the TUG tests, the same distance was covered in a shorter time in the ACB + IPACK group compared to the EA group. TUG24 scores were 36 vs. 34 (p=0.01), TUG48 scores were 32.5 vs. 30 (p=0.12), TUG72 scores were 20 vs. 18 (p=0.000) and a statistically significant difference was found between TUG24, TUG48 and TUG72 scores. Regarding ROM measurements, better ROM measurements were recorded in the ACB + IPACK group compared to the EA 'group at both 24 and 48 hours. ROM24 and ROM48 were measured as 60 vs. 80 (p=0.01) and 100 vs. 110 (p=0.001) and a significant difference was found for ROM24 and ROM48 measurements. In the EA group, 9 patients (14.1%) developed postoperative nausea-vomiting, 6 patients (9.4%) developed urinary retention and 3 patients (4.7%) developed pruritus, while in the ACB + IPACK group, 2 patients developed nausea-vomiting(3.2%) and 3 patients (4.8%) developed urinary retention. Pruritus was not observed in any patient in this group. Rescue analgesia was given to 8 patients (12.5%) in the EA group and 3 patients (4.8%) in the ACB + IPACK group. The mean length of hospital stay was similar with no statistically significant difference between groups (Table II).

DISCUSSION

Patients undergoing TKA are characterised by moderate to severe postoperative pain (11). The use of peripheral nerve blocks to provide effective analgesia for postoperative pain management after TKA is increasing daily (12). However,

Table I: Comparison of Demographic and Preoperative Characteristics Between Groups

Characteristics	GRUP EA (n=64)	GRUP ACB+IPACK (n=63)	p-value
Age	68 (45-80)	69 (53-80)	0.420
Sex n (%)			
Female	58 (91)	54 (86)	0.320
Male	6 (9)	9 (14)	
BMI (kg m^2)	35 (28-39)	35 (30-39)	0.460
ASA n (%)			
ASA II	37	39	0.360
ASA III	27	24	
Surgical Time	112 (90-135)	120 (90-130)	0.800

Values are given in parentheses with counts, percentages. Non-normally distributed values were expressed as median (min-max) using Mann-Whitney U test. **EA:** Epidural analgesia, **ACB:** Adductor channel block, **IPACK:** Area infiltration block between popliteal artery and knee capsule, **BMI:** Body mass index, **ASA:** American Society of Anesthesiologists.

studies showing that effective analgesia is achieved at the expense of reduced quadriceps muscle strength have led to the development of ACB (13). One of the new block methods recently described for the treatment of posterior knee pain after TKA, the inter-popliteal artery and posterior patella block (IPACK), provides local anesthesia to the posterior part of the knee, providing analgesia while preserving motor strength.

Adductor canal blocks (ACBs) alone cannot provide complete analgesia around the knee after TKA because the knee is innervated by both the lumbar plexus (femoral and obturator nerves) and the sacral plexus (sciatic nerve). (14). Therefore, for effective analgesia in TKA, the IPACK block is required due to its effect on the sciatic nerve. In their prospective studies, Sankineani et al. compared ACB performed with a single injection of 15 mL 0.2% ropivacaine with IPACK-ACB combination and showed that lower pain scores and better physical function were obtained in the IPACK-ACB group in the first 2 postoperative days (15). We believe that the combination of IPACK block with ACB will provide optimal pain control in TKA patients.

Table II: Comparison of Secondary Outcomes Between Groups

	Group EA Median (min-max)	Group ACB+IPACK Median (min-max)	p-value
VAS Scores (hours)			
VAS4	3 (1-5)	3 (1-4)	0.625
VAS8	5 (3-6)	4 (2-6)	0.041
VAS12	5 (2-7)	4 (2-6)	0.004
VAS24	4 (2-6)	3 (2-5)	0.001
VAS36	3 (1-4)	2 (1-4)	0.036
VAS48	2 (1-3)	2 (1-3)	0.705
ROM Angles (°)			
ROM24	60 (50-100)	80 (60-100)	0.001
ROM48	100 (70-140)	110 (90-130)	0.001
Quadriceps Strength (deg/s)			
Quatriceps24	3 (2-4)	3 (2-4)	0.690
Quatriceps48	5 (4-5)	5 (3-5)	0.496
Time up to go (sn)			
TUG24	36 (30-52)	34 (28-40)	0.001
TUG48	32.5 (28-45)	30 (28-38)	0.012
TUG72	20 (18-24)	18 (16-23)	0.000
Rescue Analgesia n (%)	8 (12.5)	3 (4.8)	0.121
Postoperative Complications n (%)			
Nausea-vomiting	9 (14.1)	2 (3.2)	0.029
Itching	3 (4.7)	0	0.082
Urinary retention	6 (9.4)	3 (4.8)	0.311
Length of Hospital stay (date)	4.75	4.74	0.910

Non-normally distributed values were expressed as median (min-max) using Mann-Whitney U test. Values are given in parentheses with counts, percentages. Numbers were presented as mean ± standard deviation. **EA:** Epidural analgesia, **ACB:** Adductor channel block, **IPACK:** Space infiltration block between popliteal artery and knee capsule, **ROM:** Range of motion, **TUG:** Time up to go.

However, some studies have shown that the analgesic quality of peripheral nerve blocks is close to that of continuous epidural analgesia (16,17). This study, which compared epidural analgesia with ABP and IPACK blocks, demonstrated the contribution of these methods to early rehabilitation and postoperative mobilisation with their analgesic effects in TKP patients. In a randomised review of 112 patients, Fisher et al. found that pain after TKP was most severe in the first 24 hours and decreased after 24 hours (18). In this study, the greatest difference between groups was observed in the VAS scores within the first 24 hours after surgery. In particular, the 8th, 12th 24th and 36th hour VAS scores were significantly lower in the ACB + IPACK group than in the EA group. While the 4th and 48th hour VAS scores were similar. This decrease in the difference in pain severity after the first day can be attributed to the decrease in severe pain caused by TKP after 24 hours. Patients with lower pain scores improved their comfort and ability to walk.

One of the goals of pain management after TKA is to maintain a balance between analgesia and muscle strength. Although FNB is known to be effective in reducing pain, this method may cause a loss of quadriceps strength. This interferes with postoperative mobilisation and increases the risk of falls (19). In recent comprehensive reviews, ACB has been shown to facilitate early mobilisation by maintaining quadriceps strength while providing a similar analgesic effect. ACB is a sensory block that only affects the motor function of the rectus medialis muscle and rarely causes quatriceps weakness (20). In the fluoroscopic evaluation by Veal et al. of a patient who had undergone continuous adductor block, the researchers found that the effects of this local anaesthesia extended to the proximal femoral level and caused long-term quadriceps weakness (21).

In our study, continuous peripheral nerve block was not performed and it was observed that the strength of the quatriceps muscle was preserved in the ABP + IPACK group. Therefore, we believe that ACB contributes to early mobilisation.

Preservation of quatriceps muscle strength after ACB and lower postoperative VAS scores have a positive effect on ROM values. Tan et al. found higher ROM values in patients with TKP and stronger quadriceps in patients who underwent ACB (1). Patients with higher ROM show better ambulation and faster functional recovery. In this study, better ROM angles were measured in the ACB + IPACK group, and a significant difference was found, especially in the first 24-hour measurements. In addition, we obtained better TUG values in the ACB + IPACK group when we looked at walking tests, and these patients walked the same distance in less time than the EA group. The increasing pain that begins when the effects of spinal anaesthesia wear off reduces the ability of patients to walk. In this context, we believe that the lower TUG scores in the ACB + IPACK group may be associated with lower VAS scores in this group.

The difference in pain scores between the groups was observed in the first 24 hours after surgery, and the magnitude of this difference gradually decreased over time. During this period, rescue analgesia was given to 8 patients in the EA group and 3 patients in the ACB + IPACK group. We observed that a greater number of patients in the EA group required rescue analgesia.

Epidural analgesia provides good pain control, less opioid use and fewer opioid-related side effects after TKP compared with systemic opioid use. There are some side effects associated with epidural analgesia. These include increased motor and sensory block, nausea, vomiting, delayed ambulation, urinary retention, pruritus and hypotension.

Another concern is how to manage the use of anticoagulants in the presence of an epidural catheter and how to deliver epidural analgesia in a safe, efficient and hygienic manner. Comparing these side effects in our study, lower rates of nausea, vomiting and urinary retention were observed, while pruritus was not observed in any patient. We believe that this low side effect profile is one of the parameters that increases patient satisfaction.

Although PNB has some advantages, it also has some side effects compared to traditional pain control techniques. These are prolonged nerve paresthesia, intra-arterial injection, motor nerve block and catheter infection when used. Veal et al. showed that patients with continuous ACB developed motor block depending on the dose of local anaesthetic used (21). These complications were not seen in this study. We believe that further research is needed on the use of an appropriate dose of local anaesthetic and an effective peripheral nerve block without causing motor nerve block.

This study has several limitations. First, it is a single-centre retrospective study without a large sample size. Studies with larger sample sizes will improve the ability to detect larger differences between these methods of anesthesia. Secondly, the long-term effects of these methods have not been evaluated. Thirdly, the optimal dose of anesthetic is not yet known. In this study, a mixture of 10 mL of 0.5% bupivacaine and 10 mL of 0.1% lidocaine was given, whereas some studies have used different doses of 0.2% ropivacaine (22).

CONCLUSION

As a result, ACB + IPACK block performed after spinal anaesthesia provides better pain control compared to epidural analgesia. It is also more effective in improving ambulation and

functional recovery in patients. It also improves patient comfort with a lower side-effect profile.

AUTHOR CONTRIBUTIONS

Conception or design of the work: MMC, OF, SU
Data collection: MMC, OF, OFC
Data analysis and interpretation: MMC, SU
Drafting the article: MMC, OF
Critical revision of the article: MMC, OF, SU
The author (MMC, OF, SU, OFC) reviewed the results and approved the final version of the manuscript.

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