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■ Original Article

Comparison of adductor canal block and local infiltration analgesia techniques for postoperative analgesia in gonarthrosis patients receiving a total knee prosthesis

Total diz protezi yapılan gonratroz hastalarında postoperatif analjezi için adduktör kanal blogu ile lokal infiltrasyon analjezi tekniklerinin karşılaştırılması

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Abstract

Aim: Total knee arthroplasty (TKA) is a major orthopaedic surgery, and patients experience severe postoperative pain. Local infiltration anaesthesia and/or peripheral nerve blocks are often used for analgesia after TKA. The aim of this study was to compare the analgesic efficacy of the local infiltration anaesthesia and adductor canal block (ACB) techniques in the first postoperative 24 hours after TKA.

Material and Methods: Sixty patients of both sexes who were aged 40-80 years, in the ASA I-III group and undergoing TKA were included in this study after approval of the local ethics committee. Spinal anaesthesia was achieved with 15 mg 0.5% heavy bupivacaine in all patients. In Group I, nerve blocks were applied under ultrasonography with a 20 mL 0.25% bupivacaine. In Group II, a 60 ml cocktail was injected into the periarticular area and subcutaneous tissue. Postoperative pain was evaluated at 0, 1, 2, 8, 12, and 24 hours with a visual analogue scale (VAS). When the VAS score was >4 or the patient reported a need for pain relief, intravenous analgesics were administered, and the analgesia requirement time was recorded. Statistical analysis was performed with IBM SPSS 23.0 software. A value of $p < 0.05$ was accepted as significant.

Results: No statistically significant differences were determined between groups with respect to the demographic data or VAS values ($p > 0.05$). All patients in Group I and 28 patients in Group II required additional analgesia at 10.0 ± 4.9 hours and 8.7 ± 6.02 hours. These differences were not statistically significant ($p > 0.05$).

Conclusion: The study showed that both methods provided effective analgesia and can be used for a multimodal analgesia method postoperatively in the first 24 hours after TKA operations.

Keywords: postoperative analgesia; total knee arthroplasty; adductor canal block; local infiltration analgesia

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Öz

Amaç: Total dizartroplastisi (TDA) major bir ortopedik cerrahidir ve hastalar postoperatif dönemde ciddi ağrı çekmektedir. Lokal infiltrasyon analjezi ve / veya periferik sinir blokları TDA sonrası analjezi amaçlı sıklıkla kullanılır. Bu çalışmanın amacı TDA sonrası postoperatif ilk 24 saat içerisinde lokal infiltrasyon analjezi ve addütor kanal blok tekniğinin etkinliğini karşılaştırmaktır.

Gereç ve Yöntemler : 40-80 yaş arası, ASA I-III grup ve TDA yapılacak 60 hasta lokal etik komite onayı alındıktan sonra bu çalışmaya dahil edildi. Tüm hastalara 15 mg 0.5% heavy bupivacaine ile spinal anestezi uygulandı. I. Gruba sinir blokajı amaçlı ultrasonografi eşliğinde 20 mL 0.25% bupivacaine uygulandı. II. Gruba periartriküler alan ve subkutan dokuya 60 mL kokteyl enjekte edildi. Vizüel analogskala (VAS) ile postoperatif 0,1,2,8,12 ve 24. saatlerde ağrı skorları değerlendirildi. VAS skoru 4 üzerinde olan ve ağrısının giderilmesine ihtiyacı olduğunu belirten hastalara intravenöz analjezikler uygulandı ve analjezi gereksinim zamanı olarak kaydedildi. İstatistiksel analiz IBM SPSS 23.0 software ile yapıldı. $p < 0.05$ değeri anlamlı olarak kabule dildi.

Bulgular: Demografik veriler veya gruplar arasında VAS skorlarında anlamlı bir fark bulunamadı ($p > 0.05$). I. Gruptaki hastaların tamamının ortalama 10.0 ± 4.9 . saatlerde ve II. Gruptaki hastaların 28'inin ise 8.7 ± 6.02 . saatlerde ek analjezi ihtiyacı olduğu gözlemlendi. Bu fark istatistiksel olarak anlamlı bulunmadı ($p > 0.05$).

Sonuç: Bu çalışmada; TDA operasyonu sonrasında ilk 24 saatte multimodal analjezi methodu olarak her iki yöntemin de yeterli analjezi sağladığı ve kullanılabileceği gösterilmiştir.

Anahtar kelimeler: postoperatif analjezi, total diz artroplastisi, addütor kanal bloğu lokal infiltrasyon analjezisi

Introduction

Total knee arthroplasty (TKA) is a major orthopaedic surgical procedure, and almost half of all patients experience severe postoperative pain. One of the most important factors in ensuring the success of the treatment process and patient comfort is the control of postoperative pain. In providing postoperative analgesia after TKA operations, local infiltration anaesthesia and/or peripheral nerve blocks are often used. [1,2]

Adductor canal blocks provide effective analgesia after TKA surgery and accelerate the recovery process. When postoperative analgesia is provided in the early stage, early pain-free mobilization of the patient can be achieved, thereby shortening the length of hospital stay. [3]

Local infiltration anaesthesia has been shown to provide effective analgesia in the postoperative period. [4]

The aim of this study was to compare the analgesic efficacy of local infiltration anaesthesia and adductor canal block techniques in the first postoperative 24 hours after the TKA procedure. Patients were evaluated with respect to demographic characteristics, postoperative pain scores, the need and time of requirement for additional analgesics and side effects.

Materials and Methods

This study was planned as a single-centre, randomized, double-blind, controlled study. Informed consent was obtained from all the patients participating in the study, and

all the researchers signed the Declaration of Helsinki. Approval for the study was granted by the local ethics committee.

The study was planned with a total of 60 patients of both sexes aged 40-80 years who were in the ASA I-II-III physical risk group and were undergoing TKA for primary or secondary osteoarthritis. The exclusion criteria were defined as patients with a previous TKA surgery on the same side, an infection in the application area, neuropathy, a local anaesthetic allergy, cerebrovascular disease, bleeding diathesis, neuromuscular disease, a renal implant, heart failure (American Heart Association Grade 3), pulmonary failure, or a mental status impairment that can create difficulties in understanding a numerical scale and patients who were in the ASA IV-V physical risk group, reported long-term use of analgesics such as NSAIDs and opioids, or exhibited unwillingness to participate. The patients were randomly allocated to one of two groups using the sealed envelope method of randomization.

Anaesthesia Technique

In both patient groups, 0.03 mg/kg midazolam IV and 1 µg/kg fentanyl IV were applied. Then, with entry into the spinal space, the spinal anaesthesia technique was used with 15 mg 0.5% heavy bupivacaine.

Adductor Canal Block (Saphenous Nerve Block) (Group I)

All the nerve blocks were applied under ultrasonography (USG) guidance by the same anaesthetist who was experienced in peripheral nerve blocks. The application area was prepared by the appropriate sepsis-antisepsis preparation procedure

in the Group I patients, and the procedure was performed using a 6-13 MHz linear ultrasound probe (Logiqe, General Electric, USA). With the patient in the supine position, the thigh was abducted and externally rotated. The probe was placed transversely at the anteromedial site at the middle third of the thigh. Once the femoral artery was identified under the sartorius muscle, the 5 cm peripheral nerve block needle (Stimuplex D. B., Braun, Melsungen, Germany) was inserted in-plane in a lateral-to-medial direction. When the needle tip was visualized medial to the artery, aspiration was performed, 1 to 2 mL of the local anaesthetic was injected to confirm the injection site, and the remaining local anaesthetic volume was administered (0.25% bupivacaine 20 mL in total) under USG guidance to the surroundings of the nerve in the adductor canal.

Local Infiltration Anaesthesia Group (Group II)

For the patients in Group II, a 60 mL mixture was injected by the surgical team during the surgical procedure from the peri-articular area to the subcutaneous tissue (posterior capsule, collateral ligament, quadriceps muscle). The local anaesthetic cocktail was composed of 200 mg 0.5% bupivacaine, 40 mg methylprednisolone, 0.15 mg adrenaline, 750 mg cefazolin and 8 mg morphine (Table 1).

Table 1. Contents of the Local Anaesthetic Cocktail

Drug	mL	mg
Bupivacaine 0.5%	40	200
Methylprednisolone	4	40
Adrenaline	0.3	0.15
Cefazolin	7.5	750
Morphine	8	8

Surgical Technique

All the surgical procedures were applied by the same orthopaedist. Routine cemented total knee prosthesis surgery was performed with a mid-vastus approach using a 250 mmHg pressure tourniquet. A drain was applied to the surgical field.

Postoperative Follow-Up

Postoperative pain was evaluated at regular intervals in the first 48 hours (at 0, 1, 2, 8, 12, 24 hours) with a visual analogue scale (VAS) marked on a ruler from 0-10 cm (0=no pain, 10=the most severe pain). Any time at which the VAS score was >4 or the patient reported a need for pain relief, the appropriate IV analgesic combination was administered (tramadol hcl 100 mcg, paracetamol 1 gr IV inf). The time of requirement for the first dose of analgesics was recorded.

During the follow-up period, nausea, vomiting, hypotension,

bleeding, bradycardia, and signs of local anaesthesia toxicity (dizziness, ringing in the ears, numbness of the tongue, spasm, arrhythmia) were monitored.

Statistical Analysis

Analyses of the study data were performed using IBM SPSS 23.0 statistics software. Descriptive statistical methods were used (number (n), percentage (%), mean, standard deviation (SD), median, minimum-maximum) when evaluating the study data, and in the comparison of qualitative data, the Chi-square test was used. Conformity of the data to a normal distribution was evaluated with the Kolmogorov-Smirnov and Shapiro-Wilk tests.

In the evaluation of quantitative data showing a normal distribution, the independent samples t-test was used, and for ordinal data not showing a normal distribution, the Mann-Whitney U test was applied. A value of $p < 0.05$ was accepted as statistically significant.

A power analysis was performed with the G*Power 3.1.9.2 statistics program. When $n_1 = 30$, $n_2 = 30$, $\alpha = 0.05$, and the effect size was $d = 0.8$, the power was determined to be $(1 - \beta) = 0.86$.

Results

The study included a total of 60 patients, with 30 in each group, for evaluation. The patient characteristics are shown in Table 2. No statistically significant differences were determined between the groups with respect to age, sex, height, weight, BMI, ASA or operating time ($p > 0.05$).

The mean age was determined to be approximately 67 in each group (ACB group 67.7 ± 5.6 , LIA group 67.2 ± 6.8). Both groups had more obese patients than patients of other BMI levels [ACB: 21 (70%), LIA: 21 (70%)], and female was the predominant sex in each group [ACB: 25 (83.3%), LIA: 24 (80.0%)].

No procedure-related side effects were observed in any patient in either group (Table 3).

No statistically significant differences were found between the groups with respect to the VAS values at any of the measured times ($p > 0.05$) (Table 4).

The mean VAS values of both groups were < 4 at all the measured times (Figure 1).

There was a need for additional analgesics in all the patients (100%) in the ACB group and in 28 (93.3%) patients in the LIA group. The time of requirement for additional analgesics was recorded as 10.0 ± 4.9 hours in the ACB group and 8.7 ± 6.02 hours in the LIA group (Table 5). These differences were not statistically significant ($p > 0.05$).

Table 2. Comparison of the Demographic Variables Between Groups [n (%)/ Mean±SD]

		Group I (n=30)	Group II (n=30)	P
Sex	Female	25 (83.3%)	24 (80.0%)	1.000*
	Male	5 (16.7%)	6 (20.0%)	
Age	67.7±5.6	67.2±6.8		0.772**
Weight (kg)	80.7±10.4	83.1±12.4		0.422**
Height (cm)	158.1±7.0	158.9±7.8		0.702**
BMI	32.0±4.1	32.9±4.7		0.455**
BMI Group	Normal	1 (3.3%)	1 (3.3%)	0.515*
	Overweight	8 (26.7%)	6 (20.0%)	
	Obese	21 (70.0%)	21 (70.0%)	
	Morbidly Obese	--	2 (6.7%)	
ASA	I	1 (3.3%)	--	0.600*
	II	21 (70.0%)	22 (73.3%)	
	III	8 (26.7%)	8 (26.7%)	
Operation Time (minute)	90.8±16.4	90.7±17.5		0.970**

BMI: Body mass index, **ASA:** American Society of Anesthesiologists, **Group I:** Adductor canal block, **Group II:** Local infiltration anaesthesia (Ranawat Block),*: Chi-square tests, **: Independent samples t-test

Table 3. Comparison of the Side Effects [n (%)]

Side Effect	Group I (n=30)	Group II (n=30)	p*
Absent	30 (100.0%)	28 (93.3%)	0.492
Present	--	2 (6.7%)	
Superficial Infection	--	2 (6.7%)	

Group I: Adductor block, **Group II:** Local infiltration anaesthesia (Ranawat Block),*: Chi-square tests

Table 4. Comparison of the VAS Scores Between Groups [Mean ± SD/Median (Min-Max)]

VAS	Group I (n=30)	Group II(n=30)	P*
0. hour	0.6±1.5 0 (0-6)	0.5±1.1 0 (0-3)	0.926
1. hour	0.4±1.0 0 (0-4)	1.0±1.4 0 (0-4)	0.073
2. hour	2.5±1.3 3 (0-6)	2.7±1.8 2.5 (0-6)	0.783
8. hour	3.5±1.4 3 (1-6)	2.9±1.1 3 (0-5)	0.059
12. hour	3.1±1.5 3 (1-6)	2.8±1.3 3 (0-5)	0.719
24. hour	2.5±1.3 3 (1-6)	2.2±1.1 2 (0-5)	0.387

Group I: Adductor block, **Group II:** Local infiltration anaesthesia (Ranawat Block),*: Mann-Whitney U

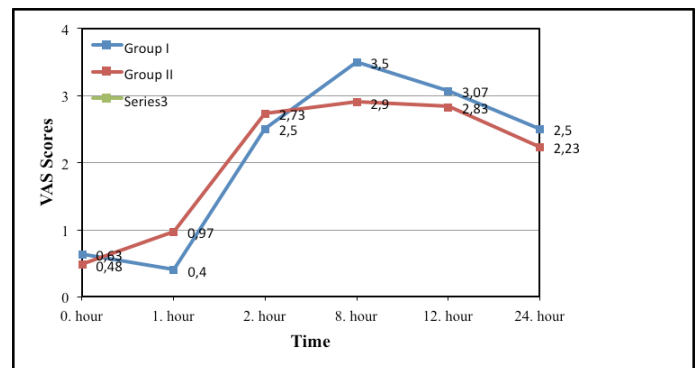


Figure 1. Comparison of the VAS Scores Between Groups

Table 5. Comparison of the Time of Requirement of Additional Analgesics and the Time of the First Analgesic Intake Between Groups [Mean ± SD/Median (Min-Max)]

		Group I (n=30)	Group II (n=30)	P
Additional analgesic need	Absent	0 (0.0%)	2 (6.7%)	
	Present	30 (100.0%)	28 (93.3%)	
First analgesic intake time		10.0±4.9 9 (1-22)	8.7±6.0 10 (1-24)	0.365**

Group I: Adductor block, **Group II:** Local infiltration anaesthesia (Ranawat Block),*: Chi-square tests, **: Mann-Whitney U

Discussion

To the best of our knowledge, this is one of the few randomized, controlled studies investigating the analgesic effects of single shot LIA versus ACB on postoperative pain in patients undergoing TKA.

Previous studies have shown that both ACB and LIA applications provide effective analgesia and do not cause weakness in the quadriceps muscle. [3-7]

However, there are very few studies that have compared ACB and LIA methods in the relief of postoperative pain after TKA and that have compared the analgesic efficacy of ACB and LIA in the first 24 hours after TKA, and the overall role of these techniques remains undefined. Therefore, this study was planned considering the scarcity of these types of studies.

The adductor canal block (ACB) has recently emerged as an alternative to the femoral nerve block (FNB). The adductor canal contains the saphenous nerve (the largest sensory branch of the femoral nerve), the medial femoral cutaneous nerve of the thigh, and the nerve to the vastus medialis (a motor nerve and the second largest sensory branch of the femoral nerve).

The obturator nerve may enter the distal part of the

adductor canal and follow the femoral artery into the popliteal fossa, supplying the posterior medial capsule of the knee joint. [8-10]

Femoral nerve blocks are used for pain control after various knee procedures, especially knee arthroplasty. The distal end of the canal is identified sonographically as the site where the femoral artery appears to enter the adductor hiatus and further continue as the popliteal artery in the posterior aspect of the thigh. Withdrawing the probe 2-3 cm from this point and injecting 5-10 mL of LA anterolateral to the artery is the method of performing the distal USG adductor canal block. It was thought that a block at this level would ensure maximum sensory block with minimal quadriceps weakness. Anatomically, at this site, the sartorius forms the medial border, the adductor longus is no longer seen, and the adductor magnus becomes less bulky and more tendinous the farther down it is inserted in the medial tubercle of the medial condyle of the femur. There have been isolated reports of quadriceps weakness (femoral nerve block) and even of the popliteal sciatic nerve becoming blocked after an adductor canal block. [11,12]

For these anatomic reasons, ACBs made with a saphenous nerve block in the adductor canal have become more preferred than FNBs because ACBs cause less weakness in the quadriceps; weakness in the quadriceps can result in a delay to begin rehabilitation, a risk for falls and a prolonged stay in the hospital. [13-15]

The primary advantage of the adductor canal block is the sparing of the motor branches to the quadriceps muscles, resulting in earlier patient mobility following TKA. [16]

Many studies have shown that the use of a cocktail for LIA anaesthesia provides effective anaesthesia, has a low side-effect profile and improves patient rehabilitation. [4,6,7] Several studies have compared LIA with femoral nerve blocks and the epidural analgesia method, and it is thought that in both methods, there is a larger risk for falls and quadriceps muscle weakness than in LIA. [1,17]

In the current study, there were no differences between the groups with respect to the demographic data, and the majority of patients were obese and female. No statistically significant differences were found between the groups with respect to adverse events.

The first 24 hours after a TKA operation is an extremely painful period for patients. There have been previous reports of patients with severe movement-related pain or VAS >8 on the first or second postoperative day after TKA. In the current

study, the VAS values of both groups were observed to be very low at all the follow-up times.

The results of the current study demonstrated similar results between the ACB and LIA groups for all outcomes of VAS scores and the time of requirement for additional analgesia in the postoperative period (0, 1, 2, 8, 12, 24 hours) after TKA.

Most patients reported better pain control with both methods at 24 hours. Although there were no high pain scores, most patients in both groups needed additional analgesia, and the difference was not statistically significant [ACB: 30 patients (100.0%), LIA: 28 patients (93.3%)].

In a study by Hanson et al. [5], a continuous adductor canal block was compared with a placebo, and reduced opioid consumption was reported for 48 hours. As reported by Vora et al. [13], the use of 20 ml of local anaesthetic solution in the ACB has been shown to provide effective analgesia and minimal quadriceps muscle weakness.

The results of the current study support the findings of these two studies of the analgesic effect created in the ACB group.

Almost all the patients in both methods required additional analgesia in the first postoperative 24 hours. According to the change in the variables between the patients in the 2 groups, on average, the requirement for additional analgesia occurred within the first 12 hours. Although not statistically significant, the need for additional analgesia occurred slightly later in the ACB group than in the LIA group (ACB: 10.0 ± 4.9 hours, LIA: 8.7 ± 6.0 hours). In patients treated with single-shot ACB, effective analgesia was determined to have been provided by this treatment alone for up to a mean of 10.0 ± 4.9 hours. The low pain scores in the first 24 hours of the current study can be attributed to the addition of IV analgesics becoming effective in the postoperative first 24 hours, and therefore, this treatment can be considered an appropriate method of multimodal analgesia. In the LIA group, effective analgesia was provided by this treatment alone for a mean of 8.7 ± 6.0 hours. Again, in patients in the LIA group, an additional analgesic application may be a component of an effective multimodal analgesia method for the first 24 hours during postoperative analgesia.

The ACB group received a USG adductor canal block with 20 mL of 0.5% bupivacaine, and the LIA group was administered a 40 mL cocktail. Additional studies are needed to evaluate the optimal volumes and concentrations that should be used in the adductor canal block for the relief of pain following TKA surgery.

Limitations of this study were that when designing the study,

patient-controlled analgesia by an epidural catheter or patient-controlled analgesia with IV morphine could have been added to the blocks, or the continuous forms of both methods could have been preferred. However, because there is a possibility of infection from a continuous form, a continuous form was not used; the aim of the study was to examine how effective applications of a single dose block and infiltrations were used in patients treated with a single dose of spinal anaesthesia by using an additional IV analgesic dose.

The findings of the current study showed that both methods provided effective analgesia with respect to pain characteristics following TKA operations. However, the applications were performed by 2 different speciality groups; if the anaesthetist had experience with ACB, ACB could be selected, and if the surgeon requested LIA, then LIA could be selected. Furthermore, it must not be forgotten that although no side effects were observed in the current study, the cocktail used in LIA contains many drugs. The application of ACB requires special equipment (USG, block needle) and skills. Taking all of these factors into account, the appropriate approach should be selected with teamwork.

Conclusion

From the results of this study, it can be concluded that these two techniques can be used interchangeably as a part of a multimodal analgesia method postoperatively in the first 24 hours after TKA operations. In this study, we did not compare the early postoperative mobilization of patients. Therefore, we did not record early motion pain. We also recommend well-structured clinical trials with appropriate protocols to compare early motion pain.

Declaration of conflict of interest

The authors received no financial support for the research and/or authorship of this article. There is no conflict of interest.

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