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Infiltration Between Popliteal Artery and Capsule of the Knee Combined with Adductor Canal Block as Analgesic Adjuvant During and Postoperative in Total Knee Replacement Surgery

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A B S T R A C T

Background: Infiltration between the popliteal artery and capsule of the knee (iPACK) is one method that has been proposed in recent years as a potential alternative to peripheral nerve block as analgesia in total knee replacement (TKR) procedures. This study presents anesthetic management using spinal anesthesia combined with iPACK and adductor canal block (ACB) in patients with grade IV osteoarthritis who underwent TKR of the right knee. **Case presentation:** A woman, a housewife aged 50 years, was planning to undergo TKR surgery. The patient came with complaints of pain in the right knee 1 year before entering the hospital. The patient was given supplemental oxygen with a nasal cannula at 3 liters per minute. Prior to spinal anesthesia, the patient was given fentanyl 25 mcg iv, ketamine 10 mg iv, and midazolam 1.5 mg IV as premedication. The patient was positioned on the right side, and a 27G Quincke needle was inserted at the level of L3-L4 and given bupivacaine heavy 0.5% 7.5 mg, then lateralized for 15 minutes. After lateralization, the patient was positioned supine and used ultrasound to direct ACB action with a regimen of ropivacaine 0.25% + dexamethasone 5 mg a volume of 20 ml, then iPACK was performed with a regimen of Ropivacaine 0.375% + dexamethasone 5 mg a volume of 20 ml. After surgery, the patient is treated in the recovery room for 1 hour until bromage score is 0. The patient received the PCA Morphine analgesic demand only 1 mg/mL, 1 mg per dose, max 5 mg over 4 hours, lockout interval 6 minutes; Paracetamol 500 mg every 6 hours PO; Ibuprofen 400 mg every 8 hours PO. **Conclusion:** TKR patients who were given analgesia using the ACB peripheral nerve block technique combined with iPACK experienced a decrease in pain levels and lower use of postoperative morphine so that patient mobilization was faster and reduced the patient's length of stay.

1. Introduction

Total knee replacement (TKR) is a treatment indicated for patients with end-stage joint disease, the benefit of which is to relieve pain and improve joint function. TKR is indicated for knee conditions with symptoms that cannot be cured by conservative measures.[1] Although TKR surgery is intended to improve the patient's quality of life, after surgery, moderate to severe postoperative pain is often complained of by patients, where 60% of patients with postoperative TKR pain experience severe pain, and 30% experience moderate pain.[2] TKR post-operative pain is often the reason for patients refuse to do this TKR procedure.[3] This post-operative knee pain, in severe conditions, will eventually limit the patient's movement, which will increase the risk of thromboembolism, and muscle stiffness which will affect the rehabilitation process, and overall will reduce the level of satisfaction and reduce the quality of life of these patients.[4] About 20% of TKR patients experience more knee pain and more swelling than before surgery.

Advances in surgical techniques, prostheses, pain control, and medical care. However, there is evidence to suggest a worsening of pain and functional scores in some patients over time after TKR surgery.[6] In the enhanced recovery after surgery (ERAS) guidelines, it is stated that the patient's pain must be fully controlled after surgery to help achieve early limb autonomic movement, speed up the rehabilitation process, shorten hospital stays, and increase patient satisfaction. Infiltration between the popliteal artery and capsule of the knee (iPACK) is one method that has been proposed in recent years as a potential alternative to peripheral nerve blocks as analgesia in TKR procedures. Its use in combination with an adductor canal block has a good analgesic effect and little impact on the strength (motor) muscles of the affected limb postoperatively, and patients treated with this method can immediately participate in initial rehabilitation exercises, having a shorter stay. In the hospital and reported better satisfaction.[9] This study presents anesthetic management using spinal anesthesia combined with iPACK and Adductor canal block (ACB) in patients with grade IV osteoarthritis who underwent TKR of the right knee.

2. Case Presentation

A woman, a housewife aged 50 years (height 159 cm, weight 70 kg; BMI 27 kg/m^2), was planned to undergo TKR surgery. The patient came with complaints of pain in the right knee 1 year before entering the hospital. In the last 1 month, the pain has been felt continuously and is exacerbated by increased activity. Denied history of fever, cough, runny nose, and shortness of breath in the last 2 weeks. Patients can carry out light and moderate household activities without complaining of chest pain and shortness of breath. History of hepatitis B since 10 years without treatment. The patient knows the disease because the patient often donates blood. The patient had no history of asthma, diabetes mellitus (DM), hypertension, and other systemic diseases. The patient had a history of sectio caesarea (SC) operations 3 times with regional anesthesia, curettage under general anesthesia and ORIF surgery and aff pen on the right leg under regional anesthesia. The patient had no complications after surgery. The patient has a history of allergy to ceftriaxone and pain medication, but the patient forgot the name of the drug.

From the preoperative physical examination, blood pressure was 120/80 mmHg, pulse 72 times per minute regularly, respiration 16 times per minute, axillary temperature 36.0^{0}C, numeric rating scale (NRS) at rest 1/10 and NRS while moving 2/10, and the metabolic equivalent of task (METs) 5-6. Physical examination of the respiratory, cardiovascular, and abdominal systems showed no abnormalities. Musculoskeletal examination showed good neck flexion, Mallampati II, no loose teeth, well palpable interspinous gaps, and the patient had no dentures. The laboratory examination, complete blood count, hemostatic examination, blood chemistry, blood gas analysis, and ECG were within normal limits. Chest X-ray examination showed aorthoscleoris, pneumonia, and thoracic spondylosis, and a cardiothoracic ratio (CTR) of 51%. X-ray genu dextra, genu skyline, and scanogram showed grade II bilateral genu osteoarthritis (according to the Kellgren-Lawrence classification) was no visible varus/valgus deformity nor lower limb discrepancy lower extremity. The actual problem we encountered in this patient was that the patient had a history of hepatitis B (reactive HbsAg) with normal SGOT and SGPT values. Another problem that has the potential to occur in these patients is the risk of bleeding. The patient was currently inferred with ASA II physical status.

Pre-anesthesia preparation, ringer lactate was given a 500 ml loading while fasting on the ward. Prepared STATICS tools, anesthesia machine, anesthetic and emergency drugs, IV line 18G on the left arm, spinal set, epidural set, and block set. The patient was given supplemental oxygen with a nasal cannula at 3 liters per minute. Prior to spinal anesthesia, the patient was given fentanyl 25 mcg IV, ketamine 10 mg IV, and midazolam 1.5 mg IV as premedication. The patient was positioned on the right side, and a 27G Quincke needle was inserted at the level of L3-L4 and given bupivacaine heavy 0.5% 7.5 mg, then lateralized for 15 minutes. After lateralization, the patient was positioned supine and used ultrasound to direct ACB action with a regimen of ropivacaine 0.25% + dexamethasone 5 mg a volume of 20 ml, then iPACK was performed with a regimen of Ropivacaine 0.375% + dexamethasone 5 mg a volume of 20 ml. Other medications given include ondansetron 4 mg IV, tranexamic acid 1000 mg IV, and ibuprofen 400 mg IV. The operation lasted 3 hours and 30 minutes. After surgery, the patient is treated in the recovery room for 1 hour until the bromage score is 0. The patient received the PCA morphine analgesic demand only 1 mg/mL, 1 mg per dose, max 5 mg over 4 hours, lockout interval 6 minutes; Paracetamol 500 mg every 6 hours PO; ibuprofen 400 mg every 8 hours PO.

Patients were evaluated during the first hour after surgery. The patient's pain complaints were said to be minimal, and based on the NRS evaluation, NRS was found to be silent 1-2 out of 10, and NRS moving 1-2 out of 10, the patient still did not do much mobilization. 3 hours postoperatively, the patient began to mobilize by tilting left and right. The patient said minimal pain with a silent NRS of 1 of 10 and a moving NRS of 2-3 of 10. 6 hours postoperatively. The patient started in a sitting position with the help of straightening the bed while eating. The patient said minimal pain with silent NRS 2 out of 10 and moving NRS 2-3 out of 10, but the patient has pressed the PCA 1 time because it starts to move when trying to sit up. 12 hours postoperatively, complaints of pain were still minimal, with NRS silent 1 in 10 and NRS moving 2-3 out of 10. The patient began to mobilize 48 hours postoperatively by sitting on the edge of the bed. On the fourth day, the patient learns to walk using a walker and walks to the bathroom, assisted by the family. The patient can go home after the fifth day of treatment.

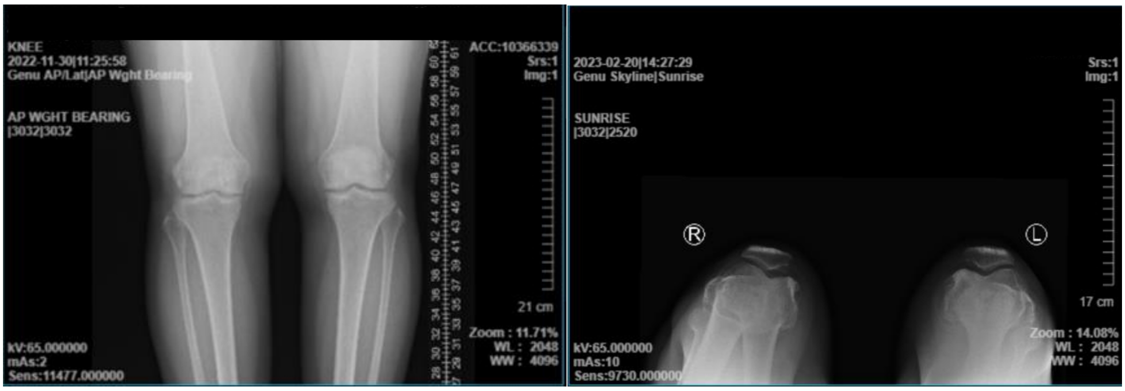

Figure 1. Lateral AP genu X-ray image of the patient, X-ray scanogram, and genu skyline image.

3. Discussion

TKR is a treatment option for genus OA that does not respond to conservative management and seriously interferes with the patient's quality of life. In people with symptomatic arthritis affecting the entire tibiofemoral joint (i.e., medial and lateral, inner and outer joints), there is general agreement that TKR is the preferred surgical option. According to estimates in 2030, it is projected that 3.48 million TKR will be carried out annually.[10] A significant problem that arises after TKR surgery is pain, which some patients feel is more severe than before TKR surgery.[4] Providing effective analgesia is very important for postoperative TKR patients. Over the last 3 decades, regional analgesia for patients undergoing TKR has evolved to become more site-selective. Several routine approaches have been proposed, such as the use of preemptive analgesia, opioids, cyclooxygenase-2 inhibitors, epidural anesthesia, peripheral nerve blockade (PNB), local infiltration analgesia, patient-controlled analgesia (PCA), and multimodal analgesia. The mechanisms underlying postoperative pain in TKR involve both peripheral and central mechanisms. Therefore, monotherapy alone is not sufficient to provide postoperative pain relief after TKR.[4]

Currently, multimodal analgesia is considered the optimal method for perioperative TKR pain management through targeting multiple pain pathways. Multimodal analgesia was first introduced by Wall in 1988, referring to a combination of several drug types and routes of distribution, including preemptive analgesia, neuraxial anesthesia, peripheral nerve blockade (PNB), PCA, local infiltration analgesia (LIA), and oral opioid and nonopioid drugs.[11] Multimodal analgesia includes preoperative, intraoperative, and postoperative analgesic regimens, which aim to maximize analgesic efficacy through the combination of several analgesic regimens while minimizing unwanted side effects. Intraoperatively, LIA is performed to directly prevent the generation and transmission of pain signals from the incision site. Postoperatively, multimodal analgesia can be used, including pharmacological agents, neuraxial anesthetics, PNB, and PCA. Compared to monotherapy, multimodal analgesia provides superior postoperative pain relief to promote knee recovery and reduces opioid consumption and related side effects.[12,13]

Previously, femoral nerve block (FNB) is known to provide superior pain control and shorten functional recovery time and length of hospital stay without significant side effects, compared to epidural or intravenous patient-controlled analgesia (PCA). However, findings from previous studies suggest that FNB decreases the strength of the femoral quadriceps muscle and results in an increased risk of falls.[14] Adductor canal block (ACB) is a relatively new alternative for post-TKR pain management. A regional anesthetic injected into the adductor canal can be easily visualized in the mid-thigh by ultrasonography. ACB after TKR is gaining popularity because it maintains motor skills with adequate analgesia. Li et al. demonstrated that ACB maintained greater quadriceps strength than FNB with similar pain control, reduced opioid consumption and concomitantly reduced antiemetic requirements associated with opioid use-induced nausea and vomiting.[15,16] In addition, Li et al. (2015) conducted a recent meta-analysis of RCTs showing that ACB achieves a better analgesic effect compared to FNB.[17] A recent study by Kim et al. demonstrated a marked improvement in NRS score ($p<0.009$) in patients who received ACB injection.[18]

From the apex of the femoral triangle to the adductor hiatus, there is an aponeurotic canal called the adductor canal. Within this canal are the superficial femoral artery, superficial femoral vein, and branches of the femoral nerves, such as the saphenous nerve and the nerve to the vastus medialis. In addition, it may contain the medial cutaneous femoral nerve and the anterior cutaneous branch of the obturator nerve depending on individual anatomic variations.[19] Previously, only the saphenous nerve block was thought to play a critical role in ACB, but now, the nerve to the vastus medialis is also known to play a major role because it is believed to innervate not only the vastus medialis muscle but also of the sensory joint capsule and medial retinaculum.[18] There is evidence that injection into the adductor canal can spread more proximally than the femoral triangle by vertical spread.[20] Therefore, it has been shown that the injection can spread outward from the femoral triangle and become an indirect femoral nerve block. However, in several clinical trials, quadriceps weakness due to vertical spread has been shown to be insignificant, and ACB is associated with less quadriceps weakness. This is thought to be because the motor nerve to the quadriceps muscle branches just below the inguinal canal, where local anesthetics generally do not spread vertically. The only motor nerve that can be affected by a mid-thigh ACB is the nerve to the vastus medialis. Therefore, ACB has pain reduction similar to femoral nerve block but is associated with less quadriceps weakness, and it is associated with earlier ambulation or better functional outcome.[21]

The new ultrasonographic technique of infiltrating local anesthetic into the space between the popliteal artery and the posterior knee capsule (iPACK) has provided significant analgesia in the posterior knee. Therefore, some clinicians choose to create additional iPACK blocks to the ACB for postoperative pain control. The iPACK technique is performed by placing an ultrasound transducer to identify the femoral condyle. After identifying the popliteal artery, the needle tip is placed to the right of the center in the bone and popliteal artery. Local local anesthetic is injected at the site.[9] Studies show the combination of iPACK with ACB has a good analgesic effect and has a small impact on the muscle strength of the affected limb after surgery, earlier initiation of rehabilitation, and shorter hospitalization. The combination of iPACK and ACB also showed better results in postoperative knee movement, morphine consumption, length of stay, and walking distance when compared to the group with ACB alone.[22]

The study by Sankineani et al. is a prospective, open-label, non-randomized study comparing iPACK block using 15 ml of 0.2% ropivacaine plus a single injection of ACB versus ACB alone, showing lower pain scores and greater physical function than the ACB alone group despite an overall pain score was low in both groups, and the multimodal regimen was limited to total acetaminophen 3 grams and gabapentin 300 mg per day.[23] Whereas other studies compared femoral nerve block combined with a superior popliteal sciatic nerve block, iPACK combined with ACB had a mild impact on early motor function after TKR.[24]

The optimal dose for iPACK block is still unknown. While a 20 ml 0.2% dose of ropivacaine was used in the Kandarian and Sankienani prospective studies, other studies used higher doses.[9,25] One study of 10 fresh frozen cadaveric knees using 20 ml of colored latex solution in iPACK injections has shown the potential for spread to the terminal branches of the sciatic nerve, which may be the basis for suggestions to limit injection volumes to or less than 20 ml.[26]

Figure 2. iPACK block procedure.

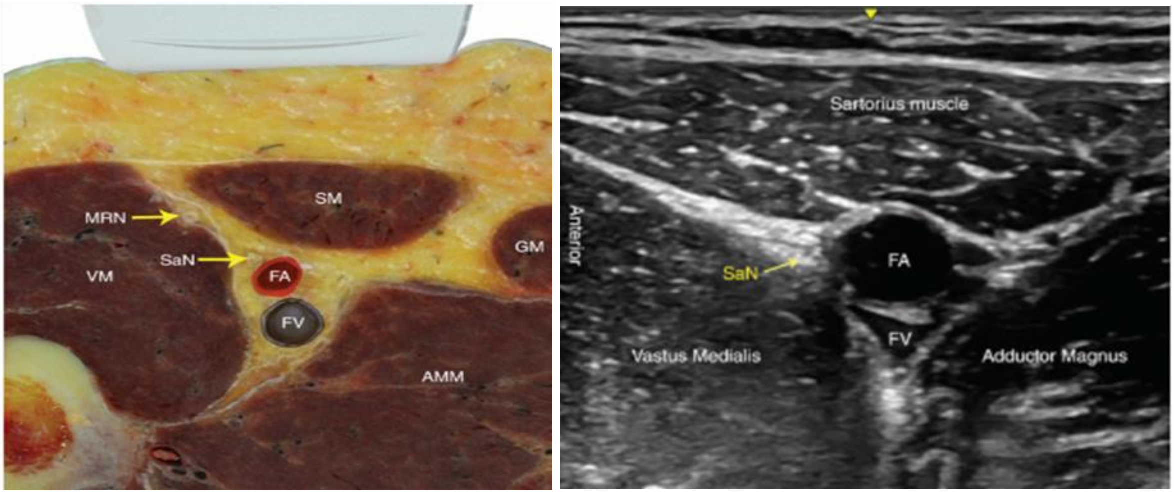

Figure 3. Anatomy and location of adductor canal block infiltration.

4. Conclusion

TKR patients who were given analgesia using the ACB peripheral nerve block technique combined with iPACK experienced a decrease in pain levels and lower use of postoperative morphine so that patient mobilization was faster and reduced the patient's length of stay.

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