



Ultrasound-guided single-injection femoral nerve block provides effective analgesia after total knee arthroplasty up to 48 hours

Ultrasonografi eşliğinde yapılan tek doz femoral sinir bloğu diz artroplastisi sonrası 48 saat'e kadar etkin analjezi sağlar

Levent ŞAHİN,¹ Halil Fatih KORKMAZ,² Mehrican ŞAHİN,³ Güneri ATALAN⁴



Summary

Objectives: The purpose of this study is to evaluate the effects of ultrasound (US) guided single-injection femoral nerve block (FNB) spinal anesthesia on pain control, morphine consumption, adverse effects, and patient satisfaction during the postoperative 48-hour period in patients undergoing total knee arthroplasty (TKA).

Methods: One hundred four ASA physical status I–III patients undergoing single TKA for degenerative joint disease were enrolled in this clinical study. Patients were randomly distributed into two groups: US-guided single-injection FNB with 40 ml of 0.5% bupivacaine and 1:200,000 epinephrine was administered to Group F (n=51) patients. Preservative-free saline was injected in Group P (n=53) patients using the same method as Group F. Pain scores, morphine consumption, incidences of adverse events, and patient satisfaction were assessed over the course of 48 hours.

Results: Group F used significantly less morphine compared with Group P (18.7 mg vs. 39.6 mg) during the first 48 hours after surgery (p<0.001). When compared with group P, the VRS scores both at rest and during movement were significantly lower in Group F at 4, 8, 12, 24, and 48 hours after TKA (for all comparisons p<0.001). In addition, patient satisfaction was better in Group F than Group P.

Conclusion: This study suggests that a US-guided single-injection femoral nerve block following TKA improves patient satisfaction and reduces consumption of morphine during the first 48 hours.

Key words: Analgesia; bupivacaine; femoral nerve block; knee arthroplasty; ultrasound.

Özet

Amaç: Bu çalışmanın amacı spinal anestezi ile total diz artroplastisi (TDA) yapılan hastalarda postoperatif 48 saatlik periyotta ultrason (US) kılavuzluğunda tek doz femoral sinir bloğunun (FSB) ağrı kontrolü, morfin tüketimi, olumsuz etkiler ve hasta memnuniyeti üzerine etkilerini değerlendirmek.

Gereç ve Yöntem: Dejeneratif eklem hastalığı nedeniyle tek taraflı TDA uygulanacak, ASA fiziksel durumu I-III olan 104 hasta bu çalışmaya dahil edildi. Hastalar rastgele iki guruba ayrıldı: Grup F (n=51) hastalara US kılavuzluğunda FSB'da 1: 200,000 epinefrin ilave edilmiş 40 ml %0.5 bupivakain, Grup P (n=53) hastalara aynı metod ile koruyucu serbest salin enjeksiyonu yapıldı. Ağrı skorları, morfin tüketimi, olumsuz olaylar ve hasta memnuniyeti 48 saat boyunca değerlendirildi.

Bulgular: Cerrahi sonrası ilk 48 boyunca Grup F'de Grup P ile kıyaslandığında anlamlı olarak daha az morfin tüketilmiştir (18.7 mg ile 39.6 mg, p<0.001). Dört, 8, 12, 24 ve 48. saatlerde Grup P ile karşılaştırıldığında Grup F'de hem istirahatette hem de hareketle VRS skorları anlamlı olarak daha düşüktür (tüm karşılaştırmalar için p<0.001). Ayrıca hasta memnuniyeti Grup F'de Grup P'den daha iyiydi.

Sonuç: Bu çalışma US kılavuzluğunda tek doz femoral sinir bloğunun TDA'ni takiben ilk 48 saatte hasta memnuniyetini artırdığı ve morfin tüketimini azalttığını göstermiştir.

Anahtar sözcükler: Analjezi; bupivakain; femoral sinir bloğu; diz artroplastisi; ultrason.

¹Department of Anesthesiology, Gaziantep University Faculty of Medicine, Gaziantep, Turkey;

²Department of Anesthesiology, Kütahya State Hospital, Kütahya, Turkey;

³Department of Anesthesiology, 75. Yıl State Hospital, Gaziantep, Turkey;

⁴Department of Anesthesiology, Elazığ State Hospital, Elazığ, Turkey

¹Gaziantep Üniversitesi Tıp Fakültesi Hastanesi, Anesteziyoloji Anabilim Dalı, Gaziantep;

²Kütahya Devlet Hastanesi, Anesteziyoloji Bölümü, Kütahya;

³75. Yıl Devlet Hastanesi, Anesteziyoloji Bölümü, Gaziantep;

⁴Elazığ Devlet Hastanesi, Anesteziyoloji Bölümü, Elazığ

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Correspondence (İletişim): Dr. Levent Şahin. Gaziantep Üniversitesi Tıp Fakültesi Hastanesi Anesteziyoloji ve Reanimasyon Kliniği Ameliyathane, Gaziantep, Turkey.

Tel: +90 - 342 - 360 60 60 e-mail (e-posta): drlsahin@hotmail.com

Introduction

Pain control after total knee arthroplasty (TKA) is an important factor in optimal postoperative knee rehabilitation.^[1] For analgesia after TKA, single-injection femoral nerve block (SFNB) has been widely studied and found to significantly improve pain control and functional outcomes such as knee flexion and length of hospital stay.^[2] The analgesia duration of SFNB applied without US has been found to be more or less than 24 hours.^[3-5] Because it improves localization of the nerve and visualization of the spread of the LA solution, US-guided SFNB results in improved blocking characteristics such as faster onset and longer duration.^[6,7] Studies about US-guided SFNB with high-volume LA and follow-up over 48 hours are rare in the literature. We wonder whether or not SFNB with high volume LA can provide postoperative analgesia over 48 hours.

The present prospective, randomized, double-blind, and placebo-controlled study was designed to investigate the efficacy of US-guided SFNB using 40 ml volume LA in the management of pain after TKA under spinal anesthesia over the postoperative 48 hours.

Materials and Methods

This prospective, randomized, double-blind, and placebo-controlled clinical study was reviewed and approved by the Dumlupınar University, Faculty of Medicine, Ethics Committee. After obtaining written informed consent, 104 patients with American Society of Anesthesiologists Physical Status Scores (ASA-PS) I-III undergoing single TKA for degenerative joint disease were enrolled in the clinical study. Patients were excluded if they were <40 or >80 years of age, pregnant, or had a history of the following: chronic obstructive lung disease, allergy to a study drug, chronic pain syndrome unrelated to their knee pathology, chronic opioid use, contraindications to regional anesthesia, or inability to understand verbal rating score (VRS) for pain (0=no pain; 10=worst pain imaginable) or patient-controlled analgesia (PCA) device usage. Once enrolled, patients were removed from the study if they experienced a failed femoral nerve block or spinal anesthesia. During the preoperative visit, patients were briefed on the use of the PCA device (Life Care Abbott PCA 4100 pump, USA).

Patients were randomized into one of two groups on the day of surgery, using computer-generated assignment. Premedication consisted of 1-2 mg of intravenous midazolam for all patients at the discretion of the anesthesia team. After placement of standard ASA monitors and supplemental oxygen, both groups received 15 mg of intrathecal hyperbaric bupivacaine (Marcaine spinal heavy 0.5% AstraZeneca, Lüleburgaz, Turkey) as the surgical anesthetic agent. Intrathecal injections were performed, with the patient in a sitting or lateral position, through the L3-4 or L4-5 interspace. Intraoperative sedation was achieved by intravenous midazolam titrated at the discretion of the primary anesthesiologist team. TKA was performed by one of two surgeons using the same surgical technique and implants. Intraoperative data that was collected includes tourniquet time and duration of surgery, defined as the time elapsed from skin incision to bandage application. In the FNB group (Group F, n=51) patients, a single shot of FNB was performed in the recovery room when the spinal block height was regressed to T12. The other group (Group P, n=53) received a placebo injection with normal saline of an equal volume. Under sterile conditions, the femoral artery and nerve were visualized using a high-resolution ultrasound device (Mindray DC-6 Expert Diagnostic Ultrasound System linear array transducer 10L4, China) at the inguinal crease. Then, a 21-gauge insulated needle (PlexoLong Nanoline Pajunk, Geisingen, Germany) was advanced under US. The final position of the needle was verified with the use of a nerve stimulator (Stimuplex HNS 12, B Braun, Germany). The end-point used for injection was an ipsilateral quadriceps contraction at <0.5 mA. At that point, 40 ml of 0.5% bupivacaine with 1:200,000 epinephrine was injected slowly after negative aspiration. The injection of LA was visualized with US. Each patient, regardless of group assignment, had a dry sterile dressing placed on his or her groin.

Postoperatively, all patients received a PCA pump programmed to deliver 2 mg intravenous morphine on demand with a lockout time of ten minutes for the first 48 hours after operation. During the hospital stay, all patients received 600 mg oral ibuprofen three times a day, beginning in the afternoon on the day of surgery. Postoperative antiemetic medication was standardized: intravenous metoclopramide (10

Table 1. Demographic data and preoperative parameters

	Group P (n=53)	Group F (n=51)
Age (yr)	59±6.8	61±5.9
Sex (F/M)	37/16	34/19
Weight (kg)	77±14.6	75±12.9
ASA-PS II	28	24
ASA-PS III	25	27
Tourniquet time (min)	69±14.5	74±12.7
Operation time (min)	98±19.4	104±22.3
Spinal injection-FNB interval	166±33.6	158±25.8

Values expressed as mean±SD or numbers (n). Group P: sham block; Group F: femoral nerve block (FNB).

mg) was given as required, and ondansetron (8 mg) was administered if nausea persisted 30 minutes after metoclopramide.

Postoperative data was collected by independent observers blinded to the groups. Time 0 was defined as when FNB was applied. The following measurements were recorded: VRS at rest and movement as primary aim; cumulative morphine consumption; incidence of adverse events (presence of nausea or vomiting, pruritus, dizziness, and injection site infection/hematoma); and patient satisfaction as secondary aims were also recorded at 1, 4, 8, 12, 24, and 48 hours, postoperatively. Prior to discharge, the patients were asked to assess their satisfaction with their anesthetic experience on a four-point categorical scale (1=outstanding; 2=very good; 3=satisfactory; 4=unsatisfactory).

After the power analysis of the incidence of postop-

erative rest pain scores at 48 hours, total sample size was 86, and effect size was 0.72 (alpha=0.05, actual power=0.95, delta=3.32). The independent sample t-test for parametric data, Wilcoxon test for VRS, and Mann-Whitney U-test were used for patient satisfaction. Statistical significance was reported when the p value was <0.05. The results of the study were evaluated using the SPSS statistical analysis package (Statistical Package for Social Sciences Release 15.0 for Windows).

Results

Of the 110 patients who underwent elective TKA surgery, six patients experienced inefficient spinal anesthesia and were excluded from the study. Of the remaining 104 subjects, 53 patients were included in the placebo group and 51 patients in the FNB group. There was no statistically significant difference in patients' age, weight, gender, ASA classifica-

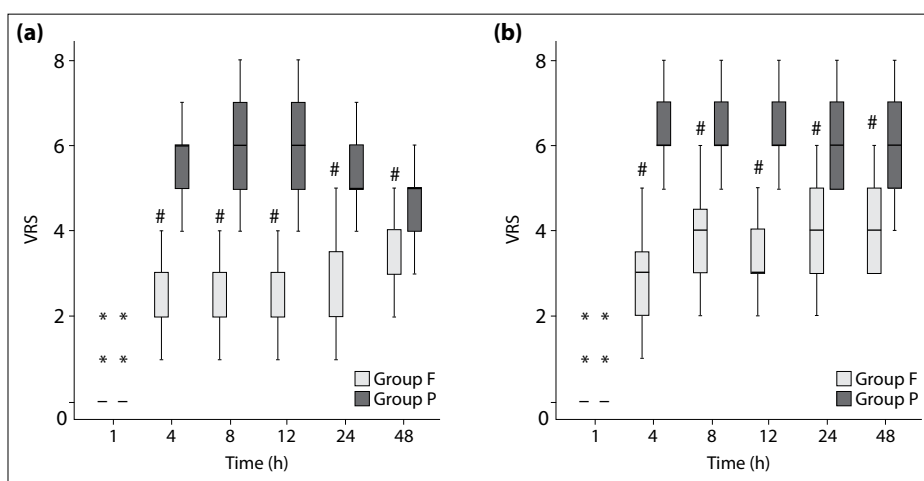


Figure 1. (a) Verbal rating score (VRS) for pain at rest in both groups. (b) Verbal rating score (VRS) for pain at movement in both groups. Values expressed as median (range). Group P: sham block; Group F: femoral nerve block; # p<0.001 between groups.

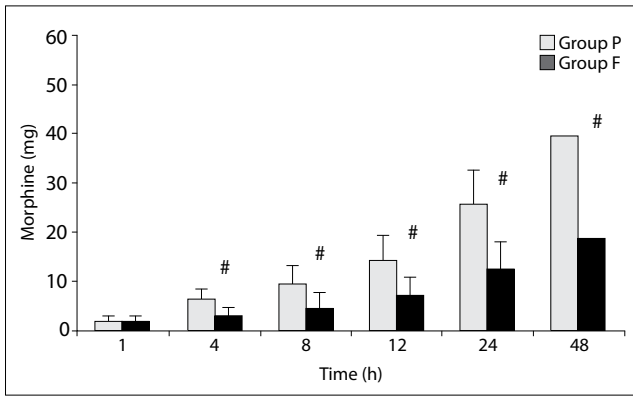


Figure 2. Cumulative morphine use for sham block compared with femoral nerve block. Values expressed as mean±SD. Group P: sham block; Group F: femoral nerve block; # p<0.001 between groups.

tion, tourniquet time, duration of operation, and times from spinal injection to the FNB procedure between the two groups (Table 1).

VRS over 48 hours at rest and during movement as primary outcomes are presented in Figures 1a and b. Except for VRS at rest and movement at the first hour, there were significant differences between VRS between the groups at all times, both at rest and during movement (for all p<0.001). The amount of cumulative morphine consumption from the secondary outcomes was significantly lower in Group F compared to Group P at all times, except for the first hour (Figure 2). Group P used more morphine compared to Group F (25.6±7.2 vs. 12.4±5.3 mg [p<0.001], 39.6±11.2 vs. 18.7±9.6 mg [p<0.001]

respectively) during the first 24 and 48 hours after surgery. A significant difference was found between the satisfactory levels of Group F and Group P (Table 2) as other secondary outcomes. Adverse symptoms related to analgesic treatment such as nausea, vomiting, pruritus, and dizziness were not found to be statistically different between the two groups (Table 3). There were no complications of prolonged anesthesia, infectious complications, or damage to the femoral nerve from the FNB procedure.

Discussion

The most important finding of the present study, US-guided SFNB with 40 ml of 0.5% bupivacaine compared to the placebo provides lower VRS both at rest and during movement, and significantly less morphine consumption during the first 48 hours following TKA.

FNBs, both continuous and single-injection techniques, are effective strategies for providing postoperative analgesia, opiate-sparing effect, and fewer associated adverse effects after TKA.^[8-11] In addition, femoral nerve blocks can reduce the reflex of the quadriceps muscle, thus reducing pain and muscle spasms,^[12] which may provide a positive contribution in facilitating physical therapy and early ambulation, as well as reduce the length of hospitalization.^[11,13] In this study, longer analgesia time may have resulted from the injection of high-volume LA

Table 2. Patient satisfaction

	Group P (n=53)	Group F (n=51)	p
Patient satisfaction	4 (1-4)	2 (1-4)	<0.01

Values expressed as median (range). Group P: sham block; Group F: femoral nerve block.

Table 3. Adverse effects related to analgesic treatment

Adverse effects	Group P (n=53)		Group F (n=51)		p
	n	%	n	%	
Nausea	13	25	9	18	NS
Vomiting	10	19	6	12	NS
Pruritus	7	13	4	8	NS
Dizziness	10	19	7	14	NS

Values expressed as number (percent). Group P: sham block; Group F: femoral nerve block; NS: not significant (p>0.05).

into the right place, due to direct observation of its spread with US guidance. Thus, reduced complications and increased success rates can be provided with the same LA volume by using US.^[6,7,14] As is well known, reduced LA volume is related to a reduced incidence of LA toxicity. However, high-volume LA was used in this study to verify the hypothesis that higher volume results in longer analgesia. In spite of the high volume, toxicity was not observed. This is likely due to the correct spread of LA under US and the addition of epinephrine to LA in order to slow the absorption of LA.

LA volume for SFNB is an effective factor for analgesia duration. Kardash et al.^[15] reported that the analgesic effect of SFNB with 20 ml LA was less than 24 hours. It can be explained by the fact that low-volume LA without US was used. However, Ozen et al.^[16] and Wang et al.,^[2] who used the high-volume LA, as in this study, found that analgesia time was 10 and 24 hours, respectively. The shorter analgesia duration, in spite of the same volume, may be because US was not used. If US is not used, one can never be sure that the entire anesthetic volume was applied to the right place. In another study, the authors compared SFNB with intrathecal morphine use, using 40 ml LA volume, as in this study. However, they only followed their patients for 24 hours.^[17] Therefore, this present controlled study is a rare study in the literature because of the 48-hour follow-up after US-guided SFNB with high-volume LA. Only one other controlled study reported that the analgesic benefits may extend through 48 hours.^[18] Although they used 0.25% bupivacaine, their results confirm ours.

A recently published meta-analysis related to FNB showed that SFNB reduces PCA morphine consumption and pain scores at 24 hours and 48 hours, compared with PCA alone in an evaluation of ten studies.^[19]

As a limitation we did not compare the single FNB to a continuous one, but considering that continuous FNB is a sophisticated technique with catheter-related complications such as infection,^[20] we believe that US-guided SFNB is a simpler, lower-cost, and effective alternative to femoral catheterization. Although the present study has clinical importance,

the findings could be considered preliminary data, and the results, especially the lower frequency of adverse effects, should be confirmed by larger studies for adequate validation. In addition, further studies must be designed to determine the optimal volume and concentration of US-guided FNB.

In conclusion, a US-guided SFNB with 40 ml volume LA following TKA is an effective and safe method for controlling pain. It decreases morphine consumption and may be a major component in pain management during the first 48 hours.

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