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A Randomized Controlled Trial Comparing Adductor Canal Catheter and Intraarticular Catheter After Primary Total Knee Arthroplasty

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ABSTRACT

Background: Multimodal analgesia, including peripheral nerve blocks, is recommended for postoperative pain relief after total knee arthroplasty (TKA). To date, no randomized controlled trial has compared the efficacy of adductor canal catheters (ACCs) and intraarticular catheters (IACs) in patients undergoing TKA.
Methods: A prospective, randomized control trial was performed in 96 primary, unilateral TKA patients comparing ACC with IAC between April, 2014 and August, 2015. Primary outcome measured was numeric pain scores before and after the first physical therapy session on postoperative day 1. Secondary outcomes were oxycodone consumption at 24 and 48 hours, total opioid consumption in morphine equivalents at 24 and 48 hours, active and passive range of motion during physical therapy, patient satisfaction, and length of stay.
Results: Results demonstrated that the ACC provided significantly better pain control on postoperative day 1 ($P = .02$) compared with the IAC. ACC trended toward significantly reduced oxycodone consumption at 24 hours postoperatively compared to IAC (25.64 vs 34.67 mg, $P = .057$). However, total opioid consumption was equivalent between the groups at 24 hours (32.24 vs 38.55 $P = .185$) or 48 hours (45.2 vs 52.0, $P = .330$).
Conclusion: ACC should be considered as part of a multimodal pain regimen after primary, unilateral TKA and provides a better option for pain control after discharge.

Significant progress has been made to reduce postoperative pain after TKA. As part of a multimodal pain management protocol, patients routinely receive nonsteroidal anti-inflammatory drugs, opioids, acetaminophen, alpha-2 antagonists, gabapentinoids, and local anesthetics delivered both neuraxially and peripherally in the perioperative period.

Adductor canal blocks (ACBs) have emerged as a component of this multimodal program with demonstrated benefits. Studies have shown that ACB reduces quadriceps strength by only 8% from baseline vs 49% with femoral nerve block (FNB), with no difference in opioid consumption, pain at rest, pain during flexion, opioid adverse events, or mobilization ability [1,2]. Ambulation distance is increased on postoperative day 1 (POD 1) and POD 2 with ACB compared to FNB [3]. The administration of an ACB may be achieved via a single shot injection or as a continuous block via perineural catheter. Adductor canal catheters (ACCs) have superior pain control compared to single shot injections with similar early functional recovery [4].

Intraarticular catheters (IACs) also have been used increasingly over the last decade as an adjunct for providing postoperative pain control after TKA. They provide analgesia through direct infiltration of local anesthetic into the joint capsule. Like ACC, quadriceps muscle strength is preserved. IAC is more effective for pain control in patients undergoing TKA when compared to intravenous (IV) or intrathecal opioids, although results are inconsistent [5,6].

To date, no randomized controlled trial has compared the efficacy of ACC and IAC in patients undergoing TKA. This study aims to compare the effect of ACC and IAC administration with regard to

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pain, range of motion (ROM), functional tests, opioid consumption, length of stay (LOS), and patient satisfaction.

Materials and Methods

Study Design

A prospective, randomized control clinical trial comparing ACC and IAC was performed from April, 2014 to August, 2015. Eligibility criteria were primary, unilateral TKA under spinal anesthesia with an American Society of Anesthesiologists (ASA) physical status classification of I-III. Exclusion criteria included allergy to anesthetics, contraindications to regional anesthesia, sensory/motor disorder involving the operative limb, greater than 20 mg of oxycodone daily at baseline (or its equivalent), English not as a primary language, ASA IV or greater, psychiatric or cognitive disorders, renal insufficiency with creatinine (Cr) >2.0 mg/dL, and hepatic failure. Institutional review board approval was obtained before study initiation.

After written consent from patients, the following data were collected: ASA physical status, age, height, weight, gender, quantitative opiate use, pain levels, and baseline Pain Management Questionnaire. Treatment groups were determined by simple randomization. After enrollment and consent, an envelope containing assigned study group was chosen from a shuffled stack.

Anesthetic and Surgical Technique

Preoperatively, all patients received oral acetaminophen 975 mg, celecoxib 200 mg, and pregabalin 75 mg. After the placement of standard ASA monitors, patients from both groups received a spinal anesthetic with 3 cc of 0.5% bupivacaine. Intraoperative sedation and IV fluid therapy was given at the discretion of the anesthesiologist or nurse anesthetist. All patients underwent a medial parapatellar approach and received cemented TKA with posterior stabilized implants and patellar resurfacing.

Intraarticular Catheter Procedure Details

Patients randomized to an IAC had the elastomeric pump catheter (On-Q Pain Relief System, Halyard Health, Alpharetta, GA) placed by an arthroplasty fellowship-trained orthopedic surgeon at the end of the procedure in the superolateral position before wound closure. Technique was based on a previously described methodology [7].

ACC Procedure Details

Patients randomized to the ACC group had the ACC placed in the postoperative anesthesia care unit (PACU). After proper skin preparation and timeout, the femoral artery was identified with a high frequency linear transducer (GE LOGIQe, 12L linear transducer with a frequency of 8-13 MHz) proximal to the operative knee in a sterile fashion. The appropriate location for injection was determined by following the femoral artery in the caudad direction until the artery was located posterior to the sartorious muscle. At this level, the saphenous nerve was identified lateral to the femoral artery and an 18-g Tuohy needle (B Braun) was inserted in an out-of-plane approach under constant ultrasound visualization until the needle tip was located posterior to the sartorius muscle and lateral to the femoral artery. Once satisfied with needle placement and after negative aspiration, 15 cc of 0.5% ropivacaine was incrementally injected through the needle under visualization. A 20-g multiorifice catheter (B Braun) was inserted approximately 4 cm beyond the needle tip in a cephalad direction and secured using SurgiSeal (Adhezion, Wyomissing, PA), benzoin, an Epi-Guard (Copenhagen Medlab, Glostrup, Denmark) device and covered with a Tegaderm (3M, St. Paul, MN).

Postoperative Analgesia

Postoperatively, all patients received a regimen of standing acetaminophen 650 mg every 6 hours, pregabalin 75 mg every 12 hours, and ketorolac 30 mg IV every 6 hours (15 mg if >70 years). Patients randomized to the IAC group received a constant infusion of 0.5% bupivacaine via the On-Q system for 48 hours. The ACC group received an infusion of 0.2% ropivacaine at 10cc/h via the On-Q system for a maximum of 48 hours. A bolus of 10 cc of 0.2% ropivacaine was given as needed for rescue to patients in the ACC group, and these boluses were recorded. No boluses were provided in the IAC group. Parenteral and IV opioid analgesia were prescribed and recorded in both groups per protocol. Opioid consumption was recorded by study personnel through the electronic medical records and converted into morphine equivalents for subsequent analysis. All patients received standard postoperative mobilization treatment, starting on POD 0 with trained physical therapists.

Outcome Assessment

A preoperative Pain Management Questionnaire, with a numeric rating scale (1-10) and a Wong-Baker verbal descriptor, was obtained and recorded before randomization. The same questionnaire was repeated at 24 and 48 hours, depending on the patient's hospital LOS. This Pain Management Questionnaire included an assessment of patient satisfaction. Patient satisfaction scores were measured on a scale of 1-6 (1 = very dissatisfied, 2 = dissatisfied, 3 = slightly dissatisfied, 4 = slightly satisfied, 5 = satisfied, 6 = very satisfied). Opioid consumption was recorded at PACU discharge and at 24 and 48 hours, postoperatively. Additional pain scores, recorded by a patient orated numeric rating scale (0-10), were recorded at the first and fourth physical therapy (PT) sessions on POD 1. This numeric pain score was recorded 3 times during each session: at rest before movement, during the therapy session, and at rest after the session. Active and passive ROM was recorded at the first and fourth sessions, as well.

Statistical Analysis

This is a study of a continuous response variable from independent control and experimental subjects with one control per experimental subject. In a previous study, the response within each subject group was normally distributed with a standard deviation (SD) of 2.9. If the true difference in the experimental and control means is 2, we will need to study 45 experimental subjects and 45 control subjects to be able to reject the null hypothesis that the population means of the experimental and control groups are equal with probability (power) 0.9.

Demographic data and other clinical variables were compared between the 2 groups using the Student t test and the Mann-Whitney U test. Categorical data were analyzed using chi-square and Fisher exact tests. Pain data were analyzed using analysis of variance with repeated measures when indicated. Post hoc analyses were performed using Bonferroni corrections. Data are presented as means ± SD, and medians with interquartile range (IQR) for data not normally distributed. The P value was set at .05 for statistical significance. Systat (Systat Software, Inc, San Jose, CA) version 13 was used to perform the statistical analyses.