

Post-operative analgesia techniques after total knee arthroplasty: A narrative review

ABSTRACT

Post-operative knee pain management has become a challenge to provide early relief and pain-free postoperative care to the patient. The major objectives of post-operative analgesic treatment are to reduce opioid requirements, post-operative pain, and adverse events related to opioid intake. This narrative review aimed to document post-operative analgesia techniques after total knee arthroplasty (TKA). The traditional approach involved high-dose opioid-based regimen, though opioid is considered strong analgesic, but are associated with a number of unwanted side effects to seek for alternative techniques. The role of sciatic nerve block in TKA pain is doubtful. Femoral Nerve Block (FNB) is still considered as the gold standard; however, FNB is associated with quadriceps weakness and risk of fall and sciatic block with foot drop. To overcome these drawback more distal nerve block techniques has evolved, namely saphenous nerve block in adductor canal, selective tibial which are claimed to provide comparable analgesia to that of femoral and sciatic nerve block. The combination of pre-emptive and multi-modal analgesia and technically well-delivered regional nerve blocks and postoperative physical therapy are an essential component which not only minimize the side effects of traditional opioid-based analgesia but also speed up functional recovery, increases patient satisfaction, and reduces the overall length of hospitalization and cost.

Key words: Multi-modal analgesia; postoperative analgesia; regional blocks; total knee arthroplasty

Introduction

Joint replacement surgeries are considered as one of the most painful orthopaedic procedures. This painful procedure is the result of inadequate and poorly treated postoperative pain after major joint replacement surgery. This pain episode must be timely addressed because not only does this significantly prolong the rehabilitation process, but also causes the increased risk of other complications. If not addressed within time or without proper approach, these postoperative painful episodes can progress into chronic pain, which eventually prolongs the overall length of hospitalization and cost.^[1] The


journey to achieve the complete and long-term pain relief begins before the surgery is performed. An important basis to achieve long-term pain relief and functional recovery after the joint surgery involves sufficient peri-operative analgesia.^[2] One of the important aspects to achieve successful outcome after joint surgery is the early joint mobilization with the initiation of physical therapy.^[3] Several new drugs and novel techniques to ameliorate the post-operative pain post-surgery are being introduced every year, but most of the patients still end up suffering from extreme pain immediately after surgery which often progresses into chronic pain.^[4]

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KRISHNA PRASAD G V

Anaesthesiologist, Military Hospital Kirkee, Pune, Maharashtra, India

Address for correspondence: Dr. G. V. Krishna Prasad, Classified Specialist Anaesthesia, Military Hospital Kirkee, Pune - 411 020, Maharashtra, India. E-mail: drkaypee99@yahoo.com

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Arthroscopic knee surgery has become increasingly popular in modern orthopaedics.^[5,6] Still, the post-operative knee pain management involving early relief and pain-free postoperative care to the patient remains a challenge to several clinicians.^[7,8] In some cases, pain management in itself has become a priority for management as a daycare procedure. Persistent pain after knee arthroplasty remains an unresolved issue for many patients.^[9,10] Pain is considered as a very subjective event because everyone has a different perception and threshold of pain.^[11] And therefore, it becomes very difficult to standardize any pain regime for a particular surgery. Several factors that cause knee pain, which include irritation of free nerve endings of the joint capsule, synovial tissue, anterior fat pad.^[12,13] Following factors influence the post-arthroplasty pain such as the;

- Anesthetic technique,
- Patient pain threshold,
- Residual effects of perioperative analgesia,
- The use and duration of tourniquet exsanguinations,
- Pre-operative pain level,
- Volume of drug injected,
- Surgical trauma involved,
- The sex of the patient,
- The experience of the surgeons, and finally,
- The postoperative activity level of the patients.^[14]

Adding to these, the post-operative pain levels are also influenced by the preoperative pain levels of the patient.^[15] It is important to remember that adequate analgesia affects the overall hospital stay and early rehabilitation of the patient after surgery.^[16,17] The conventional techniques of pain alleviation after total joint replacement included a heavy reliance on the opioid, oral or intravenous (IV), patient-controlled analgesia (PCA) with IV opioid or epidural infusion.^[18] Opioid is considered as a strong analgesic, but they are linked with several unwanted side effects like vomiting, nausea, delay ambulation, constipation, sedation, respiratory depression, and pruritus.^[19,20] Continuous epidural and PCA limits patient ambulation requires close monitoring and frequent dose adjustment and may not be appropriate for all patients.^[21,22] Studies have found out that a single dose regime might be unsuitable for every patient in PCA. All these conditions often lead to under dosing or overdosing with troublesome side effects.^[23,24] The increased understanding of pain patho-physiology, pharmacology of analgesics and their limitations have led the researchers to find alternative approaches for pain management. These novel approaches to target the pain management at different levels that support each other with minimal side effects. The aim of the current review article is to provide concisely and up to date information on the available analgesics modalities after

total knee arthroplasty, which is important for both safety and effectiveness for most patients. Optimal postoperative analgesia after total knee arthroplasty is the key for earlier recovery and functional outcomes.

Analgesics Options after TKR

The following list includes the available modalities for the management of postoperative analgesia after total knee arthroplasty (TKA):

- Pre-emptive analgesia
- Local infiltration
- Systemic analgesics- opioid, non-opioid, patient-controlled analgesia (PCA)
- Neuraxial analgesia
- Regional nerve blocks- single shot or continuous
- Combinations – multi-modal analgesia

1. Pre-emptive analgesia

Preemptive analgesia, an antinociceptive treatment, is the treatment which is initiated prior to the surgery so that the pain sensitization evoked by the incision-related and inflammatory injuries occurring during surgery can be prevented. Along with conducting before the surgery, Pre-Emptive analgesia can be utilized in the early postoperative period.^[25,26] This protective effect is provided by pre-emptive analgesia on the nociceptive system. In order to block the pain sensation, literature has recorded several approaches including drugs and routes:

1a. Parenteral and oral nonsteroidal anti-inflammatory drugs (NSAIDs): Nonsteroidal anti-inflammatory drugs (NSAIDs) involve a category of drugs that have chiefly the analgesic and antipyretic actions.^[27] Majority of NSAIDs serve as non-selective inhibitors of the enzyme cyclooxygenase (COX). Further, they also reversibly inhibit both the isoenzymes (COX-1 and COX-2).^[28] COX enzyme catalyzes the formation of thromboxane and prostaglandins from arachidonic acid. These released prostaglandins then serve as the messenger molecules in the inflammation pathway.^[29]

1b. Sublingual and intravenous (IV) opioids: Opioids are known to produce profound and prolong analgesia. This positive role in pre-emptive analgesia is due to the interaction of opioids with various opioid receptors that ultimately produce analgesia.^[30,31] The study carried out by Campiglia *et al.*, report that in patients who underwent elective abdominal surgery, the pre-medication with sublingual morphine sulfate resulted in superior control of postoperative pain, when compared to pre-medication with sublingual midazolam.^[32]

1c. Local anesthetics (LA): Local anesthetics are the membrane-stabilizing drugs. They act primarily by hampering sodium influx through voltage-gated sodium channels. This hamper mechanism thereby inhibits the generation of the action potential.^[33-35]

1d. Systemic antiepileptics (GABA (gamma-amino butyric acid) analogues): The gamma-amino-butyric acid (GABA) analogues like the pregabalin and gabapentin were conventionally employed as therapeutic adjunct towards the management of partial seizures.^[36] These both pregabalin and gabapentin are effective in reducing the perioperative pain intensity, opioid consumption and opioid-related side effects, producing very few adverse effects.^[37-40]

II. Local infiltration analgesia (LIA)

This is a simple and effective analgesic technique that involves the permeation of adjuvants throughout the wound at the time of surgery [Figure 1]. The duration of effect of analgesia can be prolonged by the precise placement of a catheter to the surgical site for postoperative administration of further local anesthetic.^[41] The most used drugs for both intra-articular and extra-articular injection are morphine, steroid, clonidine, ephenephine, keterolac, ropivacine, and bupivacaine.

III. Intrathecal morphine with local anesthesia

Local anesthesia supplemented with intrathecal (IT) morphine to alleviate post-operative pain provides good postoperative analgesia. This combination also causes the parenteral opioid-sparing effect for the first 24 hours.^[42,43] But, despite several advantages, this approach is linked with increased frequency of urinary retention, nausea-vomiting and pruritus. We suggest that the low dose intrathecal morphine (at around 100 microgram) is very effective and might be safer than single-shot femoral nerve block.^[44]

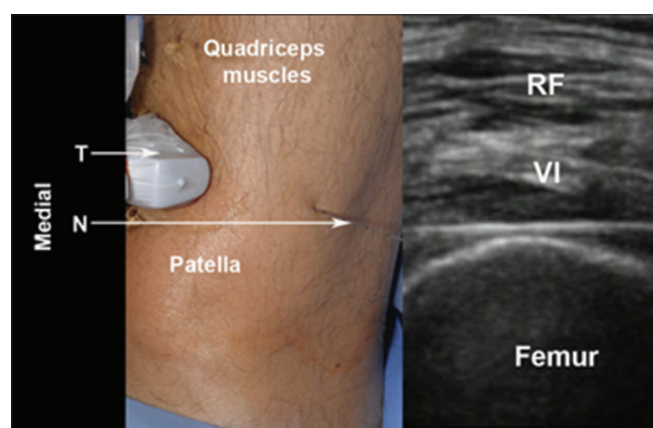


Figure 1: Ultrasound-guided local infiltration. N: Needle; RF: Rectus femoris muscle; T: Transducer (linear, high frequency); VI: Vastus intermedius muscle (Source: R. O'Donnell and J. Dolan* Anaesthesia and analgesia for knee joint arthroplasty. BJA Education, 18(1): 8e15, 2018)

IV. Epidural analgesia

Epidural analgesia has been documented to be extremely beneficial for postoperative pain relief after knee replacement surgeries. This technique is the proven and most successful technique for postoperative analgesia TKA. Without doubt, therefore, epidural analgesia has turned out to be the most widely used procedure in routine clinical practice involving knee replacement surgeries. Very few side-effects of epidural analgesia include some unintended motor blockade, dysfunction in bowel and bladder activity, and hemodynamic instability.^[45]

V. Regional nerve block techniques

Regional analgesia Block Techniques in the total knee arthroplasty (TKA) is attaining wide recognition in comparison to epidural analgesia. This approach is involved in fewer side effects and most importantly, is associated with the improved analgesic profile. Regional nerve block proceeds by blocking important nerves in the femoral region, sciatic nerve and common peroneal branches. However, by blocking these major nerves, there might be severe complications causing weakness of the muscles, motor blockade, and even paralysis. All these factors may affect the early functional recovery of the patient.^[46]

Femoral nerve block

Femoral nerve is the central nerve supply to the maximum portion of the knee joint.^[47] Femoral nerve block (FNB) can be recommended as the technique of choice since it causes better analgesia and less adverse effects. FNB's are one of the oldest blocks employed for TKA analgesia. They have been used because they provide excellent analgesia and are relatively easy to perform. However, the biggest disadvantage of FNB is the risk of fall and its associated quadriceps weakness.^[48]

Adductor canal block (ACB)

Adductor canal block (ACB), an ultrasound-guided technique, is one the most important and most simple sensory nerve block for postoperative analgesia following knee surgery. ACB provides quality pain relief when compared to femoral nerve catheter and facilitate discharge of patients after total knee arthroplasty.^[49] Adductor canal block causes a good analgesic profile by maintaining quadriceps muscle strength, thereby causing earlier mobility and complete recovery.^[50-52] [Figure 2].

Sciatic and selective tibial nerve block

Sciatic nerve provides superior analgesia after TKA.^[53] Sciatic nerve blocks the posterior knee pain by blocking at a proximal position in the perigluteal region. The performance of Block within the immediate postoperative period can be

quite challenging for the patient. The factors affecting the performance of the sciatic nerve block include the position difficulty in a narcotized patient, the nature of post-operative pain, and the availability of personnel and equipment.^[54]

Other potential blocks

Multimodal analgesia after TKA

Multimodal analgesia post-TKA involves the mixture of multiple analgesic drugs with or without techniques which act via distinct mechanism thereby causing synergistic analgesia. Multimodal analgesia post-TKA is a comprehensive approach for postoperative knee pain with an objective to amplify the analgesic effect and reduce the side effects of medications. The most commonly involved drugs in this multimodal analgesia regimen are opioid and their derivatives acetaminophen, gabapentinoid, dexamethasone and ketamine and non-steroidal anti-inflammatory drugs.^[55]

I-Pack block

It stands for the Interspace between the Popliteal Artery and the Capsule of the posterior Knee [Figure 3]. This is a comparatively recent block with not many studies worked on this block, but one study suggested that it added as an analgesic advantage when combined with adductor canal block.^[56] It is an ultrasound-guided approach which targets to serve analgesia of the posterior knee capsule. It helps by blocking the terminal articular branches of tibial and peroneal nerves sparing the main nerves.

Sub-sartorial compartment block

This is an ultrasound-guided injection of local anaesthetic (LA) below the sartorius muscle distal to the adductor hiatus

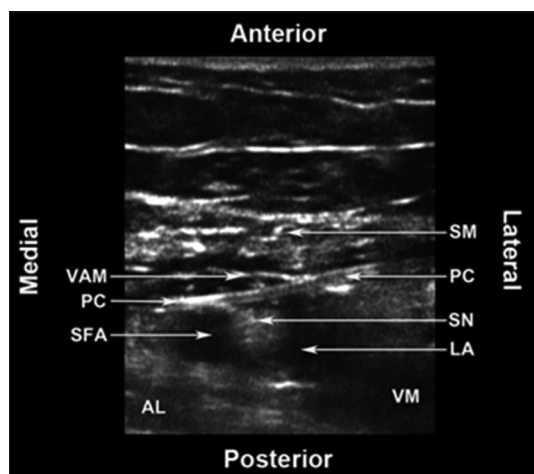


Figure 2: The adductor canal block: AL: Adductor longus muscle; LA: Local anaesthetic; PC: Perineural catheter; SFA: Superficial femoral artery; SM: Sartorius muscle; SN: Saphenous nerve; VAM: Vastoadductor membrane; VM: Vastus medialis muscle. (Source: R. O'Donnell and J. Dolan* Anaesthesia and analgesia for knee joint arthroplasty. BJA Education, 18(1): 8e15, 2018)

proximal to the knee. This approach aims at depositing LA around saphenous nerve. This nerve is adjacent to the saphenous branch of the genicular artery. In this approach, the block serves as a sensory block and does not cause any motor paralysis.^[57]

Obturator nerve block

The relative contribution of the obturator nerve in TKA pain is under dispute. This approach primarily impacts the skin and the adductor muscle over the medial aspect of thigh.^[58] The posterior branches follow the popliteal vessels and join with popliteal plexus and may play a part in the posterior knee pain TKA patients.^[59,60]

Conclusion

Early rehabilitation and quality analgesia are primary requirements for initial functional recovery post-TKA. Both these requirements are considered essential by both the interventional surgeon and the patient. The correct amalgamation of multimodal and pre-emptive analgesia, technically superior delivery model of regional nerve blocks, and post-operative physical therapy are fundamental components. This approach both speeds up functional recovery and minimizes the side effects of traditional opioid-based analgesia. In summary, it increases patient satisfaction and reduces the overall length of hospitalization and its associated cost.

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Conflicts of interest

There are no conflicts of interest.

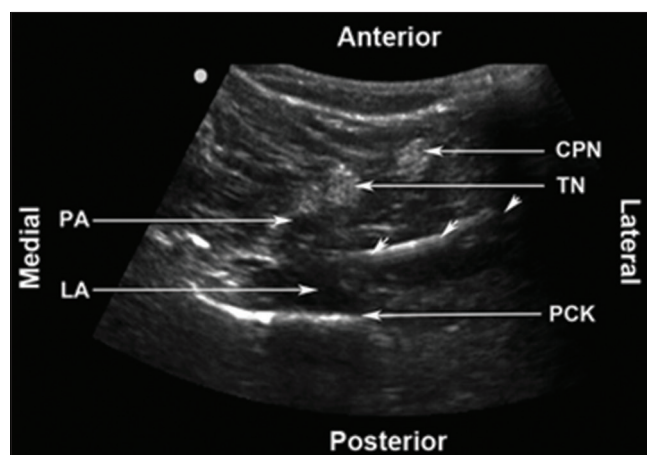


Figure 3: I-PACK Block. CPN: Common peroneal nerve; LA: Local anaesthetic; PA: Popliteal artery; PCK: Posterior capsule of the knee; TN: Tibial nerve. (Source: R. O'Donnell and J. Dolan* Anaesthesia and analgesia for knee joint arthroplasty. BJA Education, 18(1): 8e15, 2018)

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