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A Comparison of Single Shot Adductor Canal Block Versus Femoral Nerve Catheter for Total Knee Arthroplasty

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ABSTRACT

The aim of this study was to compare perioperative analgesia provided by single-injection adductor canal block (ACB) to continuous femoral nerve catheter (FNC) when used in a multimodal pain protocol for total knee arthroplasty (TKA). A retrospective cohort study compared outcome data for 148 patients receiving a single-injection ACB to 149 patients receiving an FNC. The mean length of stay (LOS) in the ACB group was 2.67 (±0.56) and 3.01 days (±0.57) in the FNC group ($P < 0.0001$). The median ambulatory distances for the adductor group were further than the femoral group for postoperative days 1 ($P < 0.0001$) and 2 ($P = 0.01$). Single-injection ACB offered similar pain control and earlier discharge compared to continuous FNC in patients undergoing TKA.

Total knee arthroplasty (TKA) is variably associated with significant postoperative pain. Therefore, multimodal analgesic protocols are used to achieve optimal pain relief, shorten length of stay (LOS), and reduce healthcare costs [1,2]. In the setting of TKA, multimodal analgesia regimens increase patient satisfaction and allow for earlier ambulation when compared to oral and intravenous opioid interventions alone [3,4]. Peripheral nerve blocks are included in many TKA pain management plans and have demonstrated superior postoperative analgesia and overall patient outcomes [2,5–10].

Evidence also suggests the utilization of continuous femoral nerve catheters (FNC) for postoperative pain control following TKA provides superior pain control relative to epidural anesthetics and opioid administration alone [11]. However, FNCs may reduce quadriceps muscle strength and have been associated with an increased risk of postoperative falls [12,13], catheter site infection, and limited ability to ambulate until postoperative day (POD) 2 [14]. In addition, mixed evidence exists to definitively state that the additional time, efforts, and cost associated with placing and managing a continuous FNC provides postoperative benefits beyond those linked to traditional single-injection femoral nerve blocks [15,16]. Therefore, adequate pain control, along with quadriceps muscle preservation, has become a goal among orthopedic departments following TKA [17].

With the exception of some variable motor fibers to the vastus medialis, the saphenous and obturator nerves traveling in the adductor canal are sensory in nature [2]. Recent studies provide evidence that continuous ACBs compared to continuous FNCs following TKA spare quadriceps motor strength [18], while achieving similar pain scores [17,19]. Thus, attention in the literature focused on evaluating the use of continuous ACBs for TKA instead of continuous FNC [17,19–22]. Postoperative outcomes for single-injection ACBs following TKA have not, however, been compared to continuous FNCs.

The aim of this study was to compare single-injection ACB to continuous FNC with respect to perioperative pain, opioid administration, rehabilitation, and hospital LOS. We hypothesized that single-injection ACB achieves adequate postoperative analgesia while facilitating earlier completion of rehabilitation requirements.

Methods

Following protocol approval by the institutional review board, we performed a retrospective review of medical records for consecutive patients who underwent unilateral TKA at our institution between August 1, 2012 and March 31, 2014. All study records were contained in the electronic medical record used at our institution. Of the 297 eligible patients, 148 patients received single-injection ACBs, while 149 patients underwent continuous FNC placement. The following demographic, perioperative, and physical therapy data were extracted and compared: age, gender, body mass index (BMI), length of stay (LOS), baseline opioid consumption, American Society of Anesthesiologists (ASA) physical status score, pain scores, opioid administration, anti-emetic

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administration, and chemical characteristics of the peripheral nerve block (0.5% ropivacaine or 0.5% bupivacaine), and physical therapy data for postoperative day (POD) 0 through 3.

Patients preoperatively received either a single-injection ACB or a continuous FNC following sterile skin preparation with chlorhexidine gluconate and lidocaine skin analgesia. Both peripheral nerve blocks were performed by the regional block team, consisting of a resident or fellow supervised by a faculty anesthesiologist with specific training in regional anesthesia, and placed under ultrasound guidance. Sedation with intravenous midazolam and fentanyl was given as needed to facilitate block placement. The adductor canal blocks were positioned on the medial thigh halfway between the inguinal ligament and patella under the sartorius muscle just lateral and superficial to the femoral artery. The femoral nerve catheters were positioned deep to the fascia iliaca approximately 1.0 cm lateral and superficial to the femoral nerve. Following negative aspiration, all patients in both groups received an injection of either ropivacaine or bupivacaine (0.5%, 20 ml). The femoral nerve group also received a continuous infusion of 0.2% bupivacaine until the morning of POD one and 0.1% until discontinued on POD 2 at a continuous rate of 5 ml per hour.

Patients underwent either spinal or general anesthesia as their primary anesthetic at the discretion of the in-room anesthesia provider. Those patients managed with general anesthesia were induced with propofol, opioids, and muscle relaxants followed by airway securement. Generally, inhaled agents were used to maintain an appropriate depth of anesthesia. Individual patient hemodynamic and respiratory response to the surgery were used to determine appropriate intraoperative anesthesia maintenance with anesthesia and opioids at the discretion of the anesthesia team caring for the patient. Post-anesthesia care unit (PACU) nurses administered anti-emetics and opioids as deemed appropriate based on patient complaints of nausea and pain. All surgical procedures were performed using a medial parapatellar approach through a standard-length incision with the patient in the supine position and a tourniquet about the proximal thigh. All operations were performed with the same technique and implant design (Zimmer NexGen, Warsaw, IN, USA). A bolus of 0.25% bupivacaine and 1:200,000-epinephrine was injected during surgery posterior to the capsule after components of the knee joint were removed. Following the procedure, a sterile dressing was applied and all patients were placed in a knee immobilizer for 12–24 hours postoperatively when out of bed and standing or walking. Time spent with a knee immobilizer was dependent on patient demonstration of strength and ambulation ability during physical therapy sessions.

Throughout each patient's hospital stay, self-rated pain scores were taken every 2–6 hours as part of standard nursing practice on the orthopedic inpatient floor. Median and peak pain scores from post-operative day 0 through discharge were obtained from the EMR. Categorical pain scores were defined as: none 0; mild 0.01–2.99; moderate 3.00–6.99; severe 7.00–10.0. Oral and intravenous opioids were administered postoperatively per protocol without standardization between comparison groups. The postoperative pain regimen included oxycodone and morphine as needed, acetaminophen every 6–8 hours, and ketorolac in selected patients. In order to comparatively assess total oral and intravenous opioid administration throughout length of stay, all opioids given were converted to intravenous morphine equivalents (Meq) with the following formula: 1/3 [mg PO morphine] + 1/2 [mg PO oxycodone] + 1/3 [mg PO hydrocodone] + 1/20 [mg PO codeine] + 10/7.5 [mg PO hydromorphone] + [mg IV morphine] + 10/1.5 [mg IV hydromorphone] + 1/10 [mcg IV fentanyl]. Rehabilitation through physical therapy was performed by patients under stable medical conditions on postoperative days 0 through 3. Ambulation distances from both morning and evening sessions were combined into a total ambulatory distance for comparative purposes. Active surgical knee range of motion data was normalized into degrees of flexion in supine (0°–90°) and degrees from complete extension (90°–0°) while seated. Physical therapy data were obtained from physical therapy notes.

Patients were encouraged to ambulate within 24 hours after procedure completion. Standard hospital rehabilitation protocol for discharge was followed. Barring medical complications, patients were discharged once both pain control and physical therapy requirements were complete.

Data were initially analyzed for normality with a D'Agostino & Pearson omnibus test. For normally distributed data, intergroup comparisons were performed using the Student's t-test and reported with a mean and standard error. For data not normally distributed, the Mann–Whitney U test was used for intergroup comparisons. These data are reported with a median and interquartile range (IQR). All statistical analyses were performed using Prism Version 6 (GraphPad Software, La Jolla, CA, USA). P values less than 0.05 were considered statistically significant.

Results

During the study period, 297 patients underwent unilateral TKA. One hundred forty-eight patients received a single injection ACB, while 149 patients received a continuous FNC. Baseline characteristics, including age, gender, BMI, ASA physical score, anesthesia type, and baseline pain score, were similar between the groups (Table 1).

There was no statistical difference between groups for mean perioperative opioid usage, in intravenous morphine equivalents, at any time frame when preoperative chronic and naïve opioid usage was taken into consideration (Table 2). More patients in the ACB group were administered anti-emetics on postoperative day 0 with a percentage of 39.86% in comparison to 24.83% in the FNC group ($P = 0.006$). Anti-emetics administration during the remaining stay did not reach statistical significance ($P = 0.72$). With respect to median self-rated pain scores during physical therapy, there was no statistical difference on postoperative day 0 ($P = 0.56$) or throughout the remaining stay ($P = 0.23$) between comparison groups.

Physical therapy data suggest statistically significant differences in rehabilitation capabilities between the ACB and FNC groups on both postoperative days 1 and 2 (Table 3). Most notably, the median ambulatory distances for the adductor group were further compared to the femoral group for postoperative day (POD) 1 with a distance for the ACB group at 175 feet (95.0–250.0) and the FNC group at 90 feet (31.5–202.5) ($P < 0.0001$). Similar results on POD 2 ambulatory distances were reported with median distance for the ACB group at 260 feet (174.0–357.0) and the FNC group at 207 feet (120.0–329.5) ($P = 0.01$). Similarly, postsurgical mean knee flexion for the adductor group were greater than the femoral group on both POD 1 ($P < 0.0001$) and POD 2 ($P = 0.001$). Additionally, our data suggest a statistically significant difference in the mean hospital length of stay with a time of 2.67 days (± 0.56) for the adductor group compared to 3.01 days (± 0.57) in the femoral group ($P < 0.0001$) (Fig. 1).

Discussion

The primary finding of this study is that patients receiving a single-injection ACB for postoperative pain control following TKA demonstrated improvements in ambulation distance and knee flexion on both PODs 1 and 2, and were discharged home sooner when compared to those receiving a continuous FNC. While the improvements in ambulation distance and hospital discharge time likely represent expected increased quadriceps strength, it is surprising that there exists no difference in self-rated pain scores or opioid administration between a block of limited duration versus a continuous catheter technique.

The sensory innervation to the articular surfaces and surrounding cutaneous regions of the knee are complex and variable [2]. Redundant afferent nerve fibers travel with the sciatic, femoral, and obturator nerves [23]. Often considered the gold standard for nerve blockade following TKA, the posterior division of the femoral nerve provides the primary motor innervation to the sartorious and quadriceps femoris muscles. A study of twelve healthy volunteer men demonstrated that femoral nerve blocks with ropivacaine reduce quadriceps strength by 49% from baseline [18]. The saphenous nerve, a branch of the posterior