

Efficiency of the Local Infiltration Analgesia Method in Total Knee Arthroplasty Surgeries

Efektivita metody lokální infiltrační analgezie při operacích totální endoprotézy kolenního kloubu

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ABSTRACT

PURPOSE OF THE STUDY

Postoperative pain after total knee arthroplasty (TKA) is severe because of bone and soft tissue trauma during the surgery and is difficult to control with oral analgesics. The primary aim of the study was to investigate the effects of the local infiltration anesthesia (LIA) method on postoperative analgesia quality and opioid consumption in patients undergoing TKA. The secondary aims were to evaluate knee flexion angle, side effects, and patient satisfaction.

MATERIAL AND METHODS

Total 40 patients, who underwent unilateral TKA surgery under spinal anesthesia were included in the prospective randomized study. Patients who underwent patient-controlled intravenous analgesia (PCA) (Group A) or LIA + PCA (Group B), were divided into two groups, randomly. For LIA application, 0.25% bupivacaine solution 150 mg in 60 ml volume was used.

The postoperative pain was evaluated in 48th hour after the recovery of motor block, and during exercise at 24, 36, and 48 hours by using the visual analogue scale (VAS). An additional morphine was administered with the PCA device when VAS ≥ 4 . The total amount of morphine consumption and the side effects were recorded. The knee flexion joint angles at the 48th hour and the patients' satisfaction was recorded.

RESULTS

Resting VAS values were lower in Group B in the first 24 hours ($p < 0.05$). However, the 36th and 48th hour measurements were not different in groups. The exercises VAS values and the total morphine consumption were significantly higher in Group A at 24, 36 and 48 hours. The knee flexion joint angles in Group B were higher than Group A in terms of 48th hour. The incidence of side effects was not different in the two groups. Patients' satisfaction was higher in the PCA+LIA group ($p < 0.05$).

DISCUSSION

In many studies the periarticular injection with multimodal drugs has been shown to reduce the requirements for analgesia, with no apparent risks, following TKA, similar to our results. LIA reduced postoperative opioid use and increased exercise tolerance.

CONCLUSIONS

In our study, we found that LIA reduced pain scores and opioid consumption during rest and exercise after TKA operation. For TKA patients where post-operative exercise is particularly important, we recommend the easy-to-use LIA method for a pain-free and unrestricted postoperative period.

Key words: total knee arthroplasty, local infiltration analgesia, postoperative analgesia, knee flexion angle, opioid consumption.

INTRODUCTION

Postoperative pain after total knee arthroplasty (TKA) is severe because of bone and soft tissue trauma during the surgery and is difficult to control with oral analgesics (4, 6). Pain has nociceptive, inflammatory, ischemic, and neuropathic origins and central and peripheral sensitization developing with the onset of the inflammation cycle affects the severity of postoperative pain and its possible chronicity (18, 11). It was reported

that postoperative pain is severe in 60% and moderate in 30% after TKA (18).

Insufficient relief of postoperative pain triggers endocrine, metabolic and inflammatory responses, which might cause pulmonary, cardiac, renal problems and serious complications such as thromboembolism (5, 15). Early physical therapy applications, which are the most important components of postoperative knee rehabilitation, are prevented in patients who have severe pain, and cause delays in ambulation and prolongation of

hospitalization, affecting the psychological level of the patient negatively and reducing patient satisfaction (5, 15, 3). Various methods are used for postoperative pain control after TKA, which include systemic or epidural opioid administration, peripheral or neuraxial nerve blocks, patient-controlled analgesia, NSAID, and adjuvant drugs (7, 8, 14). Side effects such as nausea, vomiting, itching, sedation, urinary retention because of the drugs used, motor weakness, and possible neurological complications that may develop because of nerve block caused that there has been a search for novel methods in this respect (3). Today, more peripheral and localized methods are gaining importance for pain treatment, and new peripheral nerve blocks are defined with the widespread use of ultrasonography. Local infiltration analgesia (LIA), which is defined as the injection of drugs such as NSAID, opioids, and steroids, into the periarticular region, combined with local anesthetics during surgery, has gained popularity in recent years (12). It is considered to increase the quality of analgesia, reduce opioid consumption and hospital stay, and facilitate early mobilization with its ease of application and low side-effects profile (2). TKA is a widely used surgical method to relieve knee joint problems because of osteoarthritis and to increase the quality of life and mobility (17). In TKA cases, it has been shown that it can be an effective method for postoperative analgesia by showing the anatomical spread of the drugs used in the LIA method. The development of toxicity with the LIA technique has not been reported yet, despite the use of a very high volume of local anesthetic (10).

MATERIAL AND METHODS

In this study, we aimed to investigate the effectiveness of the LIA method in preventing postoperative pain after TKA, reducing opioid use and side effects.

The local Ethic Committee approval was received for the study on April 22, 2015 with the number B.10.4.ISM.4.06.68.49. The study was conducted by obtaining verbal and written consent from all patients. A total of 40 patients, who were aged 20–80 years, who were in American Society of Anesthesiologists (ASA) I–III group, who underwent unilateral total knee arthroplasty (TKA) surgery under spinal anesthesia by the Orthopedics and Traumatology Clinic of our hospital, were included in the study. Patients who had abnormal liver enzyme levels, hepatic failure, renal failure, heart failure, morbidly obese ($\text{BMI} > 40 \text{ kg/m}^2$), neuropathic pain, cerebrovascular accident or major neurological deficit, sensory and motor impairment on the surgery side, drug addiction (opioid), those with a history of allergy to local anesthetic and unaware of pain assessment were excluded from the study.

The patients who were included in the study were taken to the premedication room before the surgery and peripheral vascular access was opened on the back of their hands. Intravenous (IV) premedication was administered with 0.02–0.03 mg/kg midazolam to all pa-

tients, and 0.9% NaCl infusion was initiated. Standard heart rate (HR), noninvasive arterial pressure (NIAP), and peripheral oxygen saturation (SpO_2) monitoring were applied to the patients who were taken to the surgery room. Spinal anesthesia was performed in the sitting position with a 22 G Quincke spinal needle through the L4–5 space and 12.5 mg 0.5% hyperbaric bupivacaine was used as local anesthetic. Surgery time, intraoperative hemodynamic data, SpO_2 values and intravenous opioid requirement were recorded.

Patients who underwent patient-controlled intravenous analgesia (PCA) (Group A) or local periarticular infiltration analgesia + PCA (Group B), which are routine methods used for postoperative pain control after TKA in our clinic, were divided into two groups as 20 in each group. The researcher who evaluated the postoperative pain did not know about the method applied to the patient. A PCA device that was prepared with morphine (BodyGuard - 575, CME, Germany) was connected to both groups postoperatively. The PCA device was adjusted as 3 mg loading dose, 1 mg bolus, 7 minutes' lock time, and 4-hour limit amount of 30 mg. The patients were informed about the use of the PCA device. For local infiltrative analgesia application, 150 mg bupivacaine solution was prepared in 60 ml volume and 0.25% concentration under sterile conditions and was applied to the surgery area by the surgeon. Before the insertion, local anesthetic infiltration was performed on the posterior capsule, posteromedial and posterolateral structures, and to the extensor mechanism, synovium, capsule, pes anserinus, anteromedial capsule, periosteum, iliotibial band, collateral ligaments and their origins after the reduction. The study was conducted in the single blind fashion.

The postoperative pain was evaluated in both groups as resting in the Post Anesthesia Care Unit (PACU) at the (T0), 2nd, 6th, 12th, 24th, 36th, and 48th hours after the recovery of motor block because of spinal anesthesia and reduction of sensory block to the L1 level using the visual analogue scale (VAS, 0 = no pain, 10 = most severe pain) and during exercise at 24, 36, and 48 hours. An additional 3 mg dose of morphine was administered with the PCA device when $\text{VAS} \geq 4$. The bolus dose requested by the patients at the 1st, 2nd, 3rd, 6th, 12th, 24th, and 48th hours and the bolus doses given by the device, the total amount of morphine consumed, the side effects such as nausea, vomiting, hypotension, confusion, urinary retention, itching, respiratory depression and their treatments were questioned and recorded. The knee flexion joint angles of the patients who participated in the study were measured at the 48th hour by using a universal goniometer in the prone position, while the hip was in extension. At the end of the study, patients in both groups were asked to rate their satisfaction levels as "I am not satisfied, I am less satisfied, I am satisfied, I am very satisfied, and excellent".

The data analysis was performed by using the IBM SPSS 21.0 statistical package program. When the study data were evaluated, the Fisher Chi-square (χ^2) test was

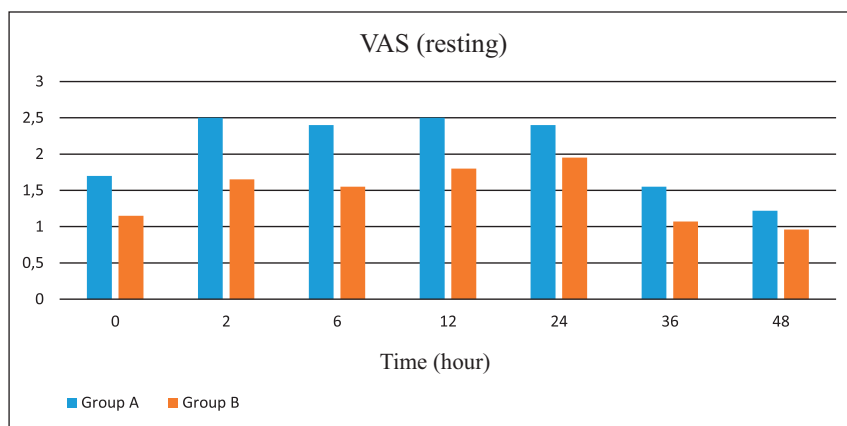
used for the comparison of the qualitative data as well as descriptive statistical methods (frequency, percentage, median, standard deviation, median, and min-max). The conformity of the data to the normal distribution was evaluated with the Kolmogorov-Smirnov and Shapiro-Wilk test. In the evaluation of normally distributed quantitative data, the Independent Samples t-test (t-test for independent groups) and the Mann-Whitney U test were used for the evaluation of the data that did not show normal distribution. Values with a probability (P) less than $X=0.05$ were taken as significant and there was a difference between groups, values with a higher probability were considered insignificant and there was no difference between groups.

Power analysis was made with G*Power 3.1.9.2 statistical package program; $n_1=20$, $n_2=20$, $\alpha=0.05$, Effect Size $d=1.0$, power $(1-\beta)=0.86$

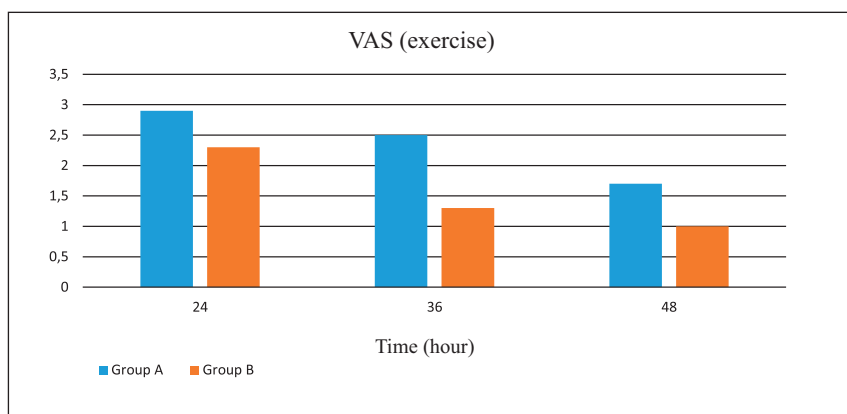
RESULTS

No statistically significant differences were detected between the groups in terms of age, gender distribution, ASA, weight, surgery time, opioid requirement and total drain volume ($p>0.05$). The demographic characteristics of the patients, duration of the surgery, intraoperative opioid requirement and comparison of the total drain volume according to the groups are shown in Table 1.

Resting VAS values were significantly lower in Group B in the first 24 hours ($p<0.05$). However, the 36th and 48th hour measurements were not different in



Graph 1. The comparison of the resting VAS values by groups (mean±SD).
* $p<0.05$



Graph 2. The comparison of the exercise VAS values by groups (mean±SD).
* $p<0.05$

groups (Graph 1). The exercise VAS values were significantly higher in Group A compared to Group B at 24, 36 and 48 hours ($p<0.05$, Graph 2).

The postoperative total morphine bolus counts measured simultaneously between the groups, requested by the patient and given by the PCA device, were found to be statistically different ($p<0.05$). In all cases with a difference, it was observed that the values of

Table 1. The comparison of demographic characteristics, operation time, intraoperative opioid needs and total drainage volume of the patients by groups (mean, n, %)

		Group A (n=20)	Group B (n=20)	P
Age (years)		65.2±6.4	66.9±5.9	0.403
Gender	female	14 (%70.0)	19 (% 95.0)	0.091
	male	6 (%30.0)	1 (%5.0)	
ASA	I	19 (%95.0)	16 (%80.0)	0.342
	II	1 (%5.0)	4 (%20.0)	
Weight (kg)		87.1±7.4	84.2±8.1	0.118
Operation duration (min)		111.5±22.9	105.8±15.1	0.355
Intraoperative opioid need	no	20 (%100.0)	19 (%95.0)	1.000
	yes (100 mcg fentanyl)	–	1 (%5.0)	
Total drainage volume (ml)		282.5±100.0	249.0±91.3	0.276

* $p<0.05$

Table 2. The comparison of postoperatively consumed total morphine amount by groups (mean±SD)

Total morphine amount (mg)	Group A (n=20)	Group B (n=20)	P
2 th hour	9.0 ± 3.2	6.6 ± 1.4	0.005*
6 th hour	27.9 ± 7.2	17.6 ± 5.4	0.000*
12 th hour	50.8 ± 9.2	33.9 ± 8.1	0.000*
24 th hour	83.6 ± 13.0	55.4 ± 8.5	0.000*
48 th hour	106.4 ± 18.6	73.5 ± 7.8	0.000*

*p<0.05

Table 3. The comparison of the knee angle by groups (mean±SD)

	Group A (n=20)	Group B (n=20)	P
Knee angle (degrees)	97.1 ± 3.5	106.0 ± 8.0	0.000*

*p<0.05

Group A patients were higher than the values of Group B patients (Table 2). It was shown that there was a significant difference between the groups in VAS values at the time of exercise at all measurement times (p<0.05).

The knee flexion joint angles of the patients in Group B were higher than Group A in terms of 48th hour. (p<0.05) (Table 3).

The incidence of side effects was not different in the two groups (Table 4).

It was shown that there were statistically significant differences between the groups in terms of patient satisfaction (p<0.05). It was also found that the satisfaction level of the patients who underwent local infiltration

Table 5. The comparison of patient satisfaction by groups (n (%))

	Group A (n=20)	Group B (n=20)	P
Less satisfied	4 (%20.0)	–	0.000*
Satisfied	13 (%65.0)	4 (%20.0)	
Much satisfied	3 (%15.0)	14 (%70.0)	
Perfect	–	2 (%10.0)	

*p<0.05

analgesia was higher than the patients who only used PCA (p<0.05, Table 5).

DISCUSSION

In the present study, it was shown that the Local Infiltrative Analgesia Method, which is applied intraoperatively for postoperative pain control after TKA, provides an effective analgesia and reduces opioid consumption. Postoperative pain scores measured at rest and during exercise were found to be significantly lower in the LIA group. Patient satisfaction was also higher in the LIA group.

Ten randomized controlled trials (RCT) included eight studies with 1,216 TKAs in 835 patients met the inclusion criteria (21). Periarticular injection with multimodal drugs in TKA was associated with short-term benefits in terms of pain relief, straight leg raise, opioid consumption. The incidence of side effects was also reduced. There were no statistically significant differences in operating time, hospital stay, wound complications and deep vein thrombosis between both groups.

Table 4. The comparison of side effects by groups (n, %)

Side effect		Group A (n=20)	Group B (n=20)	P
Nausea	No	14 (%70.0)	18 (%90.0)	0.235
	Yes	6 (%30.0)	2 (%10.0)	
Vomiting	No	17 (%85.0)	20 (%100.0)	0.231
	Yes	3 (%15.0)	–	
Urinary retention	No	20 (%100.0)	20 (%100.0)	NS
	Yes	–	–	
Itching	No	19 (%95.0)	20 (%100.0)	1.000
	Yes	1 (%5.0)	–	
Hypotension	No	20 (%100.0)	20 (%100.0)	NS
	Yes	–	–	
Bradycardia	No	20 (%100.0)	20 (%100.0)	NS
	Yes	–	–	
Sedation	No	20 (%100.0)	20 (%100.0)	NS
	Yes	–	–	

*p<0.05

Following TKA, postoperative pain is quite severe and difficult to control with oral analgesics. It is already known that an effective and adequate analgesia method facilitates patient rehabilitation by providing early physiotherapy initiation, reducing the length of hospital stay (15). Nakai et al. found that the periarticular injection with multimodal drugs significantly reduced the requirements for analgesia, with no apparent risks, following TKA, similar to our results (1). Rapid functional and physical recovery also plays important roles in the prevention of postoperative complications such as thromboembolism and nosocomial infection.

Sugihara et al. shown that the local infiltration anesthesia could be effectively reduce postoperative pain after laparoscopic hysterectomy and laparoscopic oncological surgery (19). In addition to a conventional analgesic, using local infiltration anesthesia might be improve the patient's quality of life. They reduced the pain scores of the patients for 12 hours postoperatively by LIA. In our study, we found a significant decrease in VAS values up to 24 hours, while there was a significant decrease in VAS values during exercise at 24, 36 and 48 hours.

Fourteen trials (1044 patients) were analyzed for postoperative analgesia in TKA patients (9). Adding infiltration between popliteal artery and capsule of knee (IPACK) to adductor canal block (ACB) in the setting of periarticular LIA did not improve analgesic outcomes following TKA. In the absence of LIA, adding IPACK to ACB reduced pain up to 24 hours and enhances functional recovery. Their findings did not support the addition of IPACK to ACB when LIA is routinely administered.

To select the best modality for the postoperative analgesia after TKA, a network meta-analysis of 98 randomized controlled trials which involving 7452 patients was used to compare 18 interventions which were ranked by six outcome indices (16). Continuous femoral nerve block (FNB) and FNB + sciatic nerve block (SNB) was found that the most effective interventions for postoperative pain management in TKA. But for reducing postoperative complications, fascia iliaca compartment block, FNB, SNB, and obturator nerve block showed the best results. Peripheral blocks and LIA are more preferred in terms of preventing complications and not causing limitation of movement, shortening the hospital stay and increasing patient satisfaction. In our study, we provided effective pain relief and patient satisfaction only with the easy-to-apply LIA method after TKA.

In a meta-analysis, the effect of IPACK, a type of LIA method, applied by administering a local anesthetic between the popliteal artery and the knee capsule, on postoperative pain in patients undergoing TKA was investigated (20). Postoperative pain scores were found to be low in patients who underwent IPACK, similar to our study. Opioid consumption of the patients decreased and an uncomplicated recovery process was observed.

Lychagin et al. compared LIA and femoral-sciatic nerve block (FSNB) for the treatment of pain after TKA (13). The primary outcome of this study was the postoperative pain level intensity as measured by the visual analog scale (VAS). Secondary outcome was knee function measured by the Knee Society score (KSS) and the quadriceps muscle strength recovery profile. The patients' pain scores in the first 4 hours were lower in the FSNB group. Pain scores of LIA and FSNB patients were similarly significantly lower on postoperative days 2 and 3. This effect disappeared on the 4th postoperative day. KSS score showed similar improvement in all groups. However, the Quadriceps muscle recovery profile in the FSNB group was significantly weaker than in the LIA and Control groups. As a result, considering the profit-loss ratio, it is said that LIA will be preferred for postoperative pain treatment.

In present study, in which we investigated the effects of local infiltration anesthesia (LIA) method on postoperative analgesia quality, opioid consumption, knee flexion angle, side effects and patient satisfaction, we found that LIA reduced pain scores and opioid consumption during post-operative rest and exercise in TKA operation.

CONCLUSIONS

In conclusion, LIA was found to be superior to intravenous opioid therapy in the first 24 hours in the prevention of pain after TKA. It prevented exercise pain at 24, 36 and 48 hours postoperatively, and increased the angulation of the knee. It reduced opioid consumption and increased patient satisfaction. No complications were encountered. We recommend LIA in cases of TKP, where postoperative pain management is particularly important, because it allows postoperative movement, is less likely to have complications, and is easy to apply.

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