

Pain management in total knee arthroplasty by intraoperative local anesthetic application and one-shot femoral block

Aykut Sigirci

ABSTRACT

Background: Pain after total knee arthroplasty (TKA) is a big problem in orthopaedic surgery. Although opioids and continuous epidural analgesia remain the major options for the postoperative pain management of TKA, they have some undesirable side effects. Epidural analgesia is technically demanding, and the patient requires close monitoring. Different types of local anesthetic applications can successfully treat TKA pain. Local anesthetics have the advantage of minimizing pain at the source. This study investigates the efficacy of different local anesthetic application methods on early, (1st day) pain control after total knee arthroplasty.

Materials and Methods: 200 patients who underwent unilateral TKA surgery under spinal anesthesia were randomly assigned into four different groups (fifty in each group) and were administered pain control by different peri- and postoperative regimens. Group A was the control group wherein no postsurgical analgesia was administered to assess spinal anesthesia efficacy; in Group B, only postsurgical one-shot femoral block was applied; in Group C, intraoperative periarticular local anesthetic was applied; in Group D, a combination of the one-shot femoral block and intraoperative periarticular local anesthetics were applied. Demographic data consisting of age, weight, gender and type of deformity of patients were collected. The data did not differ significantly between the four groups.

Results: Group D patients experienced significantly better postoperative pain relief ($P < 0.05$) and were therefore more relaxed in pain (painless time, VAS score) and knee flexion (degrees) than the other patient groups in the 1st postoperative day followup. Painless time of Group D was 10.5 hours and was better than Group C (6.8 hours), Group B (6.2 hours) and Group A (3.0 hours) ($P < 0.05$). Group A got the best pain Vas score degrees in the 1st postoperative day which showed the success of combined periarticular local anesthetic injection and femoral nerve block.

Conclusion: The intraoperative periarticular application of local anesthetics in addition to one-shot femoral block is an efficient way of controlling postsurgical pain after TKA.

Key words: Analgesia, femoral nerve block, pain, painless time, periarticular single-injection, total knee arthroplasty

MeSH terms: Arthroplasty, replacement, knee, analgesics, visual analogue pain scale

INTRODUCTION

Total knee arthroplasty (TKA) is an effective treatment for end stage knee arthritis, but the optimal management of postoperative pain remains

controversial. Owing to the extreme tissue dissection involved, TKA is often cited as one of the most painful known procedures.¹⁻³ Approximately, 20% of patients with osteoarthritis of the knee do not want to undergo TKA because of the expectancy of high levels of pain.² After knee surgery, the pain may also inhibit early rehabilitation to mobilize the knee joint.¹ This can cause muscle atrophy and capsular contractures that may impair the functional outcome. Tissue trauma during major surgery often leads to changes in pain perception by the central nervous

Department of Orthopaedics, Evliya Celebi Training and Research Hospital, Kütahya, Turkey

Address for correspondence: Dr. Aykut Sigirci,
Department of Orthopaedics, Evliya Celebi Training and Research Hospital, Kütahya, Turkey.
E-mail: aykutsigirci@yahoo.com

Access this article online	
Quick Response Code:	Website: www.ijonline.com
	DOI: 10.4103/0019-5413.205688

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Sigirci A. Pain management in total knee arthroplasty by intraoperative local anesthetic application and one-shot femoral block. Indian J Orthop 2017;51:280-5.

system.⁴ After open knee surgery, pain can be associated with severe reflex spasms of the quadriceps muscle, which causes further pain.

Different types of local anesthesia applications can successfully treat TKA pain. Although opioids and continuous epidural analgesia remain the major options for the postoperative pain management of TKA, they have some undesirable side effects. Epidural analgesia is technically demanding, and the patient requires close monitoring after the operation because of complications such as hypotension, nausea, and vomiting.⁵ Patient controlled analgesia pumps also need close monitoring as they are prone to technical errors in their use. The administration of intravenous (IV) opioids after surgery is associated with serious side effects, including sudden hypotension and cardiac arrest, which are difficult to treat and monitor in busy clinical settings.^{3,4} In general, patients undergoing TKA are aged over 55 years and most often have accompanying health problems such as diabetes, hypertension, and cardiac diseases, which restrict high-dosage opioid use.⁶ As a result, it is both challenging and risky to achieve optimum analgesia in such patients.⁷ Although femoral nerve block is an alternative and effective treatment to reduce TKA-associated pain, it does not provide adequate analgesia as the femoral nerve only innervates the anterior side of the knee, and posterior knee pain, which is caused by sciatic nerve, is often present postoperatively.⁸ Local anesthetics, on the other hand, have the advantage of minimizing pain at the site of origin, and have minimal side effects.⁹

To the best of our knowledge, no previous studies have explored the combined analgesic effects of one shot femoral block and the application of intraarticular local anesthesia to control TKA-related pain. In addition, this is the first study to use local anesthetics intraoperatively, instead of sciatic block, to minimize sciatic nerve based pain. Therefore, the aim of this prospective case series study was to assess the treatment of early (first 24 h) postoperative pain using local anesthetic agents. The use of local anesthetics, bupivacaine (long acting), and prilocaine (short acting), was assessed both intra- and postoperatively. Furthermore, intraoperative local anesthetics were used in combination with a femoral block as a novel approach to reduce postoperative pain in a subset of patients.

MATERIALS AND METHODS

All patients signed informed consent form. The study was approved by the institutional board. All the patients were randomly chosen and ranked in the groups according to their orthopaedic polyclinic attendance order. All included patients were operated under lumbar spinal anesthesia by

the author for knee replacement for osteoarthritis treatment between years 2011 and 2014 and were randomly assigned to four different postoperative pain treatment groups ($n = 50$ each). Group A was the control group, wherein no postsurgical analgesia was administered to assess the efficacy of spinal anesthesia alone; in Group B, only a single-injection postsurgical femoral block was applied; in Group C, an intraoperative local anesthetic was applied; and finally, in Group D, a combination of the single-injection femoral block and intraoperative local anesthetics were applied. Patient demographics did not differ significantly between the four groups [Table 1]. Patients with rheumatoid arthritis, diabetes, and thyroid abnormalities as a result of abnormal neuropathic pain responses and those with significant psychiatric disorders were excluded from the study before our study began. No patients were lost during the study followup period.

Immediately after the induction of spinal anesthesia, all patients received 1 g cefazolin, ten minutes before incision. The lower limb was then prepared and draped. It was exsanguinated, and a tourniquet was applied. Surgery was performed through a midline approach. The resection technique was used in each operation and a drain inserted at closure. No opioids were given intraoperatively. The average overall operation time was approximately 1 h in each group. Three different prostheses, all of which were posterior cruciate substituting and mobile were implanted.

In this study, a novel data parameter was introduced of painless time (PT) to determine the efficiency of pain treatments and to compare the success rates between each group. To calculate the PTs, we recorded two time-points: Time point 1 was recorded as when the patient left the operation room (time point 1). No analgesics were supplied to the patients postoperatively and the nurses noted the time when the patient began to feel pain (time point 2). For each patient, the PT value (in hours) was obtained by subtracting time point 2 from time point 1.

Visual analog scale (VAS) was used to assess the intensity of pain; wherein zero denoted “no pain” and 100 denoted

Table 1: Demographic data of patients

Demographic data	Group A	Group B	Group C	Group D
Mean age (in years)	65.6	63.7	64.6	63.4
Mean weight (kg)	83.2	81.3	79.8	80.1
Gender (male, female)	7, 43	6, 44	10, 40	4, 46
Type of deformity				
Varus	45	43	41	38
Valgus	4	4	6	8
Neutral	1	3	3	4
Type of implant	PS	PS	PS	PS
Mean duration of surgery	61.8	61	61.5	62.5

PS=Posterior (Cruciate Ligament) Substituting Knee Prosthesis

the “worst pain.” The patients assessed the intensity of pain at the end of PT and 24 h after the operation by VAS tables [Table 2].

In all groups, after the PT was reached, we first administered nonsteroidal anti-inflammatory drugs (NSAIDs) (tenoxicam IV 2 × 1 dosage) for analgesia; if ineffective, opioids (morphine 10 mg IV or im 2 × 1 dosage) were applied cautiously to avoid nausea, hypotension, and vomiting. In Group A, no postoperative local anesthetic treatment was applied. In Group B, a single-injection femoral block was provided. During the procedure, the operating room anesthesiologist located the femoral nerve precisely within the femoral sheath using a neurostimulator (Stimuplex HNS 12, Braun Melsungen, Melsungen, Germany). After the quadriceps femoris contracted at 0.5 mA as a result, 10cc of bupivacaine and 10 cc of prilocaine mixture were injected into the femoral sheath. In Group D, a mixture of 20 ml prilocaine and 30 ml bupivacaine was administered into the posterior compartment of the knee, the joint capsule, and the area of the collateral ligaments just before the cementation of the arthroplasty components. Just after skin closure, the anesthesiologist applied a femoral block with the neurostimulator in the operating theater. In Group C, only intraoperative local anesthetics were applied in a similar manner to that described in Group D, but without the femoral block.

No complications were observed after local anesthetic application. This may be due to tourniquet application in all TKA operations.

Knee flexion degrees that were calculated with goniometer were also compared within four groups 24 h after the operation.

Mann–Whitney U-test and Kruskal–Wallis tests were used to compare group results. Data were considered statistically significant if $P < 0.05$.

RESULTS

The mean PT was 3 h for Group A. These patients experienced some degree of pain despite the use of opioids. In Group B (femoral block only), the mean PT was 6.2 h. The patients in this group had no major pain on the anterior side but had excessive pain in the posterior part of the knee. Patients received NSAIDs, but opioids were required as they felt pain in all knee compartments even 8 h after the operation. Group C (intraarticular local anesthetics only) had a mean PT of 6.8 h. This group showed a better results than that of Groups A and B, but this was not statistically significant. The mean PT was 10.5 h in Group D, which was statistically much better than Groups A, B, and C ($P < 0.05$). Group D patients mostly felt only slight

pain, which could be treated by applying only 20 mg of an NSAID, tenoxicam. Only eight patients required opioids for analgesia in the 24-h period. The pain intensity was also lower in Group D than the other groups ($P < 0.05$). The patients in this Group D showed a trend toward lower mean VASs during the first 24-h period of this study. VASs did not exceed 50 mm. Intraoperative local anesthetic plus femoral block was very effective in reducing the pain intensity on the 1st day of the postoperative period. Therefore, the treatment of postoperative pain was statistically more successful in Group D than the other three groups.

It was also found that intraarticular and perineural injection of local anesthetics reduced the need for narcotics in the first 24 h period after TKA [Table 3] as local anesthetics may have blocked or attenuated nociception. These drugs also helped in increasing the range of knee motion. Postoperative knee flexion was measured 24 h after the operation, and Group D patients had a better range of motion than the other groups, but this was not statistically significant [Table 4].

On questioning patients 1 month after the operation whether they would consider another TKA on the other knees, Group B showed the highest number of positive responders (82%), followed by Group D (81%), Group C (75%), and finally Group A (70%). The response is shown by Group A most likely reflects the nonuse of local anesthetics [Table 5].

Table 2: Pain degree results of the groups

Pain degrees	Group A	Group B	Group C	Group D
Painless time (hours)	3.0	6.2	6.8	10.5
				($P < 0.05$)
VAS at time point 2	78.6	65.9	60.2	40
VAS 24 h after the operation	44.6	42	34.2	30

VAS=Visual analog scale

Table 3: Analgesics used after painless time

Analgesics needed after painless time	Group A	Group B	Group C	Group D
Narcotics (morphine)	45	20	24	8 ($P < 0.05$)
Nonsteroidal anti-inflammatory drugs (tenoxicam)	5	30	26	42

Table 4: Maximum flexion degrees 24 h after surgery

Range of motion	Group A	Group B	Group C	Group D
Flexion (degrees)	83.6	91.4	98.3	105.2

Table 5: Would you like to have an total knee arthroplasty operation on your other knee?

Number of patients	Group A	Group B	Group C	Group D
Yes	25	28	31	30
No	11	6	10	7
Total	36	34	41	37
Yes/total percentage	70	82	75	81

DISCUSSION

This appears to be the first clinical study to investigate the combined analgesic effects of intraoperative local anesthetic application and one-shot femoral block on post-TKA pain. Postoperative knee pain is a major problem, especially in the first 24 h after TKA. The levels of reported pain are severe in 60% of patients.¹⁰ In this study, the use of nerve blocks and local anesthetics were compared against spinal blocks alone.

The intraoperative application of local anesthetics to the posterior compartment of the knee and the collateral ligaments, in addition to a femoral block, is a very efficient method of pain control after TKA. Moreover, it is safe to perform, and there is no need of excessive doses of analgesics or opioids after surgery. In the meta-analysis of Richman *et al.*, it was concluded that perineural analgesia is better than opioids after knee arthroplasty ($P < 0.001$).¹¹

Nausea, vomiting, sedation, and pruritus all occur more commonly with opioid analgesia than with other agents of pain control.¹² Single-injection peripheral nerve blocks have been shown to provide superior pain control and fewer side effects than opioid use.^{13,14} In this study, single-femoral block decreased pain for an average of only 6 h after the operation, after which patients started to complain of posterior knee pain. When I intraoperatively applied local anesthetics, especially to the posterior part of the knee, the average PT improved to 10 h, and the pain intensity also decreased. Röstlund, Lombardi, and Busch have also previously emphasized the importance and success of wound infiltration by local anesthetics, but nerve blocks were not assessed in this study.^{9,12,13} Furthermore, Liu *et al.* used only femoral block with low-dose local anesthetics for TKA operations, demonstrating the importance of femoral block, but without assessing periarticular injections.¹⁵

Ng *et al.* compared local anesthetic group with femoral block group after TKA and found no difference between the two groups.¹⁶ Yadeau *et al.* compared local analgesic infiltration patients with the patients that had femoral block on the top of epidural block after TKA. Local analgesic infiltration group was successful as femoral block plus epidural block group in pain management.¹⁷ This also supports the results that we had with Group B and Group C. Martin *et al.* used femoral and sciatic blocks in his study, but he applied them before the surgery which means a time loss of at least 2 h for the patients to enable the analgesic effect of local anesthetics.¹¹ However, the success of nerve blocks was also emphasized. Kardash *et al.*⁷ studied the effects of one-shot femoral block after TKA and observed that femoral block decreases pain only in the recovery room.

In this study, patients who had a femoral block were in a painless state for nearly 6 h, but the pain they felt after this time was not at the femoral nerve dermatome, but rather within the sciatic nerve dermatome. Kardash *et al.* also stated the importance of sciatic nerve sensation, but this was not specifically investigated.

The importance of sciatic block was assessed by Ben-David *et al.*, who concluded that femoral block is not sufficient to treat the postoperative TKA pain and sciatic block should be added to the treatment.¹⁸ Sato *et al.* also emphasized the importance of a sciatic nerve block in postoperative knee pain.⁸ In that study, continuous femoral block and single-injection femoral block were applied just before the operation. However, it may be that applying nerve blocks postoperatively is more advantageous as it spares patients the pain of the injections while also conferring a longer period. Furthermore, this is a difficult technique to apply with an externally rotated hip position postoperatively, in addition to the knee surgery. In this study, no sciatic block was applied after the operation, instead, local anesthetics were injected intraoperatively into the posterior compartment of the knee.

Before 2011, only a one-shot femoral block was used for the treatment of postoperative pain in TKA in the author's clinic. Single-injection femoral nerve blocks have been shown to provide superior pain control and fewer adverse effects than opioids.⁶ However, it has been noted in our department that patients require more pain relief in the posterior side of their operated knees than the anterior side as the posterior part of the knee is innervated by the sciatic nerve and its branches [Figure 1]. Osteotomy segments of the knee are also innervated by the sciatic nerve from the S1 root.² While a sciatic block is a solution to this problem, it is a technically demanding procedure that requires considerable patient cooperation to achieve the best position for surgery.¹⁰ For this study, it was therefore decided to only use periarticular local anesthetics intraoperatively for pain relief of posterior compartment instead of sciatic block, in addition to the femoral block which was applied postoperatively. Local anesthetics were intraoperatively administered to the posterior knee compartment and the area of the collateral ligaments. Patients in Group D had longer PT values with reduced pain intensity after this regimen. However, the femoral block was not successful in eight patients in Group D who needed opioids for postoperative knee pain. Femoral blocks cannot be always applied completely. Even with the use of the neurostimulator, femoral nerve can be missed, which is a limitation of this method.

Another limitation of this study is that epidural block and local anesthetics application were not compared. Only local

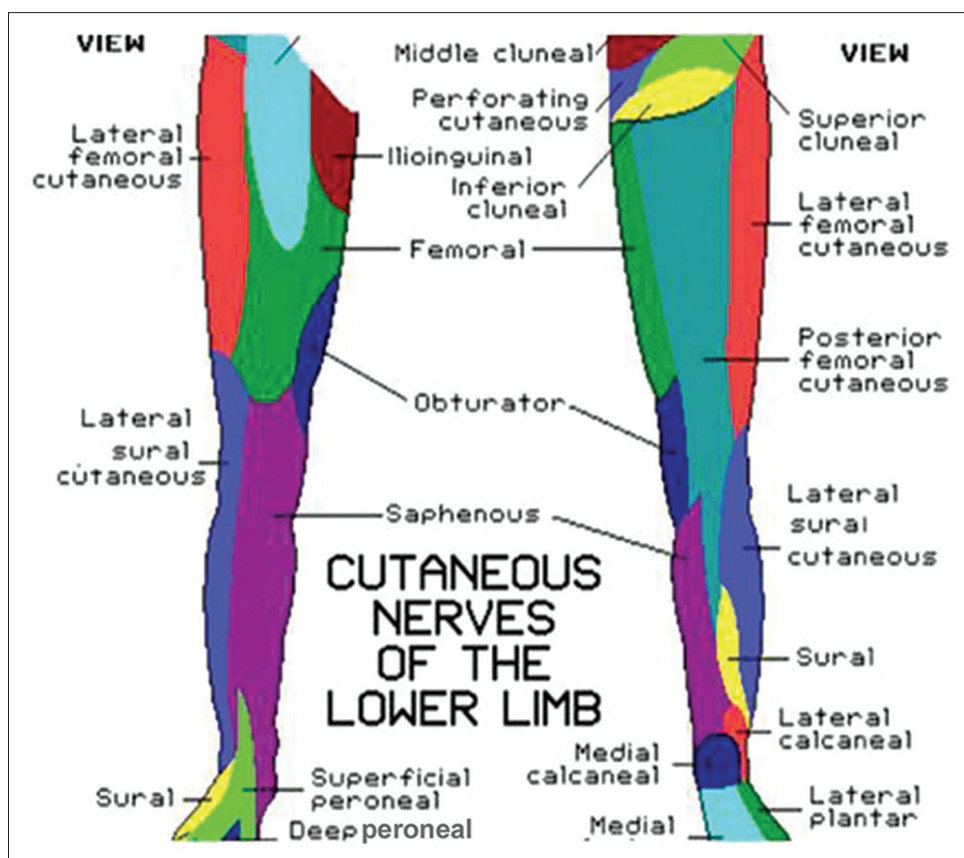


Figure 1: Anterior and posterior dermatomal innervation of knee joint

anesthetic treatments were included in this study. However, in other future studies, these two methods can be compared.

CONCLUSION

A one-shot femoral nerve block with intraoperative periarticular local anesthetic application should be considered as an effective choice for pain management after TKA.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Singelyn FJ, Deyaert M, Joris D, Pendeville E, Gouverneur JM. Effects of intravenous patient-controlled analgesia with morphine, continuous epidural analgesia, and continuous three-in-one block on postoperative pain and knee rehabilitation after unilateral total knee arthroplasty. *Anesth Analg* 1998;87:88-92.
2. Ganapathy S, Wasserman RA, Watson JT, Bennett J, Armstrong KP, Stockall CA, et al. Modified continuous femoral three-in-one block for postoperative pain after total knee arthroplasty. *Anesth Analg* 1999;89:1197-202.
3. Badner NH, Bourne RB, Rorabeck CH, MacDonald SJ, Doyle JA. Intraarticular injection of bupivacaine in knee-replacement operations. Results of use for analgesia and for preemptive blockade. *J Bone Joint Surg Am* 1996;78:734-8.
4. Allen HW, Liu SS, Ware PD, Nairn CS, Owens BD. Peripheral nerve blocks improve analgesia after total knee replacement surgery. *Anesth Analg* 1998;87:93-7.
5. Vendittoli PA, Makinen P, Drolet P, Lavigne M, Fallaha M, Guertin MC, et al. A multimodal analgesia protocol for total knee arthroplasty. A randomized, controlled study. *J Bone Joint Surg Am* 2006;88:282-9.
6. Richman JM, Liu SS, Courpas G, Wong R, Rowlingson AJ, McGready J, et al. Does continuous peripheral nerve block provide superior pain control to opioids? A meta-analysis. *Anesth Analg* 2006;102:248-57.
7. Kardash K, Hickey D, Tessler MJ, Payne S, Zukor D, Velly AM. Obturator versus femoral nerve block for analgesia after total knee arthroplasty. *Anesth Analg* 2007;105:853-8.
8. Sato K, Sai S, Shirai N, Adachi T. Ultrasound guided obturator versus sciatic nerve block in addition to continuous femoral nerve block for analgesia after total knee arthroplasty. *Jpn Clin Med* 2011;2:29-34.
9. Röstlund T, Kehlet H. High-dose local infiltration analgesia after hip and knee replacement – What is it, why does it work, and what are the future challenges? *Acta Orthop* 2007;78:159-61.
10. Robards C, Wang RD, Clendenen S, Ladlie B, Greengrass R. Sciatic nerve catheter placement: Success with using the Raj approach. *Anesth Analg* 2009;109:972-5.
11. Martin F, Martinez V, Mazoit JX, Bouhassira D, Cherif K,

- Gentili ME, et al. Antiinflammatory effect of peripheral nerve blocks after knee surgery: Clinical and biologic evaluation. *Anesthesiology* 2008;109:484-90.
12. Lombardi AV Jr., Berend KR, Mallory TH, Dodds KL, Adams JB. Soft tissue and intraarticular injection of bupivacaine, epinephrine, and morphine has a beneficial effect after total knee arthroplasty. *Clin Orthop Relat Res* 2004;428:125-30.
 13. Busch CA, Shore BJ, Bhandari R, Ganapathy S, MacDonald SJ, Bourne RB, et al. Efficacy of periarticular multimodal drug injection in total knee arthroplasty. A randomized trial. *J Bone Joint Surg Am* 2006;88:959-63.
 14. Kim MH, Nahm FS, Kim TK, Chang MJ, Do SH. Comparison of postoperative pain in the first and second knee in staged bilateral total knee arthroplasty: Clinical evidence of enhanced pain sensitivity after surgical injury. *Pain* 2014;155:22-7.
 15. Liu Q, Chelly JE, Williams JP, Gold MS. Impact of peripheral nerve block with low dose local anesthetics on analgesia and functional outcomes following total knee arthroplasty: A retrospective study. *Pain Med* 2015;16:998-1006.
 16. Ng FY, Ng JK, Chiu KY, Yan CH, Chan CW. Multimodal periarticular injection vs continuous femoral nerve block after total knee arthroplasty: A prospective, crossover, randomized clinical trial. *J Arthroplasty* 2012;27:1234-8.
 17. Yadeau JT, Goytizolo EA, Padgett DE, Liu SS, Mayman DJ, Ranawat AS, et al. Analgesia after total knee replacement: Local infiltration versus epidural combined with a femoral nerve blockade: A prospective, randomised pragmatic trial. *Bone Joint J* 2013;95-B: 629-35.
 18. Ben-David B, Schmalenberger K, Chelly JE. Analgesia after total knee arthroplasty: Is continuous sciatic blockade needed in addition to continuous femoral blockade? *Anesth Analg* 2004;98:747-9.