Shimane J. Med. Sci., Vol.41 pp.101-107, 2024

Postoperative Analgesic Effect of Additional Local Infiltration Analgesia Combined With Continuous Femoral and Sciatic Nerve Blocks in Total Knee Arthroplasty: A Single-Center Retrospective Study

Keita MATSUMOTO[1,3], Katsushi DOI[2,3], Yasue WATANABE[3], Hiroyuki KUSHIZAKI[3]

[1] *Department of Anesthesiology, Faculty of Medicine, Shimane University, Izumo, Shimane 693-8501, Japan*

[2] *Department of Anesthesiology, Saitama Medical University Hospital, Moroyama-machi, Saitama 350-0495, Japan*

[3] *Department of Anesthesiology, National Hospital Organization Hamada Medical Center, Hamada, Shimane 697-8511, Japan*

(Received September 20, 2024; Accepted October 7, 2024; Published online March 19, 2025)

Purpose: The aim of this retrospective study was to assess the efficacy of postoperative pain control with additional Local infiltration analgesia (LIA) combined with femoral nerve block (FNB) and sciatic nerve block (SNB). ***Methods:*** A total of 88 patients undergoing total knee arthroplasty (TKA) were enrolled in this study. All patients received combined continuous FNB and SNB, but only the LIA group received additional LIA, including methylprednisolone, at the end of surgery. We analyzed the numerical rating scale (NRS) for pain at rest at 24 and 48 hours postoperatively. ***Results:*** The peripheral nerve block (PNB) and LIA groups included 29 and 59 patients, respectively. The median NRS at rest at both 24 and 48 hours in the LIA group was significantly lower than in the PNB group (postoperative day 1 [POD1]: 0 vs. 5; postoperative day 2 [POD2]: 2 vs. 3; $p < 0.01$). ***Conclusion:*** Additional LIA combined with FNB and SNB provided better postoperative analgesia through POD2 compared to PNB alone.

Corresponding author: Katsushi DOI, M.D., Ph.D.
Department of Anesthesiology, Saitama Medical University Hospital, 38 Morohongo, Moroyama-machi, Iruma-gun, Saitama 350-0495, Japan
Tel: +81-49-276-1271
Fax: +81-49-276-1271
Email: kdoiepi@gmail.com

Keywords: local infiltrate analgesia, femoral nerve block, sciatic nerve block, postoperative pain, total knee arthroplasty

INTRODUCTION

Total knee arthroplasty (TKA) is a common treatment for restoring knee function in patient with various knee conditions, such as osteoarthritis and rheumatoid arthritis. Effective postoperative pain management in TKA is crucial for early rehabilitation and ensuring patient satisfaction. Adequate pain control through multimodal analgesia is essential for promoting early postoperative mobilization and reducing the length of hospital stay [1].

Peripheral nerve blocks, particularly continuous femoral nerve blocks (FNB), are effective techniques for managing postoperative pain control following TKA [2]. However, FNB alone may not provide complete pain relief; therefore, adjuncts such as sciatic nerve block (SNB) or local infiltration analgesia (LIA) are often recommended. Previous studies have demonstrated that LIA, when combined with FNB, is provide pain relief comparable to SNB [3]. Moreover, adding corticosteroids to LIA has been shown to extend the duration of the analgesic effect compared to SNB [4].

To the best of our knowledge, no studies have examined the efficacy of adding LIA combined with FNB and SNB after TKA. Therefore, this study aimed to evaluate the additional analgesic effect of LIA with corticosteroids in combination with FNB and SNB in patients undergoing TKA.

METHODS

This single-center, retrospective, observational study was approved by the ethics committee of the National Hospital Organization Hamada Medical Center (No.3058).

Electronic medical and anesthesia records from November 2015 to May 2019 were retrospectively reviewed. All patients who underwent elective unilateral TKA under general anesthesia combined with continuous FNB and SNB were included in this study. Patients who received TKA in this period were compared to the PNB (receiving continuous FNB + SNB) groups from 2015 to April 2017 and to the LIA (receiving continuous FNB + SNB and additional LIA) from May 2017 to May 2019. Exclusion criteria included American Society of Anesthesiologists physical status > 4, incomplete information, and diabetes mellitus.

All patients underwent surgery using the medial para-patellar approach. Both femoral nerve catheter insertion and SNB were performed preoperatively under ultrasound guidance. A continuous FNB catheter was inserted after the administration of 15 mL of 0.5% levobupivacaine. SNB was then performed at the popliteal fossa using 10 mL of 0.25% levobupivacaine. All blocks were performed by an anesthetist with residents or with enough experience in peripheral nerve blocks. Not all cases were combined with nerve stimulation. After both nerve blocks, general anesthesia was induced with intravenous propofol, fentanyl, and remifentanil and maintained using sevoflurane or desflurane to a bispectral index of 35–60. The lungs were mechanically ventilated to maintain an end-tidal CO_2 pressure of 35±5 mmHg. In the LIA group, a 50-mL cocktail mixture solution, containing 20 mL of 0.5% levobupivacaine, 30 mL normal saline, and 125 mg methylprednisolone, was injected into the posterior capsule of the knee joint and subcutaneous tissue by an experienced orthopedic surgeon at the end of the operation. No sham procedures were performed for the PNB group. Continuous FNB was started using 4 mL/h 0.15% levobupivacaine from the completion of surgery until postoperative day 1 (POD1).

Intravenous acetaminophen (1000 mg), diclofenac suppository (50 mg), and oral loxoprofen sodium hydrate (50 mg) were administered postoperatively as rescue analgesics, according to our perioperative care protocol.

Pain scores were collected from patients on the morning of postoperative day 1 (POD1) and postoperative day 2 (POD2). A numerical rating scale (NRS; 0 = no pain, 10 = worst pain imaginable) at rest was used to assess postoperative pain. The NRS scores, recorded by the anesthesiologist, were obtained from medical charts. The number of rescue analgesics required within 48 hours postoperatively was also analyzed. Complications or adverse events, such as foot drop, patient falls, nerve injury, surgical site infection, and local anesthetic systemic toxicity, were also examined.

Statistical Analysis

Continuous variables were analyzed using the Kolmogorov–Smirnov test to determine the normality of data distribution. Paired t-test was applied for parametric statistics, and the results were expressed as mean ± standard deviation. The chi-squared test or Fisher's exact test was used for categorical variables. Mann–Whitney U-test was used for non-parametric statistics, and the results were expressed as median (Q1–Q3). The analysis was conducted using EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria). EZR is a modified version of the R commander, which was designed to add statistical functions that were frequently used in biostatistics [5]. Statistical significance was set at $P < 0.05$.

RESULTS

A total of 92 patients who had undergone TKA were identified. Four patients were excluded because their postoperative patient information could not be collected. Finally, 29 and 59 patients were identified in the PNB and LIA groups, respectively (Fig. 1). No significant differences in patient characteristics were observed, except for the total intraoperative local anesthetic dose (Table 1).

Pain scores in the LIA group were significantly lower than those in the PNB group on both POD1 and POD2 (POD1: median [IQR], 0 [0–2] versus 5 [3–7], P < 0.001; POD2: median [IQR], 2 [1.5–3] versus 3 [2–5], P = 0.0023) (Fig. 2). The number of rescue analgesic drugs during POD1 and POD2 in the LIA group was significantly lower than that in the PNB group (POD1: median [IQR], 0 [0–0.0] versus 0 [0–1.0], P = 0.0187; POD2: median [IQR], 0 [0–0.075] versus 1 [0–1.0], P = 0.0123; During 48 h: median [IQR], 0 [0–1.0] versus 1 [0–2.0], P = 0.0072) (Table 2).

Regarding adverse events, foot drop, a temporary mobility impairment of the ankle due to common peroneal palsy after surgery, was recorded in both groups (LIA group, 8.4% (n = 5/59); PNB group, 20.7% (n = 6/29)). All patients with foot drop recovered to their preoperative condition within a few days. No other adverse events, such as local anes-

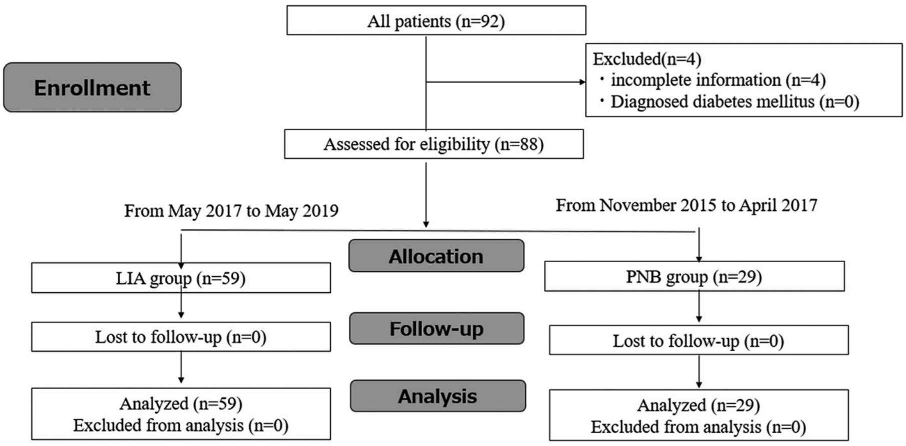

Figure 1. CONSORT flow diagram

Table 1. Baseline and perioperative characteristics of the patients

	LIA group (n = 59)	PNB group (n = 29)	P-value
Sex (male/female), n	11 / 48	6 / 23	0.572
Age, yr	79 [72–86]	81 [77–85]	0.158
Height, cm	152.3 ± 7.2	147.3 ± 8.8	0.006
Body weight, kg	57.0 ± 8.8	52.3 ± 10.7	0.039
BMI, kg/m^2	24.5 ± 2.7	24.1 ± 4.0	0.626
ASA-PS (I/II/III), n	0 / 57 / 2	0 / 25 / 4	*
Surgical time, min	166.2 [142–189]	170.3 [147–192]	0.436
Intraoperative local anesthetic agent, mg	212.5 ± [200–225]	110.0 [100–125]	< 0.001

Data are presented as the mean ± SD, median [interquartile range], or number.
LIA, local infiltrate analgesia; PNB, peripheral nerve block; BMI, body mass index.

Table 2. Pain score and number of analgesic rescue drugs

	LIA group (n = 59)	PNB group (n = 29)	P-value
NRS at rest, POD1	0 [0–2]	5 [3–7]	< 0.001
NRS at rest, POD2	2 [1.5–3]	3 [2–5]	0.0022
Rescue analgesic drugs during POD1	0 [0–0]	0 [0–1.0]	0.0187
Rescue analgesic drugs during POD2	0 [0–0.075]	1 [0–1.0]	0.0123
Rescue analgesic drugs within 48 h	0 [0–1]	1 [0-2]	0.00716

Data are presented as median [interquartile range] or number.
LIA, local infiltrate analgesia; PNB, peripheral nerve block; NRS, numerical rating scale; POD, postoperative day.

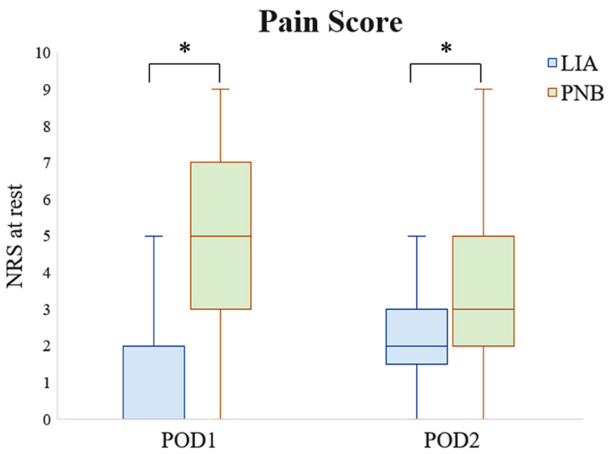

Figure 2. Pain scores at POD1 and POD2 in the LIA and PNB groups. POD, postoperative day; LIA, local infiltrate analgesia; PNB, peripheral nerve block; NRS, numerical rating scale. The box represents the 25th–75th percentiles, and the median is represented by the solid line. * $P < 0.05$.

thetic systemic toxicity, patient falls, deep venous thrombosis, or surgical site infections, were observed in both groups.

DISCUSSION

In this retrospective study, we evaluated the efficacy of an additional LIA in combination with FNB and SNB for postoperative analgesia following TKA. The main findings showed that the addition of LIA to FNB and SNB reduced the postoperative pain score and decreased the number of rescue analgesic drugs required within 48 hours postoperatively.

Postoperative pain following TKA is often severe, making effective pain management crucial for early recovery and improved outcomes [1, 2]. Over the past decade, the standard approach to postoperative pain management in TKA has shifted from epidural analgesia to peripheral nerve blocks [3]. Among these, continuous FNB with or without SNB has become the standard technique [4].

The knee area, including the surgical site of TKA, is innervated by multiple nerves such as the femoral, sciatic, some cutaneous, and obturator nerves. Therefore, combined FNB and SNB alone may not fully cover the surgical field in TKA. As a result, additional postoperative treatments, such as systemic opioid infusion, non-steroidal anti-inflammatory drugs (NSAIDs), and acetaminophen, are often required.

In addition to peripheral nerve blocks, periarticular injection of local anesthetics has been increasingly used as part of multimodal postoperative analgesia [6]. This retrospective study suggests that LIA can cover areas of the knee not adequately addressed by supplemental PNB. Moreover, the addition of corticosteroids to local anesthetics may help control surgical site inflammation and prolong the analgesic effect of LIA [7–9]. The LIA group had significantly lower pain scores and rescue analgesic drug use compared to the PNB group. Therefore, LIA can enhance perioperative pain management in TKA.

The postoperative analgesic effects of LIA in TKA have been reported in many studies, with several suggesting that LIA is a useful alternative to peripheral nerve blocks [2, 3]. In terms of pain relief, LIA has been shown to provide similar efficacy to both single and single and continuous FNB [10] as well as single SNB [11].

Comparisons of the analgesic effects of LIA and SNB in combination with FNB have shown variable results in previous reports. When combined with FNB, LIA provided similar analgesic effects compared to SNB; however, LIA was inferior to SNB in the early period up to 12 hours postoperatively [12]. A recent meta-analysis demonstrated that SNB offers superior pain relief and reduced morphine consumption within the first 24 hours compared to LIA [13]. On the other hand, LIA particularly when including corticosteroids, has been reported to provide a longer-lasting analgesic effect than SNB [14].

However, the effect of LIA in combination with FNB and SNB has not been well elucidated. In our study, adding LIA to two nerve blocks resulted in superior analgesia within 48 hours postoperatively compared with nerve blocks alone. Various agents, such as local anesthetics, epinephrine, morphine, and steroids, have been used in LIA [15–17]. In this study, levobupivacaine and methylprednisolone were administered. The use of steroids in LIA has gained attention in recent years due to their anti-inflammatory properties and ability to prolong the action of local anesthetics [18, 19]. The potential mechanisms behind the superior analgesic effect of

LIA in our study are as follows: the combination of SNB and FNB provides excellent early-phase analgesia, while the addition of corticosteroids to LIA prolongs the duration of the local anesthetic effect at the surgical site [7]. In addition, the pain scores in the PNB group on POD1 were not as low as reported in previous reports [12]. Our study involved a variety of physicians, including residents and experienced anesthesiologists, and the use of nerve stimulation was not strictly standardized. This may have contributed to the insufficient efficacy of PNB in the early stage after TKA.

The addition of LIA to FNB and SNB improved the analgesic effect after TKA. It has been reported that severe postoperative pain is associated with a longer hospital stay after TKA [20]. Therefore, efficacy in extended pain relief with the addition of LIA may promote early mobility and exercise, shorten hospital stays, and enhance patient satisfaction [21].

In this study, the Incidence of foot drop, caused by motor paralysis of the common peroneal nerve, was relatively high. Foot drop can sometimes result from surgical procedures; so, nerve block techniques that do not induce this complication are preferred. Fortunately, all patients with foot drop in our study fully recovered without any lasting neuropathy. The 0.25% concentration of levobupivacaine used in this study may have been too high. Therefore, appropriate concentration and dose of local anesthetic should be considered.

Our study had several limitations. First, general anesthesia methods were inconsistent across all patients due to its retrospective study. Variations in analgesic dosage and timing of administration during general anesthesia, as well as differences in the types of analgesics used, may have influenced the results. Additionally, there was no standardization in the methods or dosages of preoperative analgesics for knee osteoarthritis, making it unclear how preoperative analgesic use might have affected postoperative pain. Second, to more accurately assess the effect of LIA, a comparison between three groups, including one receiving only LIA, would have been beneficial. Safe and effective strategies for the use of local anesthetics should be further explored. Moreover, since there is no consensus on the composition of LIA, further studies are needed to determine the optimal regimen.

CONCLUSION

The addition of LIA to FNB and SNB provided better postoperative analgesia within the first 48 hours compared to PNB alone.

Ethical approval

This study was approved by the ethics committee of the National Hospital Organization Hamada Medical Center (No.3058).

Author contribution

All authors contributed to the study conception and design. Data collection and analysis were performed by Keita Matsumoto, Katsushi Doi. The first draft of the manuscript was written by Keita Matsumoto, Katsushi Doi, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Acknowledgments

Not applicable.

Funding

Not applicable.

Conflict of interest statement

The authors declare no conflict of interest.

REFERENCE

1) Andersen LØ, Kehlet H. Analgesic efficacy of local infiltration analgesia in hip and knee arthroplasty: A systematic review. *Br J Anaesth*. 2014;113:360-74. DOI: 10.1093/bja/aeu155.

2) Spangehl MJ, Clarke HD, Hentz JG, Misra L, Blocher JL, Seamans DP. The Chitranjan Ranawat award: Periarticular injections and femoral & sciatic blocks provide similar pain relief after TKA: A randomized clinical trial. *Clin Orthop Relat Res*. 2015;473:45-53. DOI: 10.1007/s11999-014-3603-0.

3) Cozowicz C, Poeran J, Zubizarreta N, Mazumdar M, Memtsoudis SG. Trends in the use of regional

anesthesia: Neuraxial and peripheral nerve blocks. *Reg Anesth Pain Med*. 2016;41:43-9. DOI: 10.1097/AAP.0000000000000342.

4) Memtsoudis SG, Cozowicz C, Bekeris J, *et al*. Peripheral nerve block anesthesia/analgesia for patients undergoing primary hip and knee arthroplasty: Recommendations from the International Consensus on Anesthesia-Related Outcomes after Surgery (ICAROS) group based on a systematic review and meta-analysis of current literature. *Reg Anesth Pain Med*. 2021;46:971-85. DOI: 10.1136/rapm-2021-102750.

5) Kanda Y. Investigation of the freely available easy-to-use software "EZR" for medical statistics. *Bone Marrow Transplant.* 2013;48:452-8. DOI: 10.1038/bmt.2012.244.

6) Perlas A, Kirkham KR, Billing R, Tse C, Brull R, Gandhi R, Chan VW. The impact of analgesic modality on early ambulation following total knee arthroplasty. *Reg Anesth Pain Med*. 2013;38:334-9. DOI: 10.1097/AAP.0b013e318296b6a0.

7) Chai X, Liu H, You C, Wang C. Efficacy of additional corticosteroid in a multimodal cocktail for postoperative analgesia following total knee arthroplasty: A meta-analysis of randomized controlled trials. *Pain Pract*. 2019;19:316-27. DOI: 10.1111/papr.12740.

8) Li Q, Mu G, Liu X, Chen M. Efficacy of additional corticosteroids to multimodal cocktail periarticular injection in total knee arthroplasty: A meta-analysis of randomized controlled trials. *J Orthop Surg Res*. 2021;16:77. DOI: 10.1186/s13018-020-02144-0.

9) Wang Q, Tan G, Mohammed A, Zhang Y, Li D, Chen L, Kang P. Adding corticosteroids to periarticular infiltration analgesia improves the short-term analgesic effects after total knee arthroplasty: A prospective, double-blind, randomized controlled trial. *Knee Surg Sports Traumatol Arthrosc*. 2021;29:867-75. DOI: 10.1007/s00167-020-06039-9.

10) Choi S, O'Hare T, Gollish J, *et al*. Optimizing pain and rehabilitation after knee arthroplasty: A two-center, randomized trial. *Anesth Analg*. 2016;123:1316-24. DOI: 10.1213/ANE.0000000000001469.

11) Albrecht E, Guyen O, Jacot-Guillarmod A, Kirkham KR. The analgesic efficacy of local infiltration analgesia vs femoral nerve block after total knee arthroplasty: a systematic review and meta-analysis. *Br J Anaesth*. 2016;116(5):597-609. DOI: 10.1093/bja/aew099.

12) Nagafuchi M, Sato T, Sakuma T, Uematsu A, Hayashi H, Tanikawa H, Okuma K, Hashiuchi A, Oshida J, Morisaki H. Femoral nerve block-sciatic nerve block vs. femoral nerve block-local infiltration analgesia for total knee arthroplasty: A randomized controlled trial. *BMC Anesthesiol*. 2015;15:182. DOI: 10.1186/s12871-015-0160-3.

13) Ma LP, Qi YM, Zhao DX. Comparison of local infiltration analgesia and sciatic nerve block for pain control after total knee arthroplasty: A systematic review and meta-analysis. *J Orthop Surg Res.* 2017;12:85. DOI: 10.1186/s13018-017-0586-z.

14) Tanikawa H, Harato K, Ogawa R, Sato T, Kobayashi S, Nomoto S, Niki Y, Okuma K. Local infiltration of analgesia and sciatic nerve block provide similar pain relief after total knee arthroplasty. *J Orthop Surg Res*. 2017;12:109. DOI: 10.1186/s13018-017-0616-x.

15) Yun XD, Yin XL, Jiang J, Teng YJ, Dong HT, An LP, Xia YY. Local infiltration analgesia versus femoral nerve block in total knee arthroplasty: A meta-analysis. *Orthop Traumatol Surg Res*. 2015;101:565-9. DOI: 10.1016/j.otsr.2015.03.015.

16) Fanelli G, Casati A, Beccaria P, Aldegheri G, Berti M, Tarantino F, Torri G. A double-blind comparison of ropivacaine, bupivacaine, and mepivacaine during sciatic and femoral nerve blockade. *Anesth Analg*. 1998;87:597-600. DOI: 10.1097/00000539-199809000-00019.

17) Yan H, Cang J, Xue Z, Lu J, Wang H. Comparison of local infiltration and epidural analgesia for postoperative pain control in total knee arthroplasty and total hip arthroplasty: A systematic review and meta-analysis. *Bosn J Basic Med Sci*. 2016;16:239-46. DOI: 10.17305/bjbms.2016.1072.

18) Kroin JS, Li J, Moric M, Birmingham BW, Tuman KJ, Buvanendran A. Local infiltration of analgesics at surgical wound to reduce postoperative pain after laparotomy in rats. *Reg Anesth Pain Med*. 2016;41:691-5. DOI: 10.1097/

AAP.0000000000000480.

19) El-Boghdadly K, Short AJ, Gandhi R, Chan V. Addition of dexamethasone to local infiltration analgesia in elective total knee arthroplasty: double-blind, randomized control trial. *Reg Anesth Pain Med*. 2021;46(2):130-136. DOI: 10.1136/rapm-2020-102079.

20) Missmann M, Grenier JP, Raas C. Modifiable factors influencing length of stay after total knee arthroplasty. *Eur J Orthop Surg Traumatol*. 2023;33(5):1565-1572. DOI: 10.1007/s00590-022-03306-y.

21) Seangleulur A, Vanasbodeekul P, Prapaitrakool S, *et al*. The efficacy of local infiltration analgesia in the early postoperative period after total knee arthroplasty: A systematic review and meta-analysis. *Eur J Anaesthesiol*. 2016;33(11):816-831. DOI: 10.1097/EJA.0000000000000516.