Early Experience with Bilateral Continuous Femoral Nerve Block and Single-Injection Spinal Anesthesia for Bilateral Total Knee Arthroplasty: A Case Series

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Abstract

Objective. Total knee arthroplasty (TKA) is a commonly performed surgery in the United States, with demand for unilateral and simultaneous bilateral TKAs (BTKAs) expected to increase significantly over the coming decades. This study reports the authors’ early experience in a consecutive series of simultaneous BTKAs performed under regional anesthesia and mild sedation.

Methods. In this retrospective case series, the authors examined all simultaneous BTKAs performed over two years by a single surgeon. Only patients receiving bilateral continuous femoral nerve blockade (CFNB) and single-injection sciatic nerve blockade in combination with single-injection subarachnoid block were included in the study. Of the 32 patients who underwent BTKAs during this period, 25 met the inclusion criteria. The patient’s anesthesia records, physician notes, nursing notes, pharmacy records, and physical therapy records were then reviewed systematically to create a database of information.

Results. Only one of 25 patients required conversion to general anesthesia during surgery. There were no major perioperative complications. The average Defense and Veterans Pain Rating Scale score immediately postoperation was 0.6/10, and the average daily score remained below 3.5/10 throughout the hospital stay. The use of bilateral CFNB did not prevent patients from ambulating during physiotherapy.

Conclusions. This early retrospective case series suggests that it is feasible to effectively manage the postoperative pain associated with BTKA with staged bilateral CFNB and single-injection sciatic nerve blockade in combination with single-injection subarachnoid block as the sole anesthetic technique without negatively influencing early ambulation.

Key Words. Total Knee Arthroplasty; Regional Anesthesia; Bilateral Total Knee Arthroplasty; Continuous Femoral Nerve Block

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Introduction

Total knee arthroplasty (TKA) is a commonly performed surgical procedure in the United States. In 2002, 381,000 primary total knee replacements were performed, according to the National Hospital Discharge Survey [1,2]. The number of TKA procedures continues to increase each year, and according to Kurtz, the demand is expected to grow by 673% by the year 2030 to an estimate of 3.48 million knee replacements per year [3].

Another trend that has developed over the past two decades is the increased prevalence of simultaneous bilateral TKAs (BTKAs) [4]. In the 1990s, BTKAs comprised 3.7% of all TKA surgeries. However, by the middle of the last decade, simultaneous BTKAs comprised 6% of all total knee replacement surgeries, an increase of 75% [4]. This is expected to increase significantly in the future.

Although BTKA offers patients the convenience of completing both procedures at the same time, there are higher rates of mortality and morbidity when compared with unilateral knee replacements [5–7]. In an attempt to reduce the rate of complications, various modalities of anesthesia have been employed. Regional and neuraxial anesthesia have been found to improve outcomes and reduce complications in TKA when compared with general anesthesia [8–10], yet the majority of the studies reported in the literature have investigated the use of epidural catheters to achieve anesthesia and postoperative analgesia. Zhu et al. [11] evaluated patients undergoing unilateral knee replacements [5–7]. In an attempt to increase hospital length of stay, and improve early rehabilitation in UTKA [14–18]. A recent study by Patel et al. [19] compared outcomes of CFNB with single-injection sciatic nerve block to epidural catheters in patients undergoing BTKA. The study found that the CFNB cohort had fewer episodes of hypotension, less urinary retention, and fewer blood transfusions when compared with the epidural cohort.

Due to the support for the use of CFNB and neuraxial anesthesia in the reduction of complications and improved pain control, the authors sought to apply these principles in the management of patients undergoing BTKA surgeries using a novel technique. The purpose of this study is to report our early experience in a consecutive series of simultaneous BTKAs performed under regional anesthesia and mild sedation.

Methods

Institutional review board (IRB) approval was obtained for a review of the patients’ medical records (IRB number H-160–2012). Prior to reviewing a patient’s electronic medical record (EPIC, Epic Systems Corporation, Verona, WI, USA), an electronic database was created. The patients were identified from the surgeon’s (HKP’s) personal case database. The surgeon’s database was reviewed for all BTKAs performed over two years. The electronic medical records were reviewed, and selected data were collected for 32 consecutive patients. One patient was excluded from the series due to an unrelated traumatic event occurring in the early postoperative period after discharge from the hospital that required further surgery. After reviewing the electronic anesthesia record (Centricity Perioperative Anesthesia, General Electric Healthcare Information Technologies, Fairfield, CT, USA), a further six patients were excluded from the case series because two of the patients received epidural anesthesia and four received general anesthesia. The two patients received epidural anesthesia due to the anesthesiologist’s preference. The four patients who received general anesthesia received general anesthesia because of patient factors or patient preference; two patients had a history of difficult airway management, and two patients elected not to have neuraxial anesthesia.

The database included demographic information, preoperative diagnosis, history of opioid use within three months of surgery, and past medical history. The anesthesia records were used to determine American Society of Anesthesia score (ASA health status), total anesthesia time, surgical time, tourniquet time, regional anesthesia specifics, and whether the patient required conversion to general anesthesia during the procedure. The anesthesia time was defined as the time the patient entered the operating room to the time that the patient was ready for transfer to the postanesthesia care unit. The surgical time was defined as the time from first incision to completion of the surgical dressing. The tourniquet time, defined as the time from tourniquet inflation to tourniquet release, and tourniquet pressure were recorded for both extremities. If the tourniquet was deflated and then re-inflated on one extremity during the procedure, the tourniquet time was calculated as the sum of the times for which the tourniquet was inflated.

The postoperative physician and nursing progress electronic records (EPIC) were reviewed to determine the patient’s postoperative progress and to determine the presence of complications. Postoperative laboratory results, which included daily hematocrit value
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estimation, were also reviewed from the same electronic records. The necessity and volumes of packed red blood cell (PRBC) transfusions were documented. PRBCs were given when the hematocrit was less than 22% or if the patient had symptomatic anemia (tachycardia, dyspnea, orthostatic hypotension, and fatigue). Physical therapy daily progress notes were reviewed to determine the patient’s ambulatory status, distance (in feet) of ambulation on each postoperative day, and the amount of assistance required during ambulation for 4 postoperative days or until discharge (whichever occurred first). The therapy assistance levels were classified as no assistance, minimal assistance, moderate assistance, or maximum assistance. The amount of assistance was given a numeric value to allow an average to be calculated. The numeric conversion is as follows: no assistance = 0, minimal assistance = 1, moderate assistance = 2, maximum assistance = 3. Furthermore, the patient’s six-week and three-month postoperative outpatient clinic visits were reviewed to determine knee range of motion, clinical progress, and adverse outcomes. The knee range of motion values were defined as degrees of extension and degrees of flexion for both knees.

The pharmacy records were reviewed to determine all opioids and other analgesic agents used postoperatively. The amount of oral and intravenous (IV) opioids was specifically recorded for each hospital day and was converted to dosage equivalents (DEs), where one DE equals 10 mg of intramuscular morphine [20]. The immediate postoperative anesthesia notes were reviewed from the EPIC record to determine the patient’s immediate postoperative pain. The pain score was determined using a 0 to 10 Defense and Veterans Pain Rating Scale (DVPRS) [21], where a score of 0 reflected no pain and no interference with activities, and a score of 10 reflected the most excruciating pain imaginable—as bad as it could be and nothing else matters. The Acute Pain Services (APS) rounded twice daily on the patients, and their daily progress notes were reviewed from the EPIC record to determine the patient’s daily pain scores while at rest and with activity, again using a 0 to 10 DVPRS.

Patients with history of opioid use within three months of surgery were compared with patients reporting no opioid usage within three months of surgery. Daily DVPRS, total opioid usage, and hospital length of stay (LOS) were compared between patients with a history of opioid use and those who reported no opioid usage. A two-tailed unpaired Student’s t-test was used to analyze the data, where P values of less than 0.05 represented statistical significance.

Finally, the length of stay (LOS) in the hospital was documented. The LOS was defined as the day of admission to the day of discharge. The disposition (home, skilled nursing facility, or rehabilitation center) of the patient was also recorded. If the patient was discharged to a nursing facility other than home, the length of that stay was recorded, as well as any adverse outcomes.

Anesthesia Technique

Prior to surgery, patients received CFNB catheters and a single-injection subglutal sciatic nerve block (SISNB) in the preoperative area (designated block room). For the bilateral CFNB, a 17-guage sheathed Tuohy needle (StimuCath, Arrow International, Reading, PA, USA) attached to a nerve stimulator set to a current of 1.0 to 1.2 mA, a stimulus duration of 300 msec, and a frequency of 2 Hz were used under ultrasound guidance, and following optimal needle placement, the nerve stimulator was applied to a stimulating catheter (StimuCath, Arrow International, Reading, PA, USA) at the same settings; the catheter was advanced, observing brisk quadriceps muscle contractions during advancement of the catheter. A test dose of 2 mL of lidocaine 2% with 1/200,000 epinephrine was then injected. Twenty mL of ropivacaine 0.5% was then injected through the catheter on the side to be operated on first, and an infusion pump (Curlin Pump, Curlin Medical, Huntington Beach, CA, USA) was attached to the catheter to deliver a continuous infusion of ropivacaine 0.2% at 5 mL per hour, as well as a patient-controlled bolus of 5 mL, limited by a lockout to be injected every 60 minutes if required. The contralateral CFNB was initiated in the same fashion to the primary CFNB upon skin closure of the primary total knee arthroplasty.

The subgluteal SISNBs were performed bilaterally by placing the patient on his/her side while a 22-guage, 90-mm needle (StimuQuick, Arrow International, Reading, PA, USA) was placed under ultrasound guidance next to the nerve. Ten milliliters of 0.2% ropivacaine was then injected as a single injection. This block was repeated on the other side.

After the blocks were placed, the patients were transported to the operating room, where they received a single intrathecal injection of 2 mL of bupivacaine 0.75% plus 25 mcg of fentanyl through a 25- to 27-guage pencil-point needle (Sprotte Needle, Teleflex Medical, Research Triangle Park, NC, USA). All blocks were performed by regional anesthesia fellows under the direct supervision and assistance of the regional anesthesia attending.

Patients were sedated intraoperatively with IV propofol at 10 to 50 mg/kg/min, as required according to the patients’ needs and the preference of the attending anesthesiologist. The anesthesia and sedation were performed by a combination of resident trainees and certified registered nurse anesthetists (CRNA) under the supervision of an attending anesthesiologist.

At 06:00 on the second postoperative day (POD 2), the pumps were turned off and the patient’s pain was assessed. If the patient’s pain was adequately managed with only oral medications (DVPRS of 4 or less), the
catheters were removed after full return of sensory and motor function of the legs. However, if the patient’s pain was not controlled with oral medications, the infusions were reinstated following a bolus injection of 10 mL through the appropriate CFNB catheter.

All patients routinely received 1,000 mg of acetaminophen, 200 mg of celecoxib, and 10 mg of sustained-release oxycodone if older than age 70 years or female or 20 mg of sustained-release oxycodone if younger than age 70 years or male by mouth preoperatively. Postoperatively, patients received 975 mg of acetaminophen every eight hours, 200 mg of celecoxib daily, and 50 mg of tramadol hydrochloride every eight hours orally for three days postoperation. For breakthrough pain, “rescue medication” included oxycodone 5–10 mg every four hours as needed, ketorolac 30 mg IV every eight hours as needed, and morphine sulphate 2 mg IV every four hours as needed. Scheduled sustained-release oxycodone was administered in select patients, primarily patients with a history of opioid usage prior to surgery. Five patients received scheduled sustained-release oxycodone, 4 of whom had a history of previous opioid usage.

Surgical Technique

The patients were positioned supine on the operative table, and a Foley bladder catheter was inserted. Both legs were prepared and draped for surgery in a routine sterile fashion. Posterior stabilized TKAs were completed sequentially from incision to closure, beginning with the patient’s most symptomatic extremity. Prior to starting the second arthroplasty, the CFNB on that side was initiated by injecting 20 mL of ropivacaine 0.5% through the catheter.

The surgical approach used the standard medial parapatellar approach under a thigh pneumatic tourniquet set at 250 mmHg. Upon completion of closure, the process was repeated for the contralateral extremity after confirmation of a stable medical condition with the anesthesia team. Compression bandages were used for 48 hours. All patients received 325 mg of aspirin daily for six weeks postoperation as thromboprophylaxis.

Results

The demographic data of the patients in the study are outlined in Table 1. The average intraoperative anesthesia and surgical times are outlined in Table 2. Twenty-four of the 25 patients included in the series underwent sequential BTKA anesthetized under regional anesthesia alone. One patient did require conversion to general anesthesia during the surgical procedure. The patient required sedation and a laryngeal mask airway placement due to an inability to remain still during the surgical procedure. These data are summarized in Table 3.

The average hospital stay for the patients was 4.8 days (range = 4–7 days). On discharge from the hospital, three patients were released home, one patient was discharged to a skilled nursing facility, and the remaining 21 patients were discharged to an inpatient rehabilitation facility. Two patients had their hospital stay extended by one day due to bed unavailability at the rehabilitation facility. The average LOS in the in-patient rehab facility was 9.1 days (range = 4–15 days).

The average DVPRS pain score was recorded immediately postoperation in the postanesthesia care unit. The average pain scores while at rest and during activity were also recorded each day postoperatively. The data are summarized in Table 4. The data for the average daily opioid usage and the average opioid usage for the entire hospital stay were also recorded and are outlined in Table 5.
Five patients required transfusion of packed red blood cells (PRBCs) for symptomatic anemia. The five patients received a total of 11 units of PRBCs, for an average of 2.2 units per patient transfused. One patient received two units of PRBC on POD 1, one patient received two units of PRBC on POD 3, and two patients received two units of PRBC on POD 4. One patient did require two units of PRBC on POD 1 and then required a single unit of PRBC be transfused again on POD 3.

The average ambulatory distance and amount of therapy assistance needed to ambulate are outlined in Table 6. Only 13 patients had recorded ambulatory distances on POD 4 because the patients were discharged from the hospital prior to a physical therapy encounter for the day. There were no reported falls of any patient included in the study during the hospital stay. The average postoperative knee range of motion values were collected at six weeks and three months postoperatively. These range of motion values are outlined in Table 7.

Seven complications occurred in six patients. Three patients experienced postoperative delirium. In one patient, the patient’s mental status returned to baseline after administration of Naloxone. The second patient’s delirium resolved once benzodiazepines were stopped. The third patient with delirium resolved with a reduction in opioid dosing. One patient was found to have a suture reaction, with subsequent cellulitis on POD 24. The patient was treated with five days of oral antibiotics, with no further sequelae. One patient was re-admitted within 30 days of surgery for “failure to thrive” ascribed to a urinary tract infection that started on POD 21. Finally, one patient developed urinary retention while in the rehabilitation hospital and required temporary placement of a urinary catheter.

Ten patients reported routine opioid use within three months of surgery. Patients with a history of opioid usage had an average DE of 6.5 over their entire hospital stay, compared with an average DE of 5.1 in patients without a history of opioid usage, which was not statistically significant. Four patients required more than 15 DEs during their hospital stay, three of whom had a history of previous opioid usage. The DVPRS by day of hospital stay while at rest and with activity was not statistically different between the patients with a history of opioid usage and no history of opioid usage. There was also no appreciable difference in hospital length of stay between the two groups.

Discussion

TKA procedures are becoming increasingly common, and simultaneous BTKA is being performed more frequently [1–3]. Lane et al. [5] reported increased risk for blood transfusions, almost three times the increased rate of cardiopulmonary complications, and an
increased rate of postoperative mental confusion associated with simultaneous BTKA. This is also supported by the work of Bullock [22] and Lynch [23], who reached similar conclusions.

In an attempt to improve patient outcomes and reduce complications, various means of regional anesthesia have been used for patients undergoing TKA. Regional anesthesia has been demonstrated to significantly decrease postoperative pain and improve patient satisfaction [8]. Capdevila et al. [24] found decreased postoperative pain, increased range of motion, and shorter stays in rehabilitation facilities with regional anesthesia when compared with patients treated with postoperative patient-controlled morphine. Patel et al. [19] evaluated outcomes in patients undergoing BTKA with CFNB or epidural catheters and found lower complication rates and blood transfusion rates in the CFNB cohort. Neuraxial anesthesia has also demonstrated a decrease in perioperative complications and improved function postoperatively. In a randomized trial, Williams-Russo showed that patients receiving epidural anesthesia reached rehabilitation milestones sooner than patients receiving general anesthesia [9]. Another study by Zhu et al. [11] showed lower complication and blood transfusion rates after BTKA in patients receiving neuraxial anesthesia compared with general anesthesia. These findings illustrate the need for future randomized controlled studies evaluating the effectiveness and safety of the various anesthesia techniques.

The authors sought to determine the feasibility of performing BTKA under complete regional anesthesia and neuraxial anesthesia. In our study, 96% of patients did not require additional anesthesia during the procedure. Only one of the 25 patients required conversion to general anesthesia. Patients appeared to have excellent pain control immediately postoperation, while at rest and with activity. Although opioid usage increased on POD 2, it coincided with the discontinuation of the femoral nerve blocks. Because there was no comparison group, we compared our outcomes with those reported in the literature.

To the best of our knowledge, only one study exists that investigated opioid usage and DVPRS pain scores in patients undergoing BTKA [25]. In this study by Powell et al., patients undergoing BTKA received no regional anesthesia, and pain was treated with oral and IV opioids only [25]. Powell et al. noted that opioid usage was highest in the first 48 hours after surgery. Opioid usage and pain scores were both lower in our series when compared with the work by Powell et al., suggesting that the regional anesthesia protocol presented in this study could be superior for the management of pain in patients undergoing BTKA. It also illustrates how bilateral CFNB could improve pain and rehabilitation in the early postoperative period. Further research is required to clarify this, however. One limitation of this study is that administration of sustained-release oxycodone was not standardized. Sustained-release oxycodone was primarily prescribed for patients with a history of opioid use prior to surgery; however, only 4 of the 10 patients with a positive history of opioid use were administered long-acting oxycodone. In addition, one patient with no history of previous opioid use was administered sustained-release oxycodone.

A concern with bilateral continuous femoral nerve blocks for BTKA is muscle weakness, resulting in difficulty ambulating. There was no subjected strength data available for review in this study, so patient falls and ambulatory distance were used as an alternative means to assess strength. There were no reported falls, and our study showed a gradual improvement in ambulatory distance, as well as a decreased level of physical therapist assistance as the hospital stay progressed. One study was identified that evaluated postoperative ambulatory distances in patients undergoing BTKA [25]. In this work by Powell et al., the patients underwent BTKA but received no regional anesthesia, and the ambulatory distances were recorded for the first three postoperative days. The ambulatory distances of our study are comparable with those found by Powell et al. As we gain further understanding of the influence of arthrogenic muscle inhibition (AMI) and its role in joint rehabilitation [26], the authors speculate that blockage of the AMI neural pathways for a longer period using a continuous femoral nerve blockade may contribute to faster return to function of the quadriceps [27–29]. Further studies are warranted.

Another concern with bilateral CFNB and bilateral SISNB is the possibility of local anesthetic toxicity. When calculating the total daily dose of ropivacaine administered (approximately 1,600 mg/24 h), one can note that it does approach the maximal recommended daily dose (2,016 mg; see US Food and Drug Administration...
data at http://www.accessdata.fda.gov/drugsatfda_docs/label/2010/020533s020s021bl.pdf. Our patients, therefore, were carefully selected patients who were free of renal and hepatic disease; in addition, we did not inject the femoral nerve block boluses simultaneously. Furthermore, the bulk of the total daily dose was infused at 5 mL per hour over a period of 24 hours. Patients were closely monitored for signs and symptoms of toxicity, and neither was encountered in any of the patients in the current study. We do, however, stress careful patient selection. Further studies measuring exact blood ropivacaine levels are required.

A final anesthetic concern would be resolution of the spinal anesthetic prior to conclusion of the surgical procedure. This may be the case in some situations and can be managed by converting the failing spinal to general anesthesia in this patient population. Adding 25 mcg of fentanyl to the spinal injectate may also alleviate this problem, as would the addition of femoral and sciatic nerve blocks. We did not encounter this problem in any of the patients studied or thereafter.

There was a moderate number of minor complications in the perioperative period, but no major complications occurred in this series of patients. Furthermore, there were no instances of cardiovascular complications, deep vein thromboses, pneumonia, or death. The most common complication was change in mental status. Three of the patients in the series (11.5%) had delirium within the first three postoperative days. This complication can be attributed to the study group’s advanced age (average = 66.6 years, range = 50–87 years), and it has also been hypothesized that delirium can be caused by a large burden of fat emboli from the surgical procedure [5,23,30–32].

Five of the patients (19.2%) in the series required a red blood cell transfusion in the postoperative period. This transfusion rate is well within the reported range, but is slightly higher than with unilateral arthroplasty [6,7,11,19,22,33]. There have been some studies that showed that regional and neuraxial anesthesia reduce bleeding and the need for perioperative transfusions [10,19,23].

The average LOS per hospital admission of the series was 4.8 days. This LOS is within the reported average range of LOS (3.5–8.5 days) for patients undergoing BTKA [5,11,19,24,34,35], although 84% of the patients in the current series required admission to a rehabilitation or skilled nursing facility after discharge, which is also comparable with the reported literature (61–89%) [5,25].

A significant weakness of this study is the fact there is no comparison group, and as such it is difficult to draw conclusions based on the presented data. However, based on the results found in this series, the anesthesia technique described does show promise as a potential means of anesthetic for BTKA. The results of this study as well as the benefits of peripheral regional anesthesia and neuraxial anesthesia described in the literature create a foundation for further evaluation. Future studies are needed comparing this novel technique with general anesthesia, neuraxial anesthesia, and peripheral regional anesthesia in order to make definitive conclusions.

Conclusions

Our early experience with bilateral CFNB, bilateral SISNB, and subarachnoid block for patients undergoing BTKA suggests that it is feasible to manage the postoperative pain associated with BTKA effectively and safely as the sole anesthetic technique; however, this series was not powered to make any definitive safety claims. This method of anesthesia and postoperative pain management was well tolerated by the patients and offered a viable alternative to general anesthesia. To the authors’ knowledge, this is the largest series of patients reported using this method of anesthesia for BTKA. Furthermore, an appropriately powered randomized controlled trial is needed to compare the technique used in this series with epidural anesthesia and epidural postoperative analgesia, as well as other emerging techniques such as adductor canal block and intra-articular injection of local anesthetic agents.

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