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Original Article

Retrospective analyzing the effects of nerve block on postoperative pain management after total knee arthroplasty

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Abstract

Objective: Total knee arthroplasty (TKA) is usually associated with moderate-to-severe postoperative pain. Our study investigated the possible benefits of the use of nerve blocks (NBs), including pain score reduction, the rescuing dosage of morphine, the timing of ambulation, and the length of stay (LOS) in the hospital. **Materials and Methods:** We included patients who underwent unilateral primary TKA due to primary knee osteoarthritis under general anesthesia with laryngeal mask airway. The control group only received oral pain medication with rescuing morphine injections, whereas the NB group received oral pain medication with an NB and rescuing morphine injections. We collected data on the patients' basic characteristics, postoperative visual analog scale (VAS), the dosage of rescuing morphine over 3 days, time to ambulation, and LOS in the hospital. **Results:** The NB group received significantly fewer morphine dose compared with the control group during postoperative days 1 to 3. There were no statistically significant differences between the NB and control groups on days 1 and 2 in the VAS score, and the VAS score was significantly lower in the NB group on postoperative day 3. The NB group had a significantly shorter time to ambulation compared with the control group. LOS did not differ significantly between the NB and control groups. **Conclusion:** Patients, who underwent TKA under general anesthesia with laryngeal mask airway (LMAGA) receiving NB for postoperative pain, needed less dosage of morphine and had the trend of having lower VAS. There was no association with LOS between two groups, but time to ambulation might be decreased with NB group. Some limitations might need to be further investigated in future study, such as NB regimens, knee function after TKA, muscle power, information after discharge, and NB-related complications.

Keywords: *Nerve block, Postoperative pain management, Total knee arthroplasty*

Introduction

Total knee arthroplasty (TKA) is one of the most commonly performed surgical procedures worldwide and is an effective surgery for treating advanced knee osteoarthritis. TKA is usually associated with moderate-to-severe postoperative pain [1,2], and poor postoperative pain control can contribute to more postoperative problems, including delayed rehabilitation programs, delayed discharge from the hospital, prolonged stiffness, and chronic pain [3,4]. Therefore, postoperative pain management is an important aspect of patient care after surgery. The current multimodal analgesic management with non-opioid medication is intended not only to treat pain effectively but also to reduce opioid use, including nerve blocks (NBs) [3]. Several peripheral NBs have been used for postoperative pain management, such as femoral NBs, adductor canal blocks, sciatic NBs, and obturator NBs [5,6].

Many studies have evaluated the optimal pain management to provide effective postoperative pain relief while minimizing adverse effects, reducing hospital stay, and improving early ambulation following TKA. Analyses of the effects of an NB on postoperative pain management on TKA usually focus on the analgesic effects and the dosage of opioids. No other effects, such as the length of stay (LOS) in the hospital

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or activity recovery after the surgery, have been mentioned. We retrospectively analyzed recent data on NBs that were performed in patients who had received TKA from January 1, 2007, to April 30, 2018, and investigated the possible benefits of the use of NBs, including NRS reduction, the use of opioids (morphine), the timing of ambulation, and the LOS in hospital.

Materials and methods

This study was a retrospective cohort study and was approved by the institutional review board of Hualien Tzu Chi General Hospital (research ethics committee number: IRB106-69-B, informed written consent was waived because the study was a retrospective data analysis). The data were collected from the chart review. A total of 2630 unilateral primary TKA due to primary knee osteoarthritis were performed from January 1, 2007, to April 30, 2018. We excluded patients who underwent TKA due to traumatic knee injury, rheumatic arthritis, gouty arthritis, or other non-primary arthritis. We included patients who received general anesthesia with laryngeal mask airway management and excluded patients who received general anesthesia with endotracheal intubation, spinal anesthesia, epidural anesthesia, or regional anesthesia. Patients were excluded if we did not get complete data for the analysis in our study. Other than regular oral pain medication with acetaminophen, tramadol, or compound and nonsteroidal anti-inflammatory drugs, we also excluded patients who received postoperative pain management with intravenous (IVPCA) or epidural (PCEA) patient-controlled analgesia, intrathecal or epidural morphine injections, or intravenous parecoxib injections. After screening, eligible patients were separated into two groups: a control group and an NB group. The control group included patients who did not receive an NB, whereas the NB group included patients who received a peripheral NB perioperatively. The standard approaches of peripheral NBs for TKA included femoral NB (FNB) or/and abductor canal block (ACB). Sciatic NB would be performed if persistent pain at the postanesthetic care unit even after FNB or/and ACB. The standard regimen for NB was 0.2%–0.5% bupivacaine (20–40 mL) or 0.2%–0.75% ropivacaine (20–40 mL). All the NBs were performed with ultrasound guidance for patients receiving TKA under LMAGA. We collected the patients' basic characteristics including age, gender, body mass index (BMI), hypertension, diabetes mellitus, and ASA physical status classification. After the operation, we collected data including the visual analog scale (VAS), the dosage of parenteral morphine injections for reducing postoperative pain for 3 days after the surgery, operation time, time to ambulation, and LOS in the hospital.

VAS referred to the scale to evaluate the severity of subjective pain. 0 indicated no pain and 10 extreme pain. We used the mean VAS score for each postoperative day in each patient for the data analysis. Dosage of parenteral morphine injections for reducing postoperative pain as needed referred to the average dosage that patients received postoperatively. The rescuing morphine dose as need for each injection was calculated as 0.05–0.1 mg/kg in our study. Operation time referred to the "skin-to-skin" time (minutes), starting when the physician made the first incision and ended when sutures were finished. Time to ambulation referred to the average number of days that a patient got out of bed and engaged in light activity (such as standing or walking) as soon as possible after an operation. LOS in the hospital referred to the average number of days that patients spent in the hospital.

Statistical analysis

The continuous variables were compared using an independent *t*-test or Wilcoxon rank-sum test depending on whether they were normally distributed or not. The categorical variables were compared using the Chi-squared test or Fisher's exact test. The potential risk factors included patient demographic and clinical variables, namely patient age, gender, BMI, hypertension, diabetes mellitus, ASA physical status classification, and operation time. Multiple linear regression model was adopted to evaluate the association between each outcome

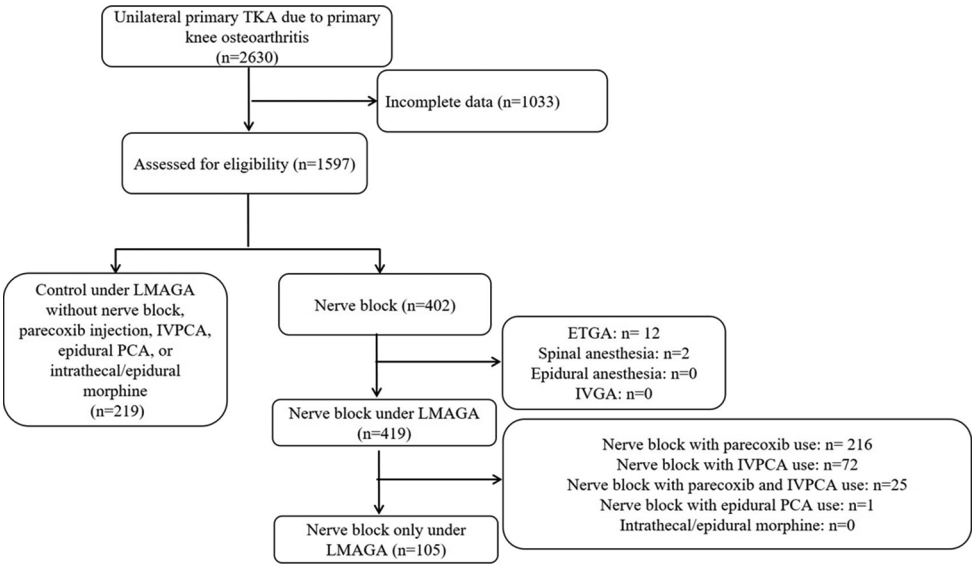

Figure 1: Flowchart for patient selection

and potential risk factors considered. $P < 0.05$ was considered statistically significant. All statistical analyses were performed using SPSS version 17.0 (SPSS Inc., Chicago, IL, USA).

Results

Two hundred and nineteen patients in the control group and 105 patients in the NB group were enrolled in our study, as shown in the flowchart [Figure 1]. The demographics, baseline characteristics, and clinical information are shown in Table 1. There were no significant associations with age, gender, and underlying comorbidities, such as hypertension and diabetes mellitus between the control and NB groups. The ASA classification and BMI also showed no statistically significant differences. The control group had a longer operation time than the NB group (121.9 ± 29.1 vs. 111.8 ± 25.6 min, $P = 0.003$). We also analyzed the accumulated dosage of postoperative parenteral morphine injections from postoperative days 1 to 3, and there were significant differences between the control and NB groups. On postoperative day 1, the NB group had a significantly fewer dosage of morphine compared with the control group (1.7 ± 3.8 vs. 8.9 ± 6.0 mg, $P < 0.001$). On postoperative day 2, the NB group had significantly fewer accumulated dosage of morphine compared with the control group (2.6 ± 6.1 vs. 14.4 ± 11.5 mg, $P < 0.001$). On postoperative day 3, the result revealed that the NB group had significantly fewer accumulated dosage of morphine compared with the control group (2.7 ± 6.3 vs. 16.4 ± 13.9 mg, $P < 0.001$). The NB group had a significantly shorter time to ambulation (days) compared with the control group (2.2 ± 1.1 vs. 2.7 ± 1.6 days, $P = 0.008$). There were no statistically significant differences between the NB and control groups on days 1 and 2 in the VAS score. The VAS score was significantly lower in the NB group than in the control group on postoperative day 3 (2.4 ± 1 vs. 2.7 ± 0.9, $P = 0.017$). LOS did not differ significantly between the NB and control groups (7.4 ± 4.2 vs. 7.2 ± 2.1 days, $P = 0.682$).

Table 1: Patients' demographics (*n*=324)

	Control	NB	Total	*P*
n	219	105	324	
Age	67.2±10.2	69.2±9.2	67.9±9.9	0.102
Gender, *n* (%)				
Male	76 (34.7)	34 (32.4)	110 (34.0)	0.708
Female	143 (65.3)	71 (67.6)	214 (66.0)	
Period, *n* (%)				
Period 1: 2007−2011	62 (28.3)	16 (15.2)	78 (24.1)	0.012*
Period 2: 2012−2018	157 (71.7)	89 (84.8)	246 (75.9)	
Hypertension (%)	134 (61.2)	70 (66.7)	204 (63.0)	0.390
Diabetes mellitus (%)	52 (23.7)	29 (27.6)	81 (25.0)	0.494
ASA classification, *n* (%)				
1−2	144 (65.8)	63 (60.0)	207 (63.9)	0.325
≥3	75 (34.2)	42 (40.0)	117 (36.1)	
BMI	28.1±4.7	27.7±4.5	27.9±4.7	0.542
Operation time (min)	121.9±29.1	111.8±25.6	118.6±28.4	0.003*
LOS in hospital	7.2±2.1	7.4±4.2	7.3±2.9	0.682
Dosage of morphine (day 1) (mg)	8.9±6.0	1.7±3.8	6.6±6.4	<0.001*
Dosage of morphine (day 1–2) (mg)	14.4±11.5	2.6±6.1	10.6±11.5	<0.001*
Dosage of orphine (day 1–3) (mg)	16.4±13.9	2.7±6.3	12.0±13.6	<0.001*
Time to ambulation (days)	2.7±1.6	2.2±1.1	2.5±1.5	0.008*
VAS (day 1)	3.3±1.5	3.2±1.3	3.3±1.5	0.460
VAS (day 2)	2.8±1.1	2.8±1	2.8±1.1	0.624
VAS (day 3)	2.7±0.9	2.4±1	2.6±1	0.017*

Data are presented as *n* or mean±SD. *$P<0.05$ was considered statistically significant after test. SD: Standard deviation, LOS: Length of stay, VAS: Visual Analog Scale, BMI: Body mass index, ASA: American Society of Anesthesiologists, NB: Nerve block

Table 2: Factors associated with the postoperative dosage of morphine (days 1–3) (*n*=324)

Predictor	Univariate		Multivariate	
	β (95% CI)	*P*	β (95% CI)	*P*
Age	-0.149 (-0.298 – 0.000)	0.050	0.035 (-0.107 – 0.177)	0.625
Gender (male vs. female)	5.892 (2.823 – 8.962)	<0.001*	4.774 (2.056 – 7.492)	0.001*
BMI	0.203 (-0.115 – 0.521)	0.210	0.191 (-0.090 – 0.472)	0.183
Type (NB vs. control)	-13.697 (-16.494 – -10.901)	<0.001*	-12.728 (-15.449 – -10.007)	<0.001*
ASA classification (1–2 vs. ≥3)	-0.032 (-3.125 – 3.060)	0.984	-0.310 (-3.055 – 2.435)	0.824
Operation time (min)	0.132 (0.082 – 0.183)	<0.001*	0.078 (0.030 – 0.126)	0.001*

Dependent variable: Postoperative dosage of morphine (days 1–3). *$P<0.05$ was considered statistically significant after test. BMI: Body mass index, ASA: American Society of Anesthesiologists, NB: Nerve block, CI: Confidence interval

Table 3: Factors associated with the postoperative Visual Analog Scale (day 1) (*n*=324)

Predictor	Univariate		Multivariate	
	β (95% CI)	*P*	β (95% CI)	*P*
Age	-0.016 (-0.033 – 0.001)	0.058	-0.016 (-0.035 – 0.003)	0.107
Gender (male vs. female)	0.257 (-0.086 – 0.600)	0.141	0.235 (-0.119 – 0.589)	0.192
BMI	-0.002 (-0.036 – 0.033)	0.928	-0.004 (-0.040 – 0.032)	0.830
Type (NB vs. control)	-0.134 (-0.491 – 0.223)	0.460	-0.111 (-0.476 – 0.255)	0.552
ASA classification (1–2 vs. ≥3)	-0.13 (-0.471 – 0.21)	0.452	-0.199 (-0.559 – 0.161)	0.277
Hypertension (yes vs. no)	-0.207 (-0.541 – 0.128)	0.224	-0.158 (-0.523 – 0.206)	0.394
Diabetes mellitus (yes vs. no)	0.122 (-0.253 – 0.497)	0.523	0.122 (-0.266 – 0.511)	0.537
Operation time (min)	0.002 (-0.003 – 0.008)	0.404	-0.001 (-0.007 – 0.006)	0.825

Dependent variable: Postoperative VAS (day 1). *P<0.05 was considered statistically significant after test. VAS: Visual Analog Scale, BMI: Body mass index, ASA: American Society of Anesthesiologists, NB: Nerve block, CI: Confidence interval

Table 4: Factors associated with the time to ambulation (*n*=324)

Predictor	Univariate		Multivariate	
	β (95% CI)	*P*	β (95% CI)	*P*
Age	-0.011 (-0.029 – 0.007)	0.216	-0.016 (-0.036 – 0.004)	0.111
Gender (male vs. female)	0.013 (-0.341 – 0.366)	0.943	-0.124 (-0.478 – 0.23)	0.493
BMI	-0.021 (-0.057 – 0.014)	0.232	-0.035 (-0.071 – 0.002)	0.062
Type (NB vs. control)	-0.488 (-0.849 – -0.127)	0.008*	-0.392 (-0.755 – -0.029)	0.034*
ASA classification (1–2 vs. ≥3)	-0.516 (-0.864 – -0.169)	0.004*	-0.542 (-0.902 – -0.183)	0.003*
Hypertension (yes vs. no)	0.046 (-0.297 – 0.388)	0.794	0.09 (-0.271 – 0.452)	0.623
Diabetes mellitus (yes vs. no)	-0.013 (-0.399 – 0.372)	0.947	-0.073 (-0.462 – 0.315)	0.710
Operation time (min)	0.009 (0.003 – 0.015)	0.005*	0.007 (<0.001 – 0.013)	0.045*

Dependent variable: Time to ambulation. *P<0.05 was considered statistically significant after test. BMI: Body mass index, ASA: American Society of Anesthesiologists, NB: Nerve block, CI: Confidence interval

According to Table 1, we compared the dependent variables in crude and adjusted analyses in Tables 2–4 with the independent factors associated with the number of morphine injections, VAS, and time to ambulation.

Based on crude and adjusted analyses, the predictor variables associated with postoperative morphine use are shown in Table 2. With different predictor variables, age, BMI, and ASA classification had no significant associations with morphine use in either group. Male patients received significantly more accumulated dosage of morphine compared with female patients (crude analysis: β = 5.892 [95% confidence interval (CI): 2.823 – 8.962, P < 0.001]; adjusted analysis: β = 4.774 [95% CI: 2.056 – 7.492, P < 0.001]). The type of analgesia revealed that the NB group had significantly fewer dosage of morphine compared with the control group (crude analysis: β = -3.697 [95% CI: -16.494 – -10.901, P < 0.001]; adjusted analysis: β = -12.728 [95% CI: -15.449 – -10.007, P < 0.001]). Operation time also had a similar result. With a shorter operation time, significantly fewer dosage of morphine were used in the NB group than in the control group (crude analysis: β = 0.132 [95% CI: 0.082 – 0.183, P < 0.001]; adjusted analysis: β = 0.078 [95% CI: 0.030 – 0.126, P < 0.001]) [Table 2].

In Table 3, factors associated with the VAS score on postoperative day 1 were also compared. As shown in Table 1, the VAS score on postoperative day 1 did not differ significantly between the NB and control groups. Other predictors such as age, gender, BMI, ASA score, hypertension, diabetes mellitus, and operation time had no significant association with the VAS score in either crude and adjusted analyses [Table 3].

Table 4 shows the factors associated with postoperative time to ambulation. The NB group had fewer days until ambulation compared with the control group (crude analysis: β = -0.488 [95% CI: -0.849 – -0.127, P = 0.008]; adjusted analysis: β = -0.392 [95% CI: -0.755 – -0.029, P = 0.034]). A lower ASA classification score (ASA = 1–2) was associated with fewer days of recovery to activity after the surgery compared with a higher ASA score (ASA ≥3) (crude analysis: β = -0.516 [95% CI: -0.864 – -0.169, P = 0.004]; adjusted analysis: β = -0.542 [95% CI: -0.902 – -0.183, P = 0.003]). The results of operation time also displayed similar findings. A shorter operation time was associated with a shorter time to ambulation (crude analysis: β = 0.009 [95% CI: 0.003 – 0.015, P = 0.005]; adjusted analysis: β = 0.007 [95% CI: <0.001 – 0.013, P = 0.045]). The predictor variables of age, gender, BMI, hypertension, and diabetes mellitus had no significant association with postoperative time to ambulation [Table 4].

Patients of the NB group mostly distributed in period 2 and the proportion of period 2 was significantly higher than that of the control group (84.8% vs. 71.7%, P = 0.012) [Table 1]. With the concern of patients in the NB group distributed mostly in period 2, we performed the same analyses with restriction to data from patients in period 2 to avoid the effect of time bias [Tables S1–S3]. In Table S1, male patients received significantly more accumulated dosage of morphine compared with female patients (crude analysis: β = 6.280 [95% CI: 3.046 – 9.515, P < 0.001]; adjusted analysis: β = 5.400 [95%

CI: 2.510 – 8.291, $P < 0.001$]). Patients in NB group had significantly fewer dosage of morphine (crude analysis: β = -12.578 [95% CI: -15.467 – -9.689, $P < 0.001$]; adjusted analysis: β = -11.956 [95% CI: -14.797 – -9.114, $P < 0.001$]). With a shorter operation time, significantly fewer dosage of morphine were used in the NB group than in the control group in crude analysis (β = 0.112 [95% CI: 0.058 – 0.167, $P < 0.001$]), but they were not statistically significant in adjusted analysis (β = 0.048 [95% CI: -0.004 – 0.100, $P = 0.070$]). In Table S2, similar result as Table 3, predictors such as NB, age, gender, BMI, ASA score, hypertension, diabetes mellitus, and operation time had no statistically significant association with the VAS score in either crude or adjusted analysis. In Table S3, age, gender, BMI, ASA classification, hypertension, DM, and operation time had no statistically significant associations with time to ambulation in either group. The NB group had fewer days until ambulation compared with the control group in crude analysis (β = -0.390 [95% CI: -0.770 – -0.010, $P = 0.044$]) but not in adjusted analysis (β = -0.353 [95% CI: -0.742 – 0.036, $P = 0.075$]).

Discussion

We retrospectively analyzed the influence of an NB on several factors including the VAS score, dosage of morphine, time to ambulation, and LOS. According to previous prospective studies [5,6], the VAS score and opioid consumption were both reduced in the NB group compared with a placebo group. In our retrospective study, the VAS score did not differ significantly on postoperative days 1 and 2 but was significantly lower in the NB group compared with the control group on postoperative day 3. According to our own hospital policy, postoperative pain management must keep the patients' VAS score ≤3, and patients in both the groups were reasonably treated. Thus, the lack of a significant effect of the NB on the VAS score may be due to the retrospective nature of this study. According to our conclusion, single-shot NB may have analgesic effect for more than 48 h after TKA, and it was different from other previous reports that the analgesic effect of single-shot NB lasts only for 24–48 h after TKR that might be due to early rehabilitation in the NB group, and early rehabilitation could cause a good control of pain [7]. There were significantly fewer dosage of morphine in the NB group, similar to other studies [5,6]. According to a previous study by McIsaac *et al*. [8], a small but significant decrease was noted in the LOS, and the mean hospital stay was 4.6 days with an NB compared with 4.8 days without an NB. In our study, we showed that there was no significant effect of an NB on the LOS. However, we were limited in performing LOS comparisons because there was no information about discharge destination, which we knew from several studies may hinder sufficient interpretation of LOS, including the transfer of patients to rehabilitation or to other institutions depending on potential economic benefits or on local traditions [9,10]. Overall, these reasons may misleadingly reduce the registered LOS after surgery. Moreover, we may not identify some bias or confounding factors which could cause different results of LOS. Different facilities or policies within different hospitals for TKA could also cause changes of LOS.

In the analysis of factors associated with the dosage of postoperative morphine, the NB was significantly negatively associated with the fewer dosage of morphine. However, the operation time was also significantly positively associated with the dosage of morphine. In the analysis of factors associated with the postoperative VAS score, no factors including NB displayed negative or positive associations in our study. In the analysis of factors associated with the time to ambulation, the NB and ASA classification were significantly negatively associated with a shorter time to ambulation before the consideration of time bias. After the consideration of time bias, the time to ambulation was still less in the NB group in crude analysis not even in the adjusted analysis. In period 2, there might be other interventions, which we did not record in our study to affect the time of ambulation, and the interventions might cause the less different time to ambulation between NB and control group. The intervention might be rehabilitation program or nursing care, etc., The operation time was also significantly positively associated with the time to ambulation before the consideration of time bias but not after the consideration of time bias. According to the previous study, as little as a 1-day difference in the day of the first ambulation may be associated with a shorter LOS, lower hospitalization costs, and improved knee function [11]. In our study, we reported a half-day difference in the time of ambulation without a different LOS, but we did not know whether a half-day difference was significant in hospitalization costs or improving knee function which we did not record in this study.

Our study still has several limitations including no information about discharge destination for performing LOS comparisons; some bias or confounding factors which could cause different result of LOS; a lack of information on the procedure name of the NB; the name, concentration, and amounts of local anesthetics for the NB; the tool that guided the NB; and information about discharge destination, costs, knee functional recovery after TKA, and rehabilitation programs. NB may offer superior muscle relaxation for surgery and cause shorter operation time. However, in the study, we did not record the muscle power or rigidity level in the electrical record, and we did not have other evidence to show the relationship or association between NB and shorter operation time. Moreover, NB-related complications such as postoperative falls are not obtained in our study, and we could not discuss about the increased risk of postoperative falls.

Conclusion

Patients who underwent TKA under LMAGA receiving NB without IVPCA, PCEA, parecoxib injection, or neuraxial analgesia for postoperative pain were evaluated in different outcomes. The need for rescued accumulated morphine injection from postoperative day 1 to 3 was fewer in the NB group compared with the control group. There was no association with LOS between the two groups, and however, time to ambulation had decreased with the NB group. Although VAS score was significantly lower only on postoperative day 3 in the NB group, there was the trend that NB group had lower VAS score compared with control group on days 1 to 3. From Tables 2−4, variable predictors were analyzed with morphine

use, ambulation, and VAS score. In consideration of time bias, we also confined the result to the period 2012–2018 and the outcomes of postoperative morphine use, and time to ambulation revealed similar results. There were still some limitations in our study such as NB regimens, knee function after TKA, information after discharge, and NB-related complications, and these limitations needed to further investigated in further study. In the present study, patients receiving NB after TKA had a positive effect on pain control postoperatively.

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Conflicts of interest

There are no conflicts of interest.

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