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Original Contribution

# Addition of buprenorphine to local anesthetic in adductor canal blocks after total knee arthroplasty improves postoperative pain relief: a randomized controlled trial☆

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**Abstract**

**Background and Objectives:** For the hundreds of thousands of patients who undergo total knee arthroplasty (TKA) in the United States each year, early mobilization has been demonstrated to improve functional outcomes and reduce complications. Management of postoperative pain is a critical factor in achieving early mobilization. Recent studies have shown that the use of an adductor canal block (ACB) after TKA results in increased preservation of quadriceps muscle strength, without significant difference in postoperative pain when compared to femoral nerve block. This increased preservation of quadriceps muscle strength leads to earlier mobilization. Studies have also demonstrated a prolongation of analgesia with the addition of buprenorphine to local anesthetic for regional block placement. This study examined the effect on postoperative opioid consumption when adding buprenorphine to an ACB vs an ACB with local anesthetic alone, for postoperative analgesia after unilateral TKA.

**Methods:** A total of 100 patients scheduled for TKA were randomized to receive postoperative ACB with local anesthetic alone or with local anesthetic and buprenorphine. The primary outcome examined was total

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opioid analgesic (milligrams of hydrocodone equivalent) consumption in the first 24 hours postsurgery. The secondary outcomes examined were the reported incidence of the opioid side effects nausea, vomiting, and pruritis.

**Results:** Postoperative opioid consumption decreased significantly in the group that received an ACB with local anesthetic and buprenorphine compared to an ACB with local anesthetic only (25.34 ± 2.62 vs 35.84 ± 2.86; $P = .0076$). Secondary outcomes showed no statistical difference between the 2 groups in terms of the incidence of nausea, vomiting, or pruritus.

**Conclusion:** The addition of buprenorphine to an adductor canal block decreases postoperative opioid consumption when compared to an ACB with local anesthetic alone. This reduction in opioid consumption, without significant increase in side effects, makes this an attractive anesthetic adjunct for TKA.



## 1. Introduction

Total knee arthroplasty (TKA) is a relatively common elective orthopedic surgery primarily performed for relief of severe arthritic symptoms. In 2010, approximately 600,000 such procedures were performed in the United States. That number is estimated to increase to 3.5 million by 2030 [1,2]. An important determinant of patient outcome is early mobilization and rehabilitation [3]. Effective postoperative analgesia is integral to early mobilization, and regional blocks have become a vital component of pain management plans in this patient population. Traditionally, the femoral nerve block (FNB) was seen as the criterion standard regional anesthetic block for postoperative analgesia after TKA. This thinking has recently been viewed more skeptically as the resulting quadriceps muscle weakness can delay mobilization [4–6]. Studies of adductor canal blocks (ACBs) have placed an emphasis on the primarily sensory blockade and the reduced muscular blockade, in comparison to FNB. In Jaeger et al, healthy volunteers performed a crossover study with an FNB vs ACB and found that FNB left patients with a quadriceps strength value of 52% of baseline, whereas an ACB maintained 91% of baseline quadriceps strength [6–13].

The addition of an opioid to the local anesthetic in regional blocks has been shown to prolong the duration of analgesia and decrease the use of oral analgesics [14–19]. Buprenorphine was demonstrated by Leffler et al [20] to have the longest duration of action of any opioid, due to its blockade of sodium channels on peripheral opioid receptors. It has been demonstrated that buprenorphine has a higher potency, slower onset, and longer duration of action than local anesthetics or other long-acting opioids [21]. To date, there have been no studies examining the addition of buprenorphine to ACB for postoperative analgesia after TKA.

The primary objective of this study was to determine if the addition of buprenorphine to bupivacaine for ACB placement would reduce opioid consumption in comparison to ACB with bupivacaine alone, in the first 24 hours after TKA. The secondary outcomes examined were the incidence of pruritus, nausea, and vomiting.

Our hypothesis was that the addition of buprenorphine to bupivacaine for ACB would decrease postoperative opioid consumption without an increased incidence of nausea, vomiting, or pruritis.

## 2. Materials and methods

For determining the group sizes, a priori power analysis using G*Power 3.1.6 program was performed. Typical input parameters of $\alpha = .05$ (type I error probability), power = $(1 - \beta) = 0.8$ ($\beta$ type II error probability), and moderate to medium size effect were assumed. It was determined that approximately 50 patients should be enrolled in each of the 2 treatment groups for a total of 100 patients. After institutional review board approval from St Joseph Mercy Oakland, 100 subjects who were undergoing TKA were identified based on preoperative evaluations. They were enrolled after informed consent was obtained in the preoperative holding area.

Patients between 18 and 100 years old were eligible. Both men and women of all races and ethnic backgrounds undergoing unilateral TKA with spinal anesthesia combined with monitored anesthesia care, followed by unilateral adductor canal block with ultrasound guidance, were eligible.

Exclusion criteria included those taking anticoagulants upon admission, significant genetic or acquired clotting/bleeding disorders (hemophilia, disseminated intravascular coagulation, etc), significant platelet dysfunction, prior back or leg surgery that precluded spinal or regional anesthesia, allergy to local anesthetics, severe aortic or mitral stenosis, liver failure, sepsis, or preexisting neurologic defects.

All participating patients received a spinal anesthetic with 11.25 mg (1.5 mL 0.75%) of hyperbaric bupivacaine combined with monitored anesthesia care. The enrolled patients were not given parenteral or oral opioids at any point during the preoperative or intraoperative period. Using a double-blinded protocol, patients were randomly assigned to 1 of 2 groups using a computer-generated randomization. Patients in group 1 (placebo) received an ACB with 30 mL of 0.25% plain bupivacaine. Patients in group 2 (buprenorphine) received an ACB with 30 mL of 0.25% bupivacaine with 200 μg of buprenorphine added. All ACB blocks were performed using ultrasound guidance by 1 of 2 participating anesthesiologists in the postanesthesia care unit.