Doctor of Nursing Practice Project:

Analgesic Efficacy for Total Knee Arthroplasty

Tierra Penick

Marian University

Leighton School of Nursing

Chair: Dr. Bradley Stelflug

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Committee Members: Dr. James Griggs

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Abstract

Background: The number of annual total knee arthroplasties (TKA) had doubled over the last decade. Although this procedure treated chronic pain and restored mobility from end-stage osteoarthritis and other etiologies, it was associated with acute moderate-to-severe pain in the early postoperative period. Various analgesic techniques such as local infiltration, neuraxial blocks, and peripheral nerve blocks (PNB) were used in conjunction with multimodal anesthesia to prevent postoperative pain following TKA. The large variety of analgesic regimens accompanied with differing institutional and provider preferences challenged the ability to standardize a postoperative analgesic technique for TKA.

Local Problem: Anesthesia providers at the project site often utilized the adductor canal block (ACB) alone or combined ACB and popliteal sciatic nerve block (PSNB) techniques for postoperative analgesia following TKA. However, it was unclear which technique was superior.

Purpose: To understand the analgesic efficacy between ACB and combined ACB/PSNB following TKA.

Methods: A retrospective chart analysis on 100 subjects that received ACB alone or ACB/PSNB for TKA in 2019. Pain was assessed upon post anesthesia recovery unit (PACU) admission, at 12 hours, and at 24 hours. Total opioid consumption was recorded for the first 24 hours. Length of hospitalization (LOH) was recorded per documentation.

Results: Pain during PACU stay, pain at 12 hours postoperatively, and opioid consumption at 12 hours postoperatively were all significantly lower in the combined ACB/PSNB group ($P = 0.0182, 0.0488, 0.0106$ respectively). Pain and opioid consumption at 24 hours and LOH were not significantly different between the two groups.

Conclusion: Combined ACB/PSNB therapy decreased pain and opioid consumption in the first 12 hours postoperatively following TKA. Large randomized controlled trials (RCT) need to be performed to deem the efficacy and incidence of related complications between these two blocks.

Keywords: Adductor canal block, sciatic nerve block, femoral nerve block, knee, total knee arthroplasty

Analgesic Efficacy for Total Knee Arthroplasty

Introduction

Total knee arthroplasty (TKA) was a commonly performed procedure that relieved joint pain and enhanced mobility in the patient with end-stage osteoarthritis and other degenerative etiologies (Li, Ma, & Xiao, 2019). Although this curable procedure often improved quality of life in the long-term, it was knowingly associated with acute moderate-to-severe pain within the first one to three postoperative days (Li, Ma, & Xiao, 2019). As modern medicine shifted focus to multimodal techniques, anesthesia providers sought after approaches to decrease postoperative complications and enhance recovery (Moucha, Weiser, & Levin, 2016). These regimens were often combined with multimodal anesthetics that included neuraxial anesthesia (e.g. spinal blockade), peripheral nerve blocks (PNB), periarticular injections, and non-opioid analgesics (e.g. ketamine or clonidine) (Moucha, Weiser, & Levin, 2016). Multimodal techniques incorporated various pharmacologic and interventional strategies to achieve optimal anesthetic and analgesic outcomes (Gaffney et al., 2017). Ideally, a balanced multimodal approach targeted postoperative pain, prevented significant changes in hemodynamic stability, allowed for early ambulation and mobility, decreased cost, avoided high-dose opioid consumption, and improved overall patient satisfaction (Li, Ma, & Xiao, 2019). As a result, PNBs that spared motor blockade (i.e. allow for ambulation) such as the adductor canal block (ACB) were becoming increasingly popular for lower extremity surgeries such as TKA. However, some studies argued that patients reported posterior and/or lateral pain knee pain when the ACB was used alone for TKA (Nader et al., 2016; Seo et al., 2017). Subsequently, different approaches to block the lower leg and knee, such as the popliteal sciatic nerve block (PSNB), were used in conjunction with the ACB to provide complete coverage (Seo et al., 2017). This project was conducted to determine the

postoperative analgesic effectiveness between two PNB regimens for patients that underwent TKA including ACB alone and combined ACB/PSNB.

Background

More than 700,000 TKAs were performed annually in the United States, making it one of the most common orthopedic procedures (Terkawi et al., 2017). In fact, the number of annual TKAs had doubled over the past decade (Abdallah et al., 2016). Osteoarthritis (OA), the number one indication for TKA, effected nearly 27 million people in the United States (Gaffney et al., 2017). As a result, it was estimated that there would be a demand for nearly 3.5 million annual TKAs by 2030 (Terkawi et al., 2017). Severe postoperative pain remained a major concern for patients that underwent TKA. In fact, some patients refused or delayed arthroplasty because of reported acute postoperative pain (Gaffney et al., 2017). Although many people had chronic pain relief following TKA, some reported postoperative pain so severe that they would not repeat the surgery again if it were necessary for chronic relief (Gaffney et al., 2017). The goal of TKA was to diminish chronic pain from OA, yet severe acute postoperative pain was associated with chronic post-surgical pain that persisted for longer than six months (Moucha, Weiser, & Levin, 2016; Terkawi et al., 2017).

Adequate pain relief was essential for optimal patient satisfaction, rehabilitation following surgery, and physiologic function (Gaffney et al., 2017). There were countless adverse physiologic outcomes associated with uncontrolled pain including cognitive dysfunction, decreased immune function, anxiety, thromboembolism, decreased mobility, insomnia, vasoconstriction leading to end-organ damage, and pneumonia (Gaffney et al., 2017). Subsequently, patients were unable to participate in rehabilitation, and this led to prolonged hospitalization and increased cost of care (Gaffney et al., 2017).

Patients that experienced intense postoperative pain usually required high doses of opioid analgesics for relief (Gaffney et al., 2017). Opioids knowingly provided adequate pain relief as well as enhanced sleep and mood after surgery (Gaffney et al., 2017). Nonetheless, high dose opioids often produced undesirable adverse effects that consequently decreased patient satisfaction (Gaffney et al., 2017). These included pruritis, constipation, urinary retention, respiratory depression, nausea and vomiting, and reduced cognition (Gaffney et al., 2017; Moucha, Weiser, & Levin, 2016). These accompanied with the nation's opioid epidemic led providers to favor balanced multimodal analgesia with minimal need for rescue opioids in the postoperative setting (Gaffney et al., 2017).

There were more than ten multimodal techniques for postoperative TKA pain at the time of this project (Terkawi et al., 2017). Historically, femoral nerve blockade (FNB) was widely accepted as the gold standard for postoperative analgesia following TKA (Kuang et al., 2017; Zhang, Wang, & Liu, 2019). While FNB improved postoperative pain scores and decreased acute opioid consumption, it was also associated with other, less favorable outcomes such as impaired postoperative mobility (Kuang et al., 2017; Zhang, Wang, & Liu, 2019). While FNB may have spared motor blockade in low concentrations, it often resulted in complete anesthesia, both motor and sensory, to the anterior and medial thigh, knee, lower leg, and foot (NYSORA, 2019). Decreased quadriceps strength delayed postoperative rehabilitation and mobility, prolonged recovery, and lengthened hospitalization (Kuang et al., 2017; Zhang, Wang, & Liu, 2019). In addition, FNB was associated with postoperative falls, increased thromboembolism risk, and inadvertent blood vessel and nerve damage (Li, Ma, & Xiao, 2019).

In recent years, the ACB had become a favorable alternative to the FNB. Studies reported ACB to be equal in analgesic effects with minimal effects on quadriceps muscle strength when

compared to FNB (Gao, et al., 2017; Zhang, Wang, & Liu, 2019). The ACB mainly anesthetized the saphenous nerve, the largest sensory branch of the femoral nerve, that supplied sensory innervation to the anteromedial knee, lower leg, and ankle (NYSORA, 2019). It also included articular branches of the obturator nerve and the knee joint (Kuang et al., 2017). These nerves traveled within a triangular-shaped canal of muscles in the distal anteromedial thigh (NYSORA, 2019). Of note, while the ACB was considered a sensory-only block, it had been shown to cause quadriceps motor weakness with large local anesthetic volumes from inadvertent blockade of the nerve that supplied the vastus medialis (NYSORA, 2019). Nonetheless, when compared to the historical FNB, ACB was shown to provide equianalgesic properties with better functional recovery following TKA (Kuang et al., 2017).

The utilization of the ACB shifted common multimodal analgesic techniques away from the use of FNB; however, some studies argued that both ACB and FNB resulted in residual posterior knee pain (Abdallah et al., 2016; Nader et al., 2016; Zorrilla-Vaca & Li, 2018). As a result, providers often used supplemental sciatic nerve blocks (SNB) that were shown to significantly reduce posterior knee pain and opioid consumption following TKA (Abdallah et al., 2016; Seo et al., 2017; Terkawi, 2017). There were proximal and distal techniques to blocking the sciatic nerve; however, the distal popliteal SNB approach spared the hamstring motor nerves while anesthetizing the posterolateral aspect of the knee joint (Abdallah, 2014). It was also associated with easier administration and more comfortable positioning than the proximal/infragluteal approach (Abdallah, 2014). Like the FNB, the PSNB may have spared motor blockade in low concentrations, but it often resulted in complete motor and sensory blockade of the lower leg and foot, excluding the anteromedial sensory innervation from the saphenous nerve (NYSROA, 2019).

Although modern techniques improved patient safety, PNBs were associated with unfavorable side effects and adverse events. A major concern for a SNB was the risk for transient dorsiflexion impairment (i.e. foot drop) from blocking the common peroneal nerve, a major branch of the sciatic nerve (Seo et al., 2017). Dorsiflexion impairment was associated with an increased risk for postoperative falls (Gaffney et al, 2017; Seo et al., 2017). When blocking the sciatic nerve, it was common for anesthesia providers to discuss the possibility of foot drop and/or lower extremity weakness with patients in the preoperative setting to avoid postoperative falls. Additionally, some surgeons were concerned that foot drop masked surgical peroneal nerve injury, but surgical nerve palsy usually persisted beyond the 24 hours of foot drop seen with PSNB (Seo et al., 2017). Nonetheless, some surgeons still advised against blocking the sciatic nerve for TKA related to dorsiflexion impairment.

The use of ultrasonography (US) allowed experienced providers to visualize real-time spread of local anesthetic, reducing the rate of failed block, intraneural injection, or intravascular injection (NYSORA, 2019). Additionally, electrical peripheral nerve stimulation was often used for motor-blocking techniques such as the PSNB (NYSORA, 2019). Nerve stimulation allowed experienced providers to locate and anesthetize peripheral nerves or plexuses with or without the use of US-guidance (NYSORA, 2019).

To promote Enhanced Recovery After Surgery (ERAS) protocols, anesthesia providers at the project site commonly used two different multimodal PNB approaches to target pain following TKA. For the orthopedic surgical patient, ERAS protocols focused on postoperative analgesia, ambulation, and decreased hospitalization for rapid recovery (Oseka & Pecka, 2018). The increased risk for falls and decreased motor strength associated with FNB favored the use of the ACB for postoperative TKA analgesia (Kuang et al., 2017; Zhang, Wang, & Liu, 2019).

Although FNB was still utilized at the project site, ACBs were more commonly used. Additionally, some anesthesia providers supplemented the ACB with a PSNB to target the posterior portion of the knee and knee joint.

Problem Statement

Inadequate pain relief in the acute postoperative setting remained a major focus for the patient that underwent TKA. Utilizing the most effective multimodal analgesic technique would have diminished postoperative complications related to uncontrolled pain, decreased length of hospitalization (LOH), improved patient satisfaction, decreased opioid consumption, and reduced cost of care. Knowing the efficacy between two common modalities used at the project site, ACB alone and ACB/PSNB combination therapy, would have ensured staff and patients that optimal analgesia was obtained while using minimal resources, expenses, and procedure times. To address the efficacy between postoperative peripheral nerve block analgesia, the following PICOT question was created:

> For adult patients undergoing TKA, is single-shot ACB and PSNB combination therapy more effective at reducing pain in the first 24 hours postoperatively compared to single-shot ACB alone?

To deliver the most effective evidence-based care, this quality improvement project explored the efficacy between these two PNBs. This project retrospectively analyzed pain scores and total opioid consumption within the first 24 hours postoperatively on adult patients that underwent TKA. Once statistical analysis was completed, the DNP student reported findings to the anesthesia department at the project site to deem significance and the need for clinical practice adjustments.

Organizational "Gap" Analysis of Project Site

The discussed clinical gap at the project site was identified by the Section Chief of the Department of Anesthesiology and Medical Director of Surgical Services. Using guidelines set by the Agency for Healthcare Research and Quality (AHRQ, 2016), a gap analysis was performed to guide the discussed DNP project. There was not a standardized protocol for multimodal analgesia or anesthesia for TKA patients at the time of this project. However, most patients underwent general anesthesia with muscle relaxation and received a PNB for postoperative analgesia. This technique was determined by length of surgery (often exceeding two hours), surgeon preference, anesthesia provider preference, and patient factors. While each anesthetic plan was individualized, the decision about PNB lied in the collaborative hands of the surgeon and assigned anesthesia provider. Some surgeons requested that the sciatic nerve was not blocked with fear of dorsiflexion impairment.

The anesthesia providers at the project site were unsure whether supplementally blocking the sciatic nerve was necessary for complete postoperative analgesia following TKA. They did not regularly follow uncomplicated post-surgical TKA patients throughout their hospitalization, so it was difficult for them to accurately assess long-term PNB efficacy. Subsequently, in collaboration with project site and Marian University staff, the DNP student proposed this quality improvement project to determine whether combined ACB/PSNB therapy was a more significant postoperative analgesic regimen when compared to ACB alone for the TKA patient.

Review of the Literature

Search Strategy

Review of supportive literature was performed after a specific problem statement was created. The DNP student searched electronic databases including *PubMed*, *Cochrane Library*,

and *Google Scholar* from 2015-2020 without language limitation or region exclusions. Results were filtered to include only clinical trials, systematic reviews, and meta-analyses. A total of 79 articles were included after excluding duplicates. Twenty-one results were found using keywords "adductor canal block," "sciatic nerve block," and "knee." Three of these articles were included based on relevance and abstract review. A second search resulted in 58 results using keywords "femoral nerve block," "sciatic nerve block," and "total knee arthroplasty." Two of these articles were included after excluding studies that did not directly discuss SNB as a complement to FNB in TKA patients. This literature review included a total of 7 peer-reviewed research articles.

ACB alone versus combined ACB/SNB Therapy

Postoperative analgesic efficacy comparing ACB to ACB/PSNB combination therapy for TKA was published in a peer-reviewed article in 2017 (Seo et al., 2017). This retrospective study performed in 2015-16 evaluated 200 patients that underwent TKA by evaluating pain, opioid consumption and associated complications following each technique (Seo et al., 2017). Patients received continuous ACB catheters in addition to placebo (group A) or local anesthetic (group B) injections for PSNB (Seo et al., 2017). All blocks were performed with US-guidance prior to subarachnoid (i.e. spinal) blockade by the same anesthesiologist, and the TKA was performed by the same surgeon (Seo et al., 2017). Outcomes were measured in intervals over seven postoperative days (POD), and statistical analysis considered significant p-values < 0.05 (Seo et al., 2017). Pain at rest, pain with knee flexion, and PCA requirements were all significantly lower in group B (combined ACB/PSNB therapy) (Seo et al., 2017). The authors stated that posterior knee pain appeared to be the main region of pain relief in those that received PSNB compared to those that received placebo (Seo et al., 2017). Although this study revealed superior analgesic effects using combined ACB/PSNB therapy, 35% ($n = 35$) that received PSNB

experienced transient foot drop (Seo et al., 2017). This finding warranted the need for further research into the technique for adequately blocking the sciatic nerve using the popliteal approach (Seo et al., 2017).

A randomized control trial (RCT) and a retrospective trial were published in 2016 comparing ACB and FNB in the presence of a SNB for patients that underwent TKA (Ardon et al., 2016, Wiesman et al., 2016). The goal of both trials was to determine if it was necessary to block the posterior aspect of the thigh and popliteal fossa using the FNB (Ardon et al., 2016; Wiesman et al., 2016). In other words, investigators wanted to know if dorsal innervation from the FNB was superior to dorsal innervation from combined ACB/SNB (Ardon et al., 2016, Wiesman et al., 2016). Like the study by Seo et al. (2017), these trials evaluated postoperative pain, analgesic consumption, and associated complications for two and three PODs (Ardon et al., 2016; Wiesman et al., 2016). All blocks were performed using US-guidance (motor blocks also utilized nerve stimulators) prior to induction of general anesthesia, although some participants from the retrospective study received spinal anesthesia instead of general (Ardon et al., 2016, Wiesman et al., 2016). All patients and providers were blinded in the RCT (Wiesman et al., 2016). Both trials considered statistically significant p-values of < 0.05 (Ardon et al., 2016; Wiesman et al., 2016).

The findings from these two studies reported no significant differences between ACB and FNB in the presence of SNB regarding overall analgesic effect, opioid consumption, or other associated complications (Ardon et al., 2016; Wiesmann et al., 2016). The only significant difference included anterior knee pain during motion on POD 1 ($P = 0.002$) that was significantly higher for one of the ACB/SNB groups (Ardon et al., 2016). However, median pain scores never exceeded 4/10; therefore, the authors still concluded equianalgesic effects between the groups

(Ardon et al., 2016). Additionally, two patients that received FNB experienced falls (Wiesman et al., 2016). In summary, when evaluating pain, opioid consumption, and other related complications, these two studies suggested ACB to be an equal and maybe even a favorable alternative to FNB in the presence of SNB (Ardon et al., 2016; Wiesman et al., 2016).

Another double blinded RCT published in 2016 used a placebo group to determine the analgesic efficacy of ACB following TKA (Nader et al., 2016). Forty patients received preoperative US-guided ACB (group A, n = 20) or saline (Group B, n = 20) in addition to periarticular infiltration and spinal anesthesia (Nader et al., 2016). Pain and opioid consumption were recorded for 36 hours postoperatively, and statistical analysis considered significant p-values < 0.05 (Nader et al., 2016). Although generalizability from this study was limited by a small sample size, results strongly supported the use of ACB over placebo (Nader et al., 2016). Opioid consumption ($P = 0.03$) and pain ($P = 0.009$) were both significantly lower in the first 36 hours in the ACB group (Nader et al., 2016). Time to discharge was also significantly lower in the ACB group ($P = 0.007$) (Nader et al., 2016). Of note, many of the patients in the ACB group reported posterior knee pain as the primary location of perceived pain (Nader et al., 2016).

Supplementing FNB with SNB

At the time of this project, there was not a published systematic review or meta-analysis directly evaluating the analgesic efficacy between ACB alone versus ACB/PSNB for TKA. This could have been in part because of the wide array of TKA analgesic modalities or because the ACB was a relatively new block. However, there were published peer-reviewed articles that reported superior analgesia when supplementing FNB with SNB to target residual dorsal knee pain (Abdallah et al., 2016; Zorrilla-Vaca & Li, 2018). These studies supported the need for

complementary posterior knee blockade for adequate postoperative TKA analgesia (Abdallah et al., 2016; Zorrilla-Vaca & Li, 2018).

Two meta-analyses aimed to determine if blocking the sciatic nerve resulted in superior postoperative TKA analgesia in the presence FNB (Abdallah et al., 2016; Zorrilla-Vaca & Li, 2018). Both studies reviewed pain, opioid consumption, and recovery outcomes in adult patients that underwent TKA (Abdallah et al., 2016; Zorrilla-Vaca & Li, 2018). Abdallah et al. (2016) reviewed 8 RCTs (n = 379), and Zorrilla-Vaca & Li (2018) reviewed 10 RCTs (n = 514). In the postoperative period, Zorrilla-Vaca and Li (2018) reported reduced pain at rest for 4 hours ($P < 0.001$) and reduced pain with activity for 12 hours ($P = 0.02$) when using a single-shot SNB in the presence of FNB. Abdallah et al. (2016) reported decreased pain at rest and activity for 8 hours using supplemental single-shot SNB ($P = 0.023$ and $P < 0.001$) and with activity for 36 and 48 hours using supplemental continuous SNB ($P = 0.004$ and $P = 0.031$). Both studies reported decreased opioid consumption for 24 hours postoperatively (Abdallah et al., 2016; Zorrilla-Vaca & Li, 2018). Although there was a gap in evidence supporting duration of analgesic efficacy, these meta-analyses concluded that SNB significantly reduced postoperative TKA pain when compared to no SNB in the presence of FNB (Abdallah et al., 2016; Zorrilla-Vaca & Li, 2018).

Evidence Based Practice

Numerous analgesic regimens have been known to control postoperative TKA pain. The variety of modalities challenged the ability to perform a single RCT using every analgesic technique. Each study in the literature review was limited by differing patient anatomical nerve innervation, approach to blockade, surgical technique, extraneous and confounding variables, and selection of local anesthetic. These variables limited appropriate evaluation of PNB efficacy. Additionally, some available literature included variables that were not included in this project,

including continuous PNB catheters, subarachnoid blockade, patient-controlled analgesics, placebo groups, and control of local anesthetic and adjuncts. However, overall results from the discussed studies supported the need for posterior knee blockade for patients that underwent TKA. Furthermore, these studies supported ACB as a favorable alternative to FNB. This DNP project focused on the two primary outcomes assessed in the literature including pain and opioid consumption. The aim of evaluating length of hospitalization was to guide future studies comparing cost savings between the two blocks. The duration of block efficacy was assessed over the first 24 hours postoperatively, and the popliteal approach to block the sciatic nerve was assessed because it was the most common technique used at the project site.

Evidence Based Practice Model

The Johns Hopkins Nursing Evidence-Based Practice (JHNEBP) model is a conceptual framework utilized in nursing to ensure current evidence-based practice (EBP) is integrated into the clinical setting (Dang & Dearholt, 2017). See Appendix A for the model diagram. This conceptual model was the framework used for this DNP project as it focuses on the key idea that healthcare professionals are lifelong learners that provide the best quality and evidence-based care (Dang & Dearholt, 2017). This three-step model uses the acronym “PET” including a problem statement, review of current evidence and literature, and practice translation (Dang & Dearholt, 2017). First, a question was derived from exploring background information gathered by the key project members (Dang & Dearholt, 2017). The PICOT (population, intervention, comparison, outcome, time) format was used because it is a focused question that can be answered with current evidence-based research (JHM, 2018). Following creation of a problem statement, the DNP student performed a comprehensive literature review to collect current, pertinent, and high-quality evidence to support the given problem (Dang & Dearholt, 2017).

Project members then determined how applicable available evidence was to the specific population (Dang & Dearholt, 2017). This is where the discussed quality improvement (QI) project implementation and analysis occurred. Once available current literature and results from the QI project was analyzed, investigators determined that there was a need for clinical practice change at the project site.

Cost-Benefit Analysis

The costs endured by this DNP project included the time for development, implementation, analysis, and proposed clinical practice change by the project members, university staff, and additional hospital staff that assisted the DNP student in implementation. The benefit of the review of literature and project findings largely outweighed the cost as it helped ensure patients were receiving the best quality and cost-effective PNB for TKA.

Timeline

Proposed approval of this project was given to the DNP student by university staff on October 11, 2019, and a final PICOT question was approved three days later. Literature review was performed over the next two months and included an annotated bibliography, matrix review, and SWOT analysis. A final project proposal was submitted December 2019. Project site approval and Marian University IRB exemption was given in February 2020. Following approval, the DNP student collaboratively discussed the need for remote Cerner access with the Department of Volunteer Services, and access was granted in April 2020. Data collection and analysis was performed over the summer of 2020. Project findings were presented to Marian University and staff at the project site as a finalized DNP project in October 2020.

Goals, Objectives, and Expected Outcomes

The overall aim of this DNP project was to determine which PNB, either ACB alone or ACB/PSNB combination therapy, was more effective at decreasing postoperative pain, opioid consumption, and LOH following TKA. A retrospective chart review was performed to determine pain scores, opioid consumption, and LOH among adult patients that received these multimodal approaches prior to unilateral TKA. The DNP student performed all data extraction and analysis, and she reported the findings to the anesthesia providers at the project site and accompanied staff at Marian University.

Ethical Considerations/Protection of Human Subjects

The Marian University IRB deemed this DNP project exempt from review—See Appendix C. Exempt status was given because this project offered minimal risk to participants, analyzed existing data, and did not have an interventional group. The DNP student also completed online CITI training for research involving human subjects prior to project initiation. All participants included in this project were protected by the Health Insurance Portability and Accountability Act of 1996 (HIPAA). Furthermore, the DNP student and other personnel involved in this project followed the Standards of Care for practice at Marian University. All patient data was immediately de-identified and stored electronically on the DNP students' personal laptop. This laptop and Cerner, the EMR used for chart analysis, were password protected to prevent access by unauthorized users.

Project Design

The comparative groups in this DNP project included ACB alone (group A) and ACB/PSNB combination therapy (group B). Both groups included adult patients that underwent unilateral TKA. All data was retrieved via retrospective chart analysis.

Project Site

The project site was a rural, Magnet, Level III Trauma Center. This hospital served approximately nine counties across the Midwest in Indiana and Illinois. Surgical services ranged from dental procedures to open-heart with a total of over 10,000 surgeries performed annually. Orthopedic services, including TKAs, were offered through the joint replacement center and program for sports injuries, joint replacement, and other bone anomalies.

The anesthesia group that staffs the project site is a private group that employs Physician Anesthesiologists and Certified Registered Nurse Anesthetists (CRNA) to collaboratively care for surgical patients. The Section Chief of the Department of Anesthesiology and Medical Director of Surgical Services at the project site acted as the liaison for the DNP student throughout this project. Additional project support came from the DNP students' program staff.

Success of this QI project relied largely on chart reviews performed on patients that underwent TKA in the operating room (OR) at the project site. Although there was a pain assessment protocol for each patient encounter, nursing documentation between nurses was highly variable, especially following PACU discharge. The inconsistency in charting resulted in repeated and missing values, and the DNP student had to adjust outcome intervals accordingly. As a result, pain and opioid consumption were recorded *at a time point* instead of cumulatively *over a time interval* following PACU discharge. Although evaluating cumulative data would have likely been more accurate, the inconsistency in charting prevented the ability to do this.

Subject Population

Subjects included adult patients that underwent primary, unilateral TKA at the project site between January 2019 and April 2019. Inclusion criteria for participants consisted of adult patients over eighteen that underwent unilateral TKA with a general anesthetic and preoperative

ACB or combined ACB/PSNB. Participants were excluded if they were unable to understand the numeric rating scale, classified as American Society of Anesthesiologists (ASA) IV or V, received contralateral or revised TKA within three months of the current surgery, received additional or rescue PNBs, or underwent alternative anesthetic methods (e.g. spinal anesthesia). Additionally, there were two subjects that were excluded because they experienced severe postoperative complications unrelated to the PNB.

Methods

This project included a retrospective, non-randomized design using a convenience sample to determine the analgesic efficacy of PNB for postoperative TKA analgesia.

Procedures

All subjects underwent primary, unilateral TKA by different surgeons using a medial parapatellar approach. Following a collaborative decision with the surgeon, anesthesia providers performed all ACBs and PSNBs prior to induction of general anesthesia. ACBs were performed with US-guidance, and PSNBs were performed with US-guidance, peripheral nerve stimulation, or both.

All outcome data was recorded separately from the subject's medical record on the DNP student's data collection form. This data form was pre-authorized by Marian University staff, and it was coded to exclude all protected health information. Chart reviews were performed through remote access using Cerner, the electronic medical record (EMR) system utilized at the project site. Collection of demographic information included patient age, ASA, and gender. Outcome variables including postoperative pain scores, opioid requirements, and LOH were recorded to determine which block was more effective at decreasing postoperative pain in the first 24 hours following TKA.

Measurement Instruments

Pain scores were recorded using an 11-point numeric rating scale (McCaffery & Pasero, 1999). This was the main pain scale utilized at the project site for awake and responsive patients. The numeric rating scale allowed patients to verbally rate pain between 0 and 10, with 0 representing *no pain* and 10 representing *worst pain ever* (McCaffery & Pasero, 1999). See Appendix B for scale.

Opioid consumption was recorded based on drug, route and dose administered. Total opioid consumption was calculated using an opioid equianalgesic conversion calculator based on American Pain Society guidelines available at https://clincalc.com/Opioids/ (ClinCalc, LLC, 2017). Each opioid was converted to intravenous (IV) morphine milligram equivalents (MME) with a 0% cross-tolerance for acute administration (ClinCalc, LLC, 2017). Outcomes were recorded for 24 hours postoperatively in two separate time intervals (t = 0-12 hours and t = 12-24 hours).

Data Collection Procedures

The DNP student collected all data via retrospective chart analysis using convenience sampling. Data was recorded and de-identified on an excel data spreadsheet that was pre-authorized by university staff. Time intervals were manually calculated and entered in Cerner based on the initial postoperative anesthesia care unit (PACU) time that was documented by the anesthesia provider. LOH was recorded as the length of stay documented in the patient's chart.

The pain assessment protocol at the project site in the PACU stated that an initial assessment must be recorded upon admission followed by an assessment every fifteen minutes until discharge. If the patient experienced analgesic changes between the fifteen-minute intervals, this pain score was also documented. All pain scores documented during the patient's

PACU stay were recorded and presented as an average PACU pain score. Pain scores were also recorded at 12- and 24-hour points (t = 12 hours and t = 24 hours). If there was more than one score documented at a given time point, the average between the scores was recorded. If there was not a pain score documented for a time point, the average between the two most recent pain scores was recorded. One patient was discharged prior to twelve hours post-operatively, and no assumptions were made or included from this patient for data analysis at t = 12 or t = 24 hours.

Total opioid consumption was recorded for 24 hours postoperatively in two separate time intervals (t = 0-12 hours and t = 12-24 hours) using the Medication Administration Record (MAR). Opioids included fentanyl, morphine, hydrocodone, hydromorphone, oxycodone, and tramadol. Each administered opioid was recorded based on route and dose, and then they were converted to intravenous MME. Total opioid consumption for each time interval was presented as total MME. Two patients received meperidine (Demerol) as an anti-shivering adjunct. Although meperidine was an opioid analgesic, these were not included in data analysis because they were not administered based on pain reported by the patient.

Data Analysis

Sigma XL in Microsoft Excel 2016 was used to perform statistical analysis for this project. Comparisons between treatment groups were determined using the Mann-Whitney U test with a statistical significance of $P < 0.05$.

Results

Participants

Subjects included 100 patients who underwent primary, unilateral TKA. Groups included 50 patients that received ACB (group A) and 50 patients that received combined ACB/PSNB (group B). Group A comprised of 28 female and 22 male subjects, with a mean age of 69.5. Of

the fifty subjects in group A, 18 were classified as ASA 2, and 32 were classified as ASA 3. Group B was comprised of 35 female and 15 male subjects with a mean age of 69.1. Of the fifty subjects in group B, 19 were classified as ASA 2, and 31 were classified as ASA 3.

Pain Scores

The average PACU pain scores were significantly lower in group B than group A (P = 0.0182). Pain at 12 hours postoperatively was also significantly lower in group B than group A (P = 0.488). There was no significant difference between pain at 24 hours postoperatively (P = 0.2183).

PAIN DURING PACU

PNB	ACB	ACB/PSNB
Count	50	50
Median	2.944	1.1

Mann-Whitney Statistic	2863.50
P-Value (2-sided adjusted for ties)	0.0182

PAIN @ 12 HOURS (t = 12)

PNB	ACB	ACB/PSNB
Count	49	50
Median	2	1.500

Mann-Whitney Statistic	2729.00
P-Value (2-sided, adjusted for ties)	0.0488

PAIN @ 24 HOURS (t = 24)

PNB	ACB	ACB/PSNB
Count	49	50
Median	3	2

Mann-Whitney Statistic	2624.50
P-Value (2-sided, adjusted for ties)	0.2183

Opioid Consumption

Opioid consumption over the first 12 hours postoperatively was significantly lower in group B than group A (P = 0.0106). There was not a significant difference between total opioid consumption from 12 to 24 hours postoperatively (P = 0.1784).

TOTAL MME 0-12 HOURS

PNB	ACB	ACB/PSNB
Count	50	50
Median	9.500	8

Mann-Whitney Statistic	2895.00
P-Value (2-sided, adjusted for ties)	**0.0106**

TOTAL MME 12-24 HOURS

PNB	ACB	ACB/PSNB
Count	50	50
Median	8	8

Mann-Whitney Statistic	2718.00
P-Value (2-sided, adjusted for ties)	0.1784

Length of Hospitalization

There was no significant difference in LOH between the two groups (P = 0.8437).

Length of Hospitalization (LOH)

PNB	ACB	ACB/PSNB
Count	50	50
Median	2.400	2.400

Mann-Whitney Statistic	2496.00
P-Value (2-sided, adjusted for ties)	0.8437

Discussion

This study aimed to determine the efficacy of PSNB in the presence of ACB as a postoperative analgesic technique for TKA. Significant findings included decreased pain and opioid consumption for up to 12 hours postoperatively for combined ACB/PSNB techniques when compared to ACB alone. These findings suggested superior analgesic effects using combined ACB/PSNB for TKA when compared to ACB alone. There was no significance between the two PNBs after twelve hours postoperatively. Additionally, there was no significance in data for LOH between the two PNB techniques. The inability to control for confounding variables such as local anesthetic type, volume, adjuncts (e.g. dexamethasone, epinephrine, etc.), and subsequent duration of action created a major limitation for this retrospective project. Future projects should control for these variables.

As mentioned, the retrospective nature of this study presented several limitations. Large sample RCTs need to be performed to accommodate for these. RCTs would allow for control of inconsistent nursing documentation that prevented the DNP student from including all pain scores documented over the 24-hour time frame. Although total opioid consumption consistently reflected the pain scores for each time interval, this limitation likely created subsequent bias. Additionally, RCTs would allow accurate exclusion of participants that have underlying chronic pain syndromes or long-term opioid use that may affect pain and opioid consumption. Lastly, complications such as dorsiflexion impairment in the presence of PSNB and the impact it has on postoperative mobility should also be further evaluated.

Conclusion

This project suggested that combined ACB/PSNB was a superior analgesic technique for the first 12 postoperative hours following TKA. Postoperative pain following TKA continues to

be a major focus for TKA patients, and inadequate analgesia results in poor postoperative outcomes. Comparative studies including randomized, blinded controlled trials need to be conducted to further determine analgesic efficacy, associated complications, and cost effectiveness between ACB and ACB/PSNB for TKA.

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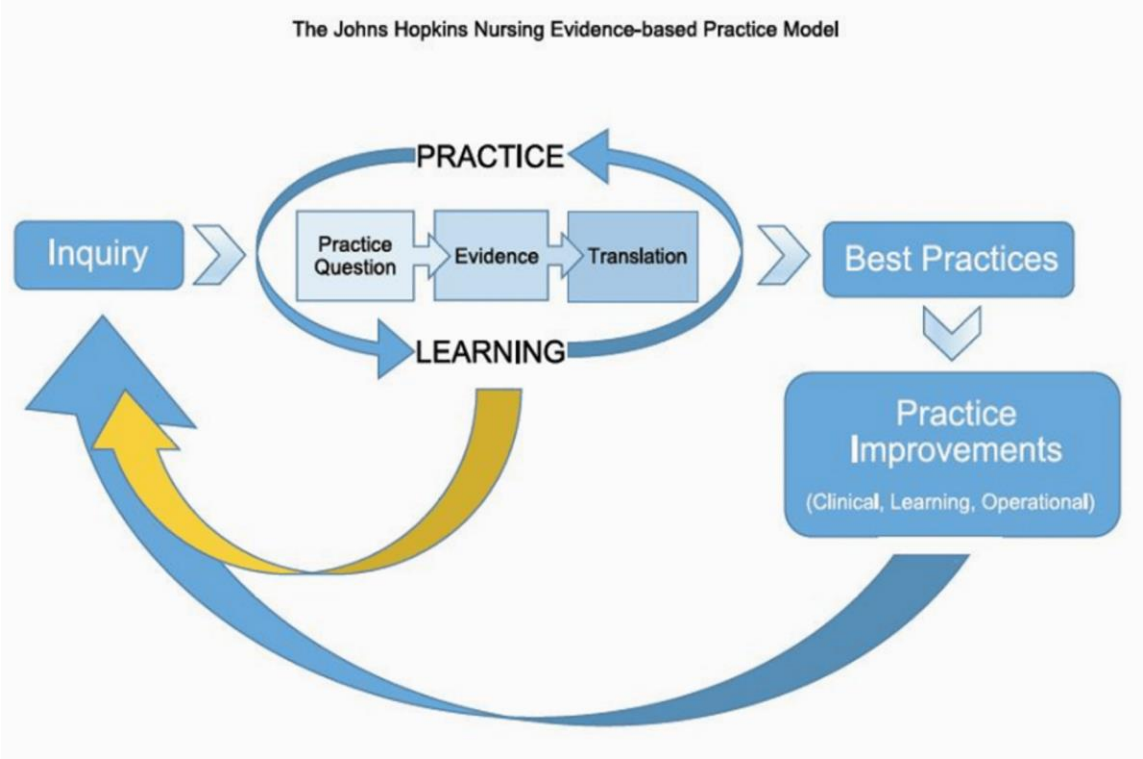
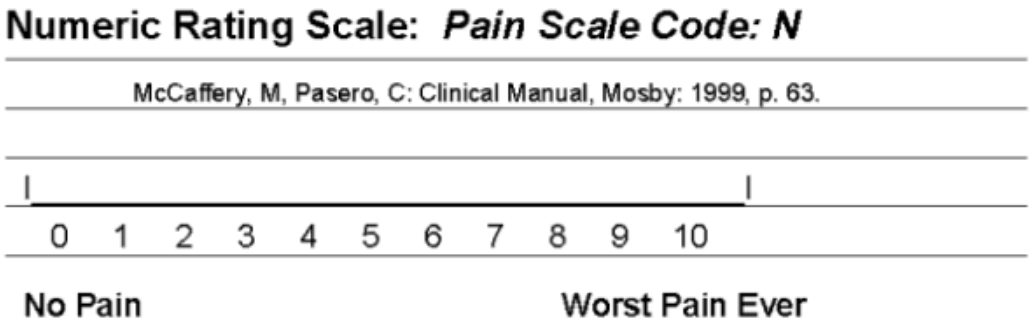
Appendix A


The Johns Hopkins Nursing Evidence-based Practice Model
PRACTICE
Inquiry
Practice Question
Evidence
Translation
Best Practices
LEARNING
Practice Improvements
(Clinical, Learning, Operational)

Appendix B


Numeric Rating Scale: Pain Scale Code: N
McCaffery, M, Pasero, C: Clinical Manual, Mosby: 1999, p. 63.
0 1 2 3 4 5 6 7 8 9 10
No Pain
Worst Pain Ever

Appendix C

MARIAN UNIVERSITY
Indianapolis ®

Institutional Review Board

DATE: 02-24-2020

TO: Tierra Penick

FROM: Institutional Review Board

RE: IRB #B20.153

TITLE: Peripheral Block Efficacy for Total Knee Arthroplasty

SUBMISSION TYPE: New Project

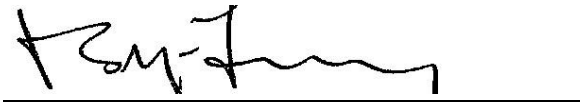
ACTION: Determination of Exempt Status

DECISION DATE: 02-24-2020

The Institutional Review Board at Marian University has reviewed your protocol and has determined the procedures proposed are appropriate for exemption under the federal regulations. As such, there will be no further review of your protocol and you are cleared to proceed with your project. The protocol will remain on file with the Marian University IRB as a matter of record. Please be mindful of the importance of reporting only de-identified, HIPAA-compliant information about the patient in any exhibit or publication.

Although researchers for exempt studies are not required to complete online CITI training for research involving human subjects, the IRB **recommends** that they do so, particularly as a learning exercise in the case of student researchers. Information on CITI training can be found on the IRB's website: http://www.marian.edu/academics/institutional-review-board.

It is the responsibility of the PI (and, if applicable, the faculty supervisor) to inform the IRB if the procedures presented in this protocol are to be modified or if problems related to human research participants arise in connection with this project. Any procedural modifications must be evaluated by the IRB before being implemented, as some modifications may change the review status of this project. Please contact me if you are unsure whether your proposed modification requires review. Proposed modifications should be addressed in writing to the IRB. **Please reference the above IRB protocol number in any communication to the IRB regarding this project.**



Bryan Larsen, Ph.D.

Chair, Marian University Institutional Review Board

Appendix D

Opioid	Equianalgesic Dose (mg)	
	IV/IM	PO
Fentanyl	0.1	N/A
Hydrocodone	N/A	0.4
Hydromorphone	2	0.8
Morphine	1	N/A
Oxycodone	N/A	0.4
Tramadol	N/A	0.04