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A comparison of peri-articular injection and femoral block for pain management after total knee arthroplasty: A prospective cohort study

Total diz artroplastisi sonrası periartiküler enjeksiyon ile femoral bloğun ağrı üzerindeki etkinliğinin karşılaştırılması: Prospektif kohort çalışma

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Abstract

Aim: Though Total knee arthroplasty (TKA) is an effective treatment method for osteoarthritis, insufficient postoperative pain control negatively affects patients' satisfaction and functional results. The aim of this study is to compare the effects of intraoperative peri-articular injection and postoperative single-dose femoral nerve block on functional results, the need for analgesia, and pain in the short-term following total knee arthroplasty (TKA).

Methods: Thirty-one patients who received peri-articular injection (PAI) during TKA and 38 who were administered a single dose of femoral nerve block (FNB) postoperatively were evaluated. In both groups, an intravenous patient-controlled analgesia (PCA) device was utilized for postoperative analgesia. Analgesia demand and the amount administered from the PCA in the first 24 hours were recorded. For the evaluation of the level of postoperative pain, a visual analog scale (VAS) was used at rest at 2nd, 4th, 8th, 12th, and 24th hours, and dynamic VAS was used at the 24th hour to assess pain with mobilization. Range of movement (ROM) was recorded with the measurements of active flexion and extension angles at the first, second and third postoperative days.

Results: The resting VAS scores at the 2nd, 4th, 8th, and 24th hours were significantly lower in the PAI group than in the FNB group (P=0.032, P=0.037, P=0.014, P=0.004, respectively). The number of patients' demands on the PCA for pain relief and the number of doses administered were higher in the FNB group. The ROM values measured on postoperative days 1, 2, and 3 were insignificantly greater in the PAI patients (P=0.956, P=0.103, P=0.162, respectively).

Conclusion: The peri-articular injection technique, when used appropriately, is easy to apply with a low-side effect profile. Therefore, it can be considered a safe and effective analgesia method providing a higher level of patient comfort and greater range of movement.

Keywords: Peri-articular injection, Femoral nerve block, Total knee arthroplasty, Pain management

Öz

Amaç: Total diz artroplastisi (TDA) diz osteoartriti için etkili bir tedavi yöntemi olmasına rağmen, postoperatif yetersiz ağrı kontrolünün uygulanması hastaların memnuniyetini ve fonksiyonel sonuçları etkiler. Bu çalışmanın amacı intraoperatif periartiküler enjeksiyon ile postoperatif tek doz femoral sinir bloğunun total diz artroplastisi sonrası erken dönemde ağrı, analjezik gereksinimi ve fonksiyonel sonuçlar üzerine olan etkilerini karşılaştırmaktır.

Yöntemler: Total diz artoplastisi sırasında intraoperatif periartiküler enjeksiyon uygulanan (PAG) 31 hasta ve postoperatif tek doz femoral sinir bloğu uygulanan (FBG) 38 hasta çalışmada değerlendirildi. Postoperatif iki gruba da analjezi için intravenöz hasta kontrollü analjezi (PCA) cihazı takıldı. 24 saatlik analjezik talebi ve PCA'dan verilen miktar kaydedildi. Postoperatif ağrı düzeyini değerlendirmek için istirahatte vizüel analog skala (VAS) skoru 2., 4., 8., 12. ve 24. saatlerde, mobilizasyon ile değerlendirmeye başlanan dinamik VAS (DVAS) ise 24. saatte değerlendirildi. 1. gün, 2. gün ve 3. günde aktif fleksiyon ve ekstansiyon dereceleri ölçülerek eklem hareket açıklıkları (EHA) kaydedildi.

Bulgular: Postoperatif sırasıyla 2., 4., 8. ve 24. saatteki istirahat VAS skorları PAG'ta FBG'na göre anlamlı şekilde daha düşük bulundu (sırasıyla P-değerleri: P=0,032, P=0,037, P=0,014, P=0,004). Ağrı kontrolü için kullanılan PCA'ya basma miktarı ve PCA tarafından verilen doz sayısı PAG'ndaki hastalarda FBG'undaki hastalara göre daha az olduğu görüldü. PAG'ndaki hastaların eklem hareket açıklıklarının 1., 2. ve 3. günlerde daha fazla ölçülmesine rağmen iki grup arasındaki bu fark anlamlı bulunmadı (sırasıyla P-değerleri: P=0,956, P=0,103, P=0,162).

Sonuç: Periartiküler enjeksiyon tekniğine uygun olarak uygulandığı zaman kolay uygulanabilir, düşük yan etki profili ile ameliyat sonrası daha yüksek düzeyde hasta konforu ve daha fazla hareket açıklığı sağlayan etkili ve güvenilir bir analjezi yöntemidir.

Anahtar kelimeler: Periartiküler enjeksiyon, Femoral sinir bloğu, Total diz artroplastisi, Ağrı yönetimi

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Introduction

With appropriate pain control following total knee arthroplasty (TKA), early functional healing can be provided, and patient satisfaction can be increased. Therefore, multimodal analgesia methods, such as intravenous opioids, peripheral nerve blocks, epidural analgesia, intra-articular injections, infiltration catheter, pre-incisional injections, and oral analgesics [1-3] can be used after TKA. The aim of multimodal analgesia is to reduce narcotic consumption to a minimum while providing pain control through different clinical pathways, thereby avoiding side-effects such as nausea, vomiting, respiratory depression, and urinary retention [4,5].

Although there is no consensus on a gold standard for postoperative pain management, to reduce opioid consumption and avoid opioid-related side-effects, there is now a trend towards multimodal approaches with regional anesthesia for more effective postoperative pain management [6].

The aim of this study was to compare the effects of intraoperative peri-articular injection and postoperative femoral nerve block on functional results, the need for analgesia, and pain in the short-term following TKA.

Materials and methods

This prospective cohort study included patients who underwent TKA surgery for moderate-advanced osteoarthritis in Bartın State Hospital between 2018 and 2019. The study was performed in accordance with the principles of Declaration of Helsinki and approved by the local Ethics committee (no: 2016/02-14). Patients who received spino-epidural or general anesthesia during the surgery, those who underwent bilateral knee surgery in the same session, and those to which multimodal analgesia methods other than peri-articular injection or femoral nerve block had been applied were excluded. A total of 69 patients who underwent TKA under spinal anesthesia were included in the study, comprising 31 patients who received peri-articular injection (PAI group), and 38 who received postoperative single-dose femoral nerve block (FNB group) (Table 1).

Premedication of 0.03 mg/kg intravenous (iv) midazolam (Zolamid®, Defarma, Ankara, Turkey) was administered to all patients in the operating room. Preoperative hydration was provided by 15-20 ml/kg saline administered intravenously in 30 minutes. With the patient in a sitting position, the appropriate area was cleaned, and the subarachnoid space was entered with a 25 G Quinke spinal needle (Egemen ®, Izmir, Turkey) from the midline between L3-4 or L4-5 vertebrae. After the visualization of cerebral spinal fluid (CSF), 10-15 mg 0.5% bupivacaine HCl was administered (Buvasin® 0.5% spinal heavy, VEM, Tekirdağ, Turkey). Following the application of spinal anesthesia, the sensory level was determined with pinprick test and the motor block level with Bromage score: 0: no paralysis, 1: only the knee and foot can be moved, 2: the knee cannot be flexed and only the foot can be moved, 3: the foot and big toe cannot be moved, total paralysis. The surgical procedure began when sensory block reached T10 level and the Bromage score was 2.

All the operations were performed under pneumatic tourniquet. The tourniquet pressure was adjusted to be 150 mmHg higher than the systolic blood pressure of the patient. All patients were approached with an anterior incision and the joint was reached with medial parapatellar arthrotomy. The same prosthesis was used in all cases. A patellar implant was not used in any of the patients. All patients received drains.

For the PAI group, a 100ml solution was prepared in two 50ml syringes, comprising 20ml 0.5% bupivacaine (Bustesin®, Vem, Ankara, Turkey), 0.6ml of 1 mg/ml adrenalin (Adrenalin®, Oesel, Istanbul, Turkey), 1ml of 100 mcg/ml of dexmedetomidine(Precedex®, Meditera, Izmir, Turkey), 4 ml of 8.4% magnesium sulphate (Magnezyum Sulfat®, Biofarma, Istanbul, Türkiye), 4 ml of 10 mg/ml methylprednisolone (Prednol-L®, Mustafa Nevzat, Istanbul, Turkey), 5 ml of 10 mg/ml morphine (MorphineHCl®, Galen, Istanbul, Turkey) and 65.4 ml saline. When administering the injections, attention was paid to areas with increased neurosensorial and mechanoreceptors, as defined in the study by Dye et al [7].

The injections were administered using the technique described by Guild et al [8]. Sixty milliliters of the prepared mixture was injected to the tibial and femoral incisions, then to the medial retinaculum, medial collateral ligament, the medial meniscocapsular junction, the attachment site of the posterior cruciate ligament to the tibia, the attachment site of the anterior cruciate ligament to the femur, the lateral retinaculum, the lateral collateral ligament and the lateral meniscocapsular junction (Figure 1a). Care was taken not inject more than 2-3 ml of active substance at once into each point to avoid overflow to soft tissue. Following placement of the tibial and femoral components, the remaining 40cc of the mixture was administered to the suprapatellar pouch, quadriceps tendon, patellar tendon, and patellar fat pad (Figure 1b).

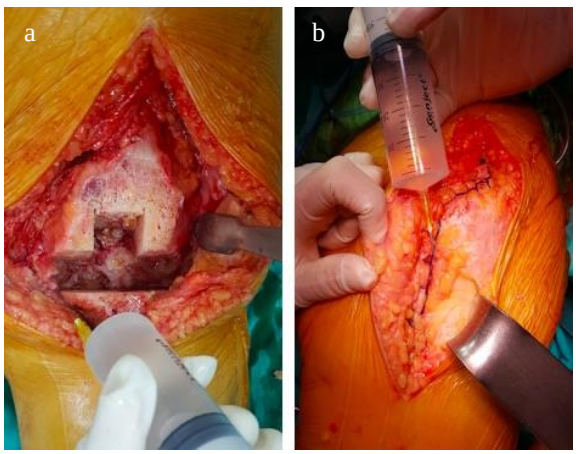

Figure 1a-b: Periarticular injection to the tibial - femoral incisions, and after closure of the joint

The patients in the femoral nerve block (FNB) group were transferred to the recovery room postoperatively. With the patient in a supine position, under ultrasound guidance (SonoSite S-Nerve, Bothell, WA, USA) using a linear probe, the femoral artery was identified immediately below the inguinal ligament (Figure 2a). With visualization of the femoral nerve, and following negative aspiration, 10 mL 0.5% bupivacaine (Bustesin ®, Vem, Ankara, Turkey) was administered along the nerve sheath using a 50mm stimulation needle (Stimuplex, Kanule A, B Braun, Germany) (Figure 2b, 2c).

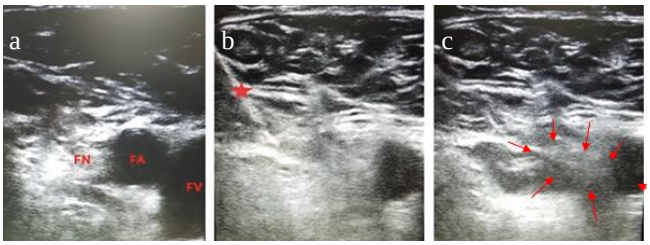

Figure 2: a: Identification of the femoral artery, vein, and nerve. b: The stimulation needle reaching the nerve sheath c: application of anesthesia, Star: Stimulation needle

For postoperative analgesia, both groups received an intravenous patient-controlled analgesia (PCA) device (CADD-Legacy® PCA, Smiths Medical, St Paul, USA). A tramadol solution at a concentration of 4mg/mL was prepared by adding 400mg tramadol to 100mL 0.9% NaCl. The PCA was adjusted to administer 10 mg infusion, with a 10ml bolus at a dose-locked period of 20 mins.

For the evaluation of the level of postoperative pain, a visual analog scale (VAS) was used at rest at the 2nd, 4th, 8th, 12th and 24th postoperative hours. Pain with mobilization was evaluated with dynamic VAS (DVAS) at the 24th hour. The PCA was used for 24 hours and 24-hour analgesia demand and amount administered by PCA were recorded. If postoperative analgesia control was not sufficient, 50 mg dexketoprofene trometamol (Ketavel ®, DEVA, Kocaeli, Turkey) was administered intravenously for rescue analgesia.

Joint range of movement (ROM) was assessed by the active flexion and extension angles measured on postoperative days 1, 2, and 3.

Statistical analysis

Data obtained in the study were analyzed using SPSS for Windows v11.5 software (SPSS Inc., Chicago, IL, USA). Descriptive statistics were presented as mean ± standard deviation and as median (minimum-maximum) for normally and non-normally distributed values, respectively. Nominal variables were shown as number (n) and percentage (%). As there were two groups, the significance of the difference between the groups was evaluated with the Student's t-test or the Mann Whitney U-test. Categorical variables were evaluated with the Pearson Chi-square test or the Fisher Exact test. A value of $P<0.05$ was considered statistically significant.

Results

No significant differences were determined between the groups with respect to age, gender, height, weight, and comorbid diseases such as hypertension, coronary artery disease, chronic obstructive pulmonary disease, diabetes, or asthma. All patients had varus alignment. The deformities of the patients were similar (Table 1).

The resting VAS scores at the 2nd, 4th, 8th and 24th postoperative hours were significantly lower in the PAI group than in the FNB group. DVAS results assessed after mobilization at the 24th postoperative hour were similar between the two groups (Table 2).

The number of patients' demands on the PCA was lower in the PAI group. The doses delivered by the PCA within 24 hours were alike. Insignificantly fewer patients in the PAI group required rescue analgesia (Table 3).

The joint ROM values measured on postoperative days 1, 2, and 3 were insignificantly greater in PAI patients (Table 4).

Table 1: Demographic data of the patients

	PAI (n=31)	FNB (n=38)	*P*-value
Age (years) #	66.29(7.39)	67.02(7.81)	0.691
Gender (F) α	26(83.9%)	27(71.1%)	0.209
(M) α	5(16.1%)	11(28.9%)	
Weight (kg) #	76.90(12.54)	76.18(11.46)	0.805
Height (cm) #	163.39(5.73)	162.95(6.62)	0.772
Presence of comorbid diseases α	28(90.3%)	33(86.8%)	0.722
ASA α			
I	7(22.6%)	7(18.4%)	
II	20(64.5%)	27(71.1%)	0.810
III	4(12.9%)	4(10.5%)	
Preoperative Deformity # (Degree)	8.54(5.23)	8.65(4.36)	0.925

ASA: American Society of Anesthesiology, # mean (standard deviation), α n(%)

Table 2: Postoperative resting and dynamic pain scores

	VAS			DVAS		
	PAI	FNB	*P*-value	PAI	FNB	*P*-value
2 hours post-op€	1 (0-5)	2 (0-5)	0.032*	-	-	-
4 hours post-op €	1 (0-6)	2.5 (0-6)	0.037*	-	-	-
8 hours post-op €	1 (0-6)	4 (0-6)	0.014*	-	-	-
12 hours post-op €	2 (0-6)	4 (0-6)	0.064	-	-	-
24 hours post-op €	4 (2-6)	6 (2-8)	0.004*	4 (2-6)	6 (2-8)	0.064

*p<0.05, € median (minimum-maximum)

Table 3: Requirement for analgesia in the postoperative period

	PAI	FNB	*P*-value
Number of demands on PCA in 24 hours €	17 (11-83)	24,5 (13-57)	0.002*
Number of analgesia doses administered by PCA in 24 hours €	16 (8-23)	17 (10-23)	0.126
Number of patients requiring rescue analgesia α	2(6.5%)	9(23.7%)	0.095

*p<0.05, € median (minimum-maximum), α n (%)

Table 4: Postoperative ROM values (degrees)

	PAI	FNB	*P*-value
ROM 1#	99.51(13.80)	98.68(12.61)	0.956
ROM 2#	104.35(12.95)	99.73(10.58)	0.103
ROM 3#	107.58(10.07)	103.94(9.09)	0.162

mean (standard deviation)

Discussion

In this study, the effects of intraoperative peri-articular injection and postoperative single-dose femoral nerve block on postoperative pain were compared. The results showed that the VAS scores at the 2nd, 4th, 8th and 24th postoperative hours, along with the number of demands on the PCA device, were significantly lower in the PAI group. The mean DVAS values, examined with mobilization, were insignificantly higher in the FNB group.

TKA is a routinely performed orthopedic procedure and severe postoperative pain reduces patient satisfaction, limits joint ROM, and delays healing and rehabilitation [9]. Although systemic opioids administered after TKA are still an effective and easy-to-apply pain control method, there are several side-effects on the respiratory, circulatory, urinary, gastrointestinal, and nervous systems [10,11]. Therefore, various methods such as pre-emptive analgesia, preventative analgesia and multimodal analgesia have been developed for improvement of postoperative pain control and management. Although there is no consensus on a gold standard for postoperative pain management, to reduce opioid consumption and avoid opioid-related side-effects, there is now a trend towards multimodal approaches with regional anesthesia for more effective postoperative pain management [6].

In a previous study conducted to avoid the potential side effects of epidural analgesia and compare its efficacy with that of peri-articular injection, peri-articular injection was reportedly more effective than epidural analgesia in reducing postoperative pain and regaining knee flexion, and the incidence of side-effects such as nausea was lower [12].

In the current study, periarticular injection and single-dose femoral nerve block were selected to minimize the systemic effects of opioids and to prioritize the efficacy of multimodal

analgesia. Kovalak et al. [13] compared the effects of continuous femoral nerve block and peri-articular injection, and reported that patients who received continuous femoral nerve block experienced less postoperative resting and dynamic pain than the patients who received peri-articular injection, had lower PCA requirement and reached greater ROM. The difference from our study was that infiltration anesthesia was administered to the posterior capsule of the knee joint continuously for 24 hours.

It has been reported that although nerve blocks are effective for pain relief following TKA, there is an increased risk of quadriceps weakness and postoperative falls because of the motor and sensorial block caused by femoral nerve block [5-14]. In addition, despite more frequent application of continuous femoral blocks, there are studies which show that the application of single dose femoral nerve block is a simpler and cheaper method [15].

In our study, while benefit was obtained from the regional analgesic efficacy of femoral nerve block, single-dose application was preferred to avoid possible adverse effects. In a similar study, Youm et al. [15] administered single-dose FNB, PAI and FNB+PAI, and reported that in the early postoperative period (0-8 hours), PAI was more effective on pain, but at 24 hours, rebound pain was determined in the PAI group. It was concluded that the combination of FNB+PAI could avoid this and provide better pain management.

The VAS and DVAS scores evaluated at the 24th postoperative hour were lower in the PAI group in this study. No 24-hour rebound pain was observed, as mentioned in the previous study. This was attributed to the use of bupivacaine in both our groups, with an effect lasting 30 hours, in contrast to the 24-hour-long effect of ropivacaine, which was used in the other studies [16].

Examining the number of PCA demands allowed the quantitative evaluation of the pain level and the values were consistent with the VAS values in the first 24 hours. The number of PCA demands, in other words, the need for pain relief, of the patients in the PAI group with lower mean VAS values were also lower. Similarly, fewer patients in the PAI group required rescue analgesia. In accordance with these data, PAI can be considered to provide better analgesia.

In this study, the ROM values obtained on the 1st, 2nd and 3rd postoperative days were better in the PAI group compared to the FNB group. In the literature, different multimodal analgesia methods were reported to have conflicting effects on ROM and functional results [1,3,12,13,17]. Evaluating the results of our study and the others, it can be said that sufficient analgesia in the early postoperative period has a direct effect on ROM. A reduction in pain after exercise increases patient comfort and encourages patients to exercise [18].

Limitations

There were some limitations to this study. First, patients could not be randomized and there was no preoperative ROM measurement. It should not be forgotten that studies with a greater number of subjects could obtain different results. Moreover, postoperative functional status could be better evaluated using scoring systems such as the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and the Knee Society Score (KSS) in addition to joint ROM measurements.

Conclusion

Peri-articular injection can be recommended as a safe and effective analgesia method. It can be easily applied to the knee joint with appropriate technique, and it provides greater postoperative patient comfort.

To date, there is no consensus on the best practices for pain management following TKA. Further research would be needed to determine the best procedure regarding the use of multimodal analgesia in clinical practice. We will continue to see the development of clinical practice to optimize better postoperative algorithms in pain control.

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