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Original Article

Anterior vs Posterior Periarticular Multimodal Drug Injections: A Randomized, Controlled Trial in Simultaneous Bilateral Total Knee Arthroplasty

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ABSTRACT

Background: Currently, various techniques are used to overcome postoperative pain after total knee arthroplasty. A local analgesic infiltration with periarticular multimodal drug injection (PMDI) is favorable because of its simplicity, safety, and efficacy. The present study compared the efficacy of a PMDI at the anterior vs posterior compartments.

Methods: Forty-six patients were randomized to receive the PMDI at either the anterior or posterior compartment, with the contralateral knee receiving the PMDI at the opposite compartment. The PMDI injected to the posterior capsule, medial and lateral meniscal remnant, was defined as the posterior compartment injection, whereas the injection to the medial retinaculum, quadriceps muscle, pes anserinus, and retropatellar fat pad was defined as the anterior compartment injection. Pain scores at rest, knee flexion angle, quadriceps function, and drainage blood loss were evaluated in both groups.

Results: The anterior PMDI group had significantly lower pain scores at rest during 96 hours postoperatively. On the day of discharge, 19 patients (41.3%) favored the knee with the anterior PMDI, which was superior to 9 patients (19.6%) who favored the knee with the posterior PMDI. The anterior PMDI demonstrated a superior recovery of quadriceps function during the same period, but there was no significant difference in terms of other parameters.

Conclusion: The PMDI at the anterior compartment can reduce pain after total knee arthroplasty with potentially better quadriceps function compared with that in the PMDI at the posterior compartment. We recommend infiltrating the anterior compartment with a greater amount of PMDI than the posterior compartment.

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Although total knee arthroplasty (TKA) is one of the most successful pain-relieving surgical procedures for patients with end-stage knee disease, >50% of patients experience moderate-to-severe postoperative pain [1] owing to large, deep incisions in the muscle, bone, and soft-tissue dissection. This unfavorable postoperative pain can lead to immobility-related complications (such as venous thromboembolism and arthrofibrosis), as well as prolonged hospitalization and delays in rehabilitation that may hinder functional outcome and patient satisfaction [2].

Currently, various techniques are used to overcome this postoperative pain, such as epidural analgesia, patient-controlled analgesia (PCA) opioids, and peripheral nerve block. However, each of these techniques has its limitations. Epidural analgesia is associated with an incidence of hypotension, urinary retention, spinal headache, and a failure rate ranging from 4% to 20% [3,4]. Systemic opioid via PCA has frequent adverse opioid-related effects. Peripheral nerve block has shown excellent postoperative pain control with less adverse effects, but unpleasant numbness, impaired quadriceps function, which can delay rehabilitation, and increase risk of fall are its limitations [5–7].

Local analgesic infiltration with a periarticular multimodal drug injection (PMDI) is an alternative anesthesia technique. Because of its simplicity, safety, and efficacy [1,2], PMDI has rapidly gained popularity in the last decade. Many studies in the literature [8–13] compared PMDI with other anesthesia techniques mentioned

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previously, and they found the PMDI to be at least as comparable with those techniques in terms of analgesic effect with less adverse effects and complications. Normally, PMDI is performed intraoperatively through the surgical site to the area that has increased neurosensory perception and mechanoreceptor, such as the posterior capsule, quadriceps tendon, and medial-lateral retinaculum. Consensus on whether the anterior or posterior compartment PMDI during the TKA procedure offers better pain relief and clinical outcome is still inconclusive. Therefore, this prospective, randomized, controlled trial (RCT) was designed to compare the clinical efficacy between PMDI at the anterior and posterior compartments.

Materials and Methods

This study was a prospective RCT of patients undergoing simultaneous bilateral primary TKA at a single institution. All patients scheduled for simultaneous bilateral primary TKA were enrolled. Patients with a past history of knee surgery, previous history of knee infection, neuromuscular disorder, known allergy to the drugs being used in this protocol, or a history of thromboembolic accident were excluded. The study was approved by the institutional review board. All patients gave a written informed consent after receiving an explanation of the study protocol.

All surgical procedures were performed by a single surgeon via a standard medial parapatellar approach under spinal anesthesia with bupivacaine (2.8-3.6 mL). Identical cemented, posterior-stabilized, fixed-bearing prostheses were used in all cases. The PMDI mixture consisted of 100 mg bupivacaine (0.5% Marcaine 20 mL; AstraZeneca, Sweden), 30 mg ketorolac (Ketorolac 1 mL; Siu Guan, Taiwan), 5 mg morphine sulfate, and 300 μg adrenaline (1:1000, 0.3 mL). This cocktail was mixed with a sterile normal saline solution to a total volume of 100 mL, and then divided into 2 50-mL syringes. The surgery was simply randomized using sealed envelope to start on 1 side and randomized to determine the compartment for the PMDI on completion of all bony procedures. The other side received the PMDI at the opposite compartment. The knee injected with the PMDI in the anterior compartment was defined as “group A.” On the other hand, the knee which received the PMDI in the posterior compartment was defined as “group B.” In group A, the PMDI was injected into the medial retinaculum and pes anserinus (20 mL), quadriceps muscle (25 mL), and retropatellar fat pad (5 mL), whereas the targets for the PMDI in group B were medial posterior capsule (10 mL), lateral posterior capsule (10 mL), medial collateral ligament and medial meniscal remnant (15 mL), and lateral collateral ligament and lateral meniscal remnant (15 mL). Identical postoperative pain management, prophylaxis of antibiotics, and rehabilitation protocols were used in all patients. For the first 48 hours, an intravenous morphine PCA was added for pain control. The morphine PCA was set to inject an on-demand bolus of 2 mL of a 100-mL solution containing 50-mg morphine sulfate with a 5-minute lockout period and a 4-hour limitation not exceeding 30 mg. After 48 hours, the morphine PCA, intravenous fluid, Foley catheter, and drains were discarded, and continuous intravenous morphine of 3 mg was given every 8 hours. Ketorolac (30 mg) was given intravenously every 12 hours until 72 hours postoperatively and then continuing with oral naproxen (250 mg) every 12 hours throughout the admission period. In addition, 2 mg of morphine was used intravenously as the acute pain rescuer every 4 hours. A continuous passive motion (CPM) device was applied on the day after surgery, and patients began walking with gait aids on postoperative day 2. All patients received low-molecular-weight heparin subcutaneously for the first 48 hours combined with oral warfarin for up to 10 days to prevent deep vein thrombosis (DVT).

All patients were assessed by the same group of independent investigators who were blinded to the treatment protocol and were not present during the randomization process. Postoperative pain level at rest was self-estimated using the 10-mm visual analog scale (VAS). The VAS pain scores were recorded at 6, 12, 24, 48, 72, 96 hours, and at 2 and 6 weeks after surgery. The maximal flexion angle that the patients could tolerate with the CPM device was noted every day until discharge, and the active knee flexion angle was observed at 2 and 6 weeks postoperatively. The postoperative quadriceps function was determined by measuring the degree of active straight leg raise (SLR) and active knee extension performed by the patients. Other collected data were drainage blood loss, operative duration, complications, and patient's preferable side at the day of discharge and in the second and sixth week after the surgery.

Data collection was summarized with descriptive statistics such as mean and standard deviation. Statistical analyses for the VAS pain scores, degree of knee flexion, degree of SLR, and degree of extension lag (EL) were performed by the Wilcoxon matched-pairs signed rank test with the statistical significance defined as $P < .05$. The comparison of the number of patients able to perform the SLR of the knee was determined using a chi-square test. The SPSS software (Statistical Package for Social Sciences, version 17.0; SPSS Inc, Chicago, IL) was used for all analyses.

Results

There were 46 patients with tricompartmental osteoarthritis who underwent simultaneous bilateral TKA; thus, 92 knees were included in our study. Demographic data of the patients are demonstrated in Table 1. Preoperative VAS pain scores and degree of active knee flexion were not different between groups.

The postoperative VAS pain scores at rest were significantly lower in the anterior PMDI group compared with those in the posterior PMDI group at 6, 12, 24, 48, 72, and 96 hours postoperatively, but it was comparable at 2 and 6 weeks follow-up. The degree of active SLR was significantly higher in the anterior PMDI group at 24, 48, and 96 hours postoperatively, whereas the degree of EL was significantly lower at 48 and 72 hours. The degree of EL was not different between the 2 groups after 72 hours postoperatively, and the results are as summarized in Table 2.

However, there was no significant difference in the number of patients who could perform the SLR as per the following details: 16 (34.8%) and 12 (26.1%) of the 46 patients were able to perform SLR at 24 hours after the surgery ($P = .365$). For the patients who had the anterior PMDI, 19 (41.3%), 27 (58.7%), and 30 (65.2%) patients could raise the leg at 48, 72, and 96 hours after surgery,

Table 1
Demographic Data.

Demographic Data	Outcome	*P* Value
No. of patients	46	
Mean age ± SD, y	59.98 ± 7.79 (45-86)	
Gender (male:female)	2:44	
Mean BMI ± SD, kg/m^2	27.72 ± 4.44 (21.09-43.28)	
Mean length of stay, d	7.14 ± 1.31 (5-12)	
The side of the knee injected first (right:left)	23:23	
The first site of the PMDI (anterior:posterior)	24:22	
Preoperative VAS pain scores		
Group A “Anterior,” mean ± SD	8.17 ± 1.25	
Group B “Posterior,” mean ± SD	7.98 ± 1.45	.203
Preoperative degree of active knee flexion		
Group A “Anterior,” mean ± SD	115.10 ± 15.92	
Group B “Posterior,” mean ± SD	113.76 ± 17.71	.551

BMI, body mass index; PMDI, periarticular multimodal drug injection; SD, standard deviation; VAS, visual analog scale.

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