

Winter 12-15-2022

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Reducing Post-Operative Complications and Improving
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Regional Anesthesia Techniques for Total Knee Arthroplasty: Reducing Post-Operative
Complications and Improving Rehabilitation and Recovery.

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December 15, 2022

Abstract

Purpose

Total knee arthroplasty (TKA) is one of the most commonly performed procedures in the developed world, with several hundred thousand performed yearly in the United States alone.¹ Majority of the patients will experience severe post-operation pain following TKA, limiting early mobilization and slowing the rehabilitation process.² Femoral nerve blocks (FNB) are often used for TKA analgesia, but cause a decrease in quadricep strength, increasing the risk of post-operative falls as well as limiting early post-operative mobilization.² Other nerve blocks, such as femoral triangle block and adductor canal block are thought to preserve quadricep strength aiding in quicker recovery times and decrease the number of post-operative complications such as inpatient falls.² The aim of this review is to assess the effects of FNB on quadricep strength, and subsequent effect on early mobilizations and risk of falls, compared to Adductor Canal Block (ACB) and Femoral Triangle Block (FTB) in patients undergoing TKA.

Methods

The search engine PubMed was used to find and collect data related to nerve blocks during TKA. The general search feature on PubMed were initially used to search “Total Knee Arthroplasty and Nerve Blocks”. Using the advanced search tool, further exploration was conducted using the key terms “Total Knee Arthroplasty”, “Femoral Nerve Block”, and “Adductor Canal Nerve Block”. A final follow-up search adding the key term “Reducing Falls” was completed.

Conclusion

Pain management and leg strength are two key factors to maximize rehabilitation and recovery from TKA. It is clear that both ACB and FNB provide benefits but what is not clear is which nerve block provides the best route for recovery and minimizes post-operative complications, although it will be institutional dependent. Further large-scale studies are needed to accurately assess the best role for nerve blocks in TKA.

Introduction

Knee osteoarthritis (OA) is a progressive degenerative joint disease caused by wear and tear of the joint. It predominantly effects the elderly community, with as many as 40% of those over the age of 70 have OA.³ Medications and physical therapy are commonly used as treatment for symptoms but there is currently no disease-modifying treatment to slow the progression of degeneration, eventually leading to end-stage OA.³ The treatment for end-stage OA is surgical correction via total knee arthroplasty (TKA).³

TKAs are one of the most commonly performed procedures in the developed world, with several hundred thousand performed yearly in the United States alone.¹ Majority of the patients will experience severe post-operation pain following TKA, limiting early mobilization and slowing the rehabilitation process. Multimodal analgesia approaches are commonly used for post-operative pain in patients undergoing TKA. Ensuring proper pain control, allows for early mobilization, reduced thromboembolic complications, faster functional recovery time, and increased overall patient satisfaction.^{2,4}

Regional nerve blocks are an important part of the multimodal approach to analgesia, as they provide direct analgesia to the surgical leg while having fewer adverse effects compared to patient-controlled analgesia (PCA).² Femoral nerve blocks (FNB) are often used for TKA analgesia, as they provide comparable analgesia to epidural blocks, while limiting the amount of

PCA needed post-operatively.² Due to its effects on the sensory and motor pathways of the femoral nerve, FNBs cause a decrease in quadricep strength, increasing the risk of post-operative falls as well as limiting early post-operative mobilizations.² While the incidence of inpatient falls following FNB was only 2%, any number of falls is unacceptable.⁴ Other nerve blocks, such as femoral triangle block and adductor canal block are thought to preserve quadricep strength aiding in quicker recovery times and decrease the number of post-operative complications such as inpatient falls.²

The aim of this review is to assess the effects of FNB on quadricep strength, and subsequent effect on early mobilizations and risk of falls, compared to ACB and FTB in patients undergoing TKA for OA. Secondary aims are to assess analgesic effect of the three regional nerve blocks.

Discussion

Anatomy of Regional Blocks

The femoral nerve arises from the ventral rami of L2-L4, enters the femoral triangle inferior to the inguinal ligament and splits into an anterior/posterior division near the circumflex artery.⁵ The anterior division innervates the sartorius muscle, while the posterior division provides motor innervation for the quadricep femoris muscle and gives rise to the saphenous nerve.⁵ The femoral nerve also provides sensory innervation to the anterior thigh, knee, and medial aspect of the lower leg.⁵

The saphenous nerve separates from the femoral never at the proximal thigh before descending through the adductor canal, a musculoaponeurotic tunnel found in the mid-thigh extending from the femoral triangle to the adductor magnus. The saphenous nerve later divides into multiple subcutaneous branches in the lower leg providing sensory innervation medial,

anteromedial, and posteromedial lower leg, ankle, and foot.^{5,6} The motor nerve for the vastus medialis also transverses through the adductor canal.⁷

Regional nerve blocks inhibit the propagation of nerve impulses by directly administering anesthesia into the nerve.⁵ Femoral nerve blocks are performed at the level of the inguinal ligament, providing anesthesia to the motor and sensory distribution of the femoral nerve.^{2,5} The adductor canal blocks (ACB) are performed at the level of the mid-thigh, providing anesthesia to the distribution of the saphenous nerve.^{6,8} The ACB is expected to have some effect on the quadriceps since it also would anesthetize the motor nerve to the vastus medialis, but not as great of an effect as the FTB which has motor innervation for all four parts of the quadriceps.⁷ Regional nerve blocks are performed via ultrasound guidance and can be administered as a single injection or as continuous infusions.⁵

Analgesia Effect

Multiple studies suggest the use of ACB, as part of a multimodal postoperative pain control, have similar analgesic effect as FNB.^{2,4,7,8} A recent study conducted by Lim YC et al.⁸ comparing the analgesic effect and the effect on quadriceps strength from single shot ACB and FNB following TKA found no statistically significant difference in analgesia between the two blocks. At one, 24 and 48 hours the two groups had similar pain scores and perioperative morphine consumption.⁸ While comparing FNB with distal ACB and distal FTB, Jaremko et al², rendered similar results. They found no statistically significant difference in postoperative pain at rest or during active and passive knee flexion between the two groups.² At 6- and 48-hours post-operative they found no statistically significant difference in rescue opioid analgesia consumption but did find that the FNB group had a statistically significant increase at 24 hours.² Neither group had a difference in adverse effects from opioid consumption. The researchers

concluded that both blocks provided adequate analgesia effect, but the need for rescue opioids increased as the blocks wore off.²

Interestingly, a study that looked specifically at lateral knee pain, as well as overall knee pain, found that the ACB group had significantly more lateral knee pain compared to the FNB group, but overall knee pain was similar in both groups.⁴ At 24-hours post-operative, the ACB group had statistically significant higher visual analog scale (VAS) on lateral knee pain, at rest and with activity compared to FNB. At 48-hours both groups had similar VAS scores at rest and with activity. Overall knee VAS scores were similar at 24-hours, 48-hours, and 72-hours at rest and with activity.⁴ Total opioid-consumption, and interruptions of sleep due to pain, were not statistically significantly different between the two groups.⁴ The increase in lateral knee pain in FNB group did not have had an effect on overall knee pain, and the difference may be due to the anatomy of the two blocks.

Quadricep Strength

An early study conducted by Jaeger et al⁷ investigating the effects of FNB and ACB on quadricep strength compared to that of a placebo block, found that FNB had the greatest effect on quadricep strength. The group that received ACB had an 8% reduction in quadricep strength compared to the placebo, but it may not be functionally important as 10% side-to-side difference is a normal variance in healthy individuals.⁷ The FNB for comparison had a 49% decrease in quadricep strength in comparison to baseline.⁷ Jaeger et al⁷ noted that the reduction in quadricep strength after ACBs, may be due to the amount of anesthesia used, as large fluid volumes could diffuse to surrounding motor fibers causing a motor blockade.

Interestingly, recent studies^{1,2,4} support the findings reported above. For example, Tan Z et al.⁴ found that ACB had a reduced impact on quadricep strength and range of motion (ROM)

post-operatively. At 24-hours post-operative, the FNB group had statistically significant reduced quadricep strength, but equalized at 48-hours and beyond. ROM was reported to be superior in the ACB group at 24-, 48-, and 72-hours post-operatively, equalizing at the time discharge.⁴ The authors found that the ACB group had shorter hospital stays, as the retention of quadricep strength promoted recovery of the knee joint function.⁴ Additionally, patients in another study¹ were able to sit, stand, and walk quicker after receiving ACB compared to FTB.

In contrast to the previously mentioned research, the study conducted by Lim YC et al⁸ were unable to show a significant difference in analgesic effect nor a difference in quadriceps strength 24 and 48 hours post-operatively. As a result, researchers hypothesize this might be due to the fact that they did not collect data prior to 24 hours post-operative. This is important as previous studies have found the greatest difference in quadriceps strength to be during the first 24 hours.⁸ Jaremko et al² found that the use of FNB had a significantly reduced quadricep strength at 3-, and 6- hours post-operatively compared to the use of FTB+ACB. This supports the theory from Lim YC et al² that the difference between quadricep strength may have been hidden due to the lack of early post-operative data collection.

Conclusion

Regional anesthesia techniques can affect both motor and sensory nerves. Techniques that spare motor nerve distribution should have less of an impact on post-operative muscle strength and theoretically reducing fall risk. In the end, no falls occurred in any of the studies above. Despite no definitive evidence suggesting one type of nerve block over the other, this review was able to shed some light on other factors, such as quadricep strength, and pain management. Regional anesthesia techniques used during TKA are going to be institutional

dependent and will vary depending on the Physicians preference. Further large-scale studies are needed to accurately assess the best role for nerve blocks in TKA.

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