

Postoperative Analgesia in Total Knee Arthroplasty (TKA)- The Changing Trends

Surjya Prasad Upadhyay^{1*}, Sudhakar Tellicherry¹, Sunil Kulkarni², Partha P Saikia³, Piyush N mallick⁴
and Waleed Elmatite⁵

¹Department of Anesthesia, NMC Hospital DIP, Dubai

²Department of Orthopedics, NMC Hospital DIP, Dubai

³Department of Anesthesia, Life Line hospital Dubai

⁴Department of Anesthesia, Al Zahra Hospital, UAE

⁵Department of paediatric anesthesia, Children and women Hospital, Buffalo, New york. USA

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***Corresponding author:** Surjya Prasad Upadhyay, Specialist Anesthesiologist, NMC Hospital DIP, United Arab Emirates, Dubai

Abstract

Joint replacement surgeries are considered as one of the most painful procedure in orthopedics. Achieving complete and long term pain relief starts from the time of surgery, and perhaps even before the surgery. The traditional approached involved high dose opioid based regimen, though opioid are considered strong analgesic, but are associated with number of unwanted side effects which lead the researcher to sought for alternative techniques. Neuraxial techniques (intrathecal long acting opioid) and continuous epidural analgesia were popular and were accepted by many but they also have limitations and drawback, after epidural analgesia, next popular technique that has evolve major nerve block namely femoral and sciatic, of which femoral nerve block (FNB) seems to provide equianalgesia to epidural without the side effects of epidural. The role of sciatic nerve block in TKA pain is doubtful. FNB still hold its place and many expert consider femoral nerve block as 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 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 overall length of hospitalisation and cost.

Keywords: Postoperative Analgesia; Total Knee Arthroplasty; Multi-Modal Analgesia; Regional Blocks

Introduction

Optimal postoperative analgesia after total knee arthroplasty is the key for earlier recovery and functional outcomes. Joint replacement surgeries are one of the most painful orthopaedic procedure. Inadequate or poorly treated postoperative pain after major joint replacement surgery not only significantly prolongs the rehabilitation process, increased risk of other complications, sometime progress as persistent postoperative pain into chronic pain and it also prolonged the overall length of hospitalization and cost [1]. Achieving complete and long term pain relief starts from the time of surgery, and perhaps even before the surgery. Adequate perioperative analgesia is the key to success after knee arthroplasty surgeries, to maintain long term pain relief and functional recovery after the surgery. Early joint mobilization with initiation of physical therapy is one of the important aspects

to achieve successful outcome after total knee arthroplasty [2]. Despite the introduction of newer drugs and techniques and better understanding of postoperative pain mechanism, majority of patients still suffer from extreme pain immediately after surgery that often progress into chronic pain [3-6].

Persistent pain after knee arthroplasty is still an unresolved issue for many patients [7]. Pain is a very subjective phenomenon; everyone has different pain threshold and perception of pain. So there can have individual range of experience and interpretation of pain very differently. It is very difficult to standardise any pain regime for a particular surgery. As per individual perception and requirement, the analgesic regime should be tailored to once need rather than making it fixed regime for all patient. Traditional techniques of pain relief after total joint replacement were primarily

relied on opioid, oral or intravenous (IV), patient controlled analgesia (PCA) with IV opioid or epidural infusion [8]. Although opioid are considered strong analgesic, but are associated with number of unwanted side effects notably nausea vomiting, sedation, constipation, confusion, pruritus, urinary retention, respiratory depression, delay ambulation and overall increased length and cost of hospitalization [9,10]. Continuous epidural and PCA limits patient ambulation, requires close monitoring and frequent dose adjustment and may not be appropriate for all patients. One dose regime may not be suitable for every patient in PCA and often leads to under dosing or overdosing with troublesome side effects [11].

With increased understanding of pain patho-physiology, pharmacology of analgesics and their limitations, have led the researchers find alternative approaches for pain management targeting pain at different levels that complements each other in terms of analgesic actions with minimal side effects. The aim of the current article is to provide concise and up to date review on the available analgesics modalities after total knee arthroplasty and to provide evidence based standardized guideline or protocol which is important for both safety and effectiveness for most patients.

Analgesics Options After TKR

Available modalities for the management of postoperative analgesia after total knee arthroplasty are

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

Pre-Emptive Analgesia

Pre-incision (at least 1 hour prior to incision) use of analgesics opioid, non-steroidal anti inflammatory drugs (NSAIDs), cyclooxygenase (cox-2) inhibitor, gabapentanol (gabapentin and pregabalin)) has been shown to reduces the central and peripheral sensitization of pain mechanism and thereby reduces short and long term postoperative pain level and decreases the need of rescue analgesics in postoperative period [12-17]. pre-emptive use of opioid is controversial for fear of opioid related short and long term side effects and many expert do not recommend routine use of opioid even in postoperative period and there is growing trends to exclude opioid from pre-emptive analgesic regime due to risk of opioid related side effects; [16,18] however, opioids should be reserve for rescue analgesia. Non-steroidal anti inflammatory drugs (NSAIDs) or COX-2 inhibitors when given pre-emptively not only has anti-inflammatory effects, they facilitate pain relief and reduce opioid requirements and their related complications.

Local Infiltration Analgesia (LIA)

Intra operative peri-articular (intra-articular and extra-articular) injection of long acting local anaesthetic along with opioid or other

adjuvants in varying proportion significantly reduces pain without major side effects specially when such regime is incorporated as part of multi-modal analgesia regimens. There are too heterogeneous techniques in term of drug dosing such as concentration, volume and adjuvants dose. Most commonly used drugs for peri-articular injections are bupivacaine, ropivacaine, morphine, clonidine, steroid, ketorolac, ephedrine. So far, we don't have any consensus guideline on optimal drug, and dose - regimens [16,19-23].

Intrathecal Morphine with Local Anesthesia

Intrathecal morphine as an adjunct to local anesthesia provides good postoperative analgesia with parenteral opioid sparing effect for first 24 hours. However, intrathecal morphine is associated with higher incidences of pruritus, nausea-vomiting and urinary retention. Because of heterogeneous study design and dose regime, the dose - response relationship is not clear and there is not enough evidence to provide the optimal dose of intrathecal morphine for postoperative knee arthroplasty [19,23-26]. Low dose intrathecal morphine (100 microgram) has been proven to be more effective and may be safer than single-shot femoral nerve block [27].

Epidural Analgesia

Continuous epidural analgesia is time tested and one of the most effective technique for postoperative analgesia TKA and it is considered by many as gold standard and to which other analgesic techniques are compared. No doubt, it has definite effectiveness and still being widely used in routine clinical practice. However, it has its some drawback or side-effects such as haemodynamic instability, bladder and bowel dysfunction, unintended motor blockade, it makes patient confined to bed, pruritus and risk of respiratory depression, because of these effects its routine use is slowly declining and varieties of other regional analgesic techniques are being evaluated [28,29].

Regional Nerve Block Techniques:

Regional analgesia in the form of peripheral nerves block(s) in total knee arthroplasty is gaining popularity over epidural analgesia as it has not only better analgesic profile, but also has lesser side-effects. Two main nerves that supply majority of knee joint are femoral for anterior aspect and sciatic nerve through its tibial and common peroneal branches for posterior aspect of knee joint. By blocking these two major nerves can provide almost complete analgesia after unilateral knee arthroplasty, however, complete nerve block results in motor blockade also resulting in paralysis or weakness of the muscles supplied by that particular nerves (quadriceps paralysis in femoral and foot drop in sciatic nerve) and this may delay the functional recovery of the patient.

Femoral Nerve Block

Femoral nerve is the main nerve supply the majority of knee joint. Single shot or continuous femoral nerve block has been shown to provide significant reduction in pain score and opioid consumption for up to 24 -48 hours [30-34]. Recent studies comparing epidural versus continuous femoral nerve block has demonstrated comparable postoperative analgesia with preserving the function of non-operative limb that may help in early rehabilitation [33,35]. Since femoral nerve is a branch

of lumbar plexus, a lumbar plexus block either single shot or continuous infusion can also provide equivalent analgesia [36]. No doubt, femoral nerve block provide excellent analgesia after knee arthroplasty, the main drawback or concern is associated quadriceps weakness, impaired proprioception and risk of fall [37,38]. As a result, alternative techniques of nerve blocks has been explored- one such technique is motor sparing femoral block; that is blocking the saphenous nerve (terminal branch of femoral nerve after its gives of motor branches).

Adductor Canal Block (ACB)

The adductor canal in middle third of the thigh contain the saphenous nerve and last motor branch of femoral nerve- nerve to vastus medialis, blocking the nerves at this level results in less quadriceps weakness compared with single shot femoral injection. Recently, there are growing publications on the use of adductor canal block after total knee arthroplasty with or without periarticular local anesthetic infiltration. Most of the studies on adductor canal block shows comparable analgesic profile with better preserve quadriceps muscle strength resulting n earlier mobility and functional recovery [39-46]. Single shot adductor canal block provides 24 hours of good analgesia which can be extended for 3-4 days with inserting continuous infusion of local anesthetic through an indwelling catheter. The continuous adductor canal block has been part of standard protocol in many centers [41,44,47]. In a recent meta-analysis of 7 randomised controlled trial (RCT) by Fuqiang G on ACB Versus FNB for TKA found that patient with ACB achieve faster mobilization and functional recovery without a reduction in analgesia in comparison to FNB patients [48].

Sciatic and Selective Tibial nerve block

Though sciatic nerves, through its tibial and common peroneal branches innervates the postero-lateral aspect of knee joint and by blocking the sciatic nerve in addition to femoral or saphenous nerve block, though the role of sciatic nerve block in TKA is disputed by many authors, [49-51] it has undergone a controversial debate on usefulness in patients undergoing TKA. Some studies have proved that it provides superior analgesia after TKA [52-56]. Varieties of techniques of blocking the blocking the posterior knee pain have been described, including blocking sciatic nerve proximally at perigluteal region, distally at popliteal fossa or even isolated selective tibial nerve block [53-56]. So far we don't have enough evidence to say one technique is superior to other.

Similarly, unlike femoral nerve block with continuous infusion, there is no evidence that continuous sciatic nerve block is superior to single shot sciatic in terms of functional recovery and discharge readiness [57- 59]. There are some additional factors that must be considered before blocking the sciatic nerve in patient undergoing TKA. The TKA related sciatic nerve injury incidence is around 2.4% (0.3-10%) and many surgeons want to evaluate the sciatic nerve function immediately after surgery or after spinal effect wear off [59-62]. Block performance in the immediate postoperative period may be more challenging for both patient and the provider due to postop pain, position difficulty in a narcotized patient, availability of personnel and equipment etc.

some clinician keep the sciatic block as an optional or as rescue block in recovery when the sciatic derived pain is intolerable to the patients [58,60]. Abdallah et al. [61] conducted a systemic review on use of sciatic nerve block in combination with femoral nerve block, use of sciatic nerve blocks (both for single shot or continuous) resulted in analgesic and opioid sparing effects for first 24 hours only and no analgesic benefit beyond 24 hours [61]. So the question arises do we need a separate catheter for continuous sciatic nerve block when the single shot provides equianalgesic effects. Complete sciatic nerve blockade (tibial and common peroneal) results in foot drop due to blockade of common peroneal component of sciatic nerve which carries the motor nerve fibre for dorsiflexion and eversion of the ankle and toe along with sensory innervation along the anterolateral leg and dorsum of foot. Though both common peroneal and tibial nerve innervates the knee joint as they cross the knee, but the sclerotomal distribution from each nerve is still unknown; blocking femoral and selective isolated tibial nerve at popliteal crease provided satisfactory analgesia similar to proximal sciatic + femoral nerve block [56]. The optimal volume and concentration of local anesthetics for selective tibial nerve block has not been estimated yet, generous volume of local anaesthetic at the popliteal crease may result in significant proximal spread and may also block the common peroneal component of sciatic nerve. The spread of local anaesthetic is also depend on the bifurcation point of sciatic nerve. A shorter bifurcation length is associated with greater proximal spread of local anesthetics and potential to at least partial blockade of common peroneal nerve, which is undesirable in patients at risk for peroneal nerve damage after TKA [62,63].

Other Potential Blocks:

4.9.1 Sub-sartorial Compartment Block: This is an ultrasound guided injection of local anaesthetic (LA) below the sartorius muscle distal to the adductor hiatus, 7-10 cm proximal to the knee; aiming to deposit LA around saphenous nerve adjacent to the saphenous branch of the genicular artery [64-66]. At this level, the block work as a pure sensory block and does not produce any motor paralysis. Theoretically this block will likely produce analgesia equivalent to adductor canal block. Unfortunately there are no studies comparing this block with femoral or adductor canal blocks [67,68].

I-Pack Block: (Inter space between the Popliteal Artery and the Capsule of the posterior Knee): First described by SK Sinha in a conference presentation, its an ultrasound guided dilute local anaesthetic infiltration (15-30 ml) in Inter space between the Popliteal Artery and the Capsule of the posterior Knee (I PACK) aiming to provide analgesia of the posterior knee capsule by blocking the terminal articular branches of tibial and peroneal nerves sparing the main nerves. This is relatively newer block and there have not been many studies on this block, some studies and case report reported as added analgesic advantage when combined with adductor canal block [63-65].

Obturator Nerve Block:

The relative contribution of obturator nerve in TKA pain is debatable. It mainly innervates the adductor muscle and skin

over the medial aspect of thigh and sends articular branches to the knee joint. The posterior branch and occasionally anterior or accessory obturator nerves follow the popliteal vessels and join with popliteal plexus and may contribute the posterior knee pain TKA patients. Two recent studies has shown conflicting results of obturator nerve block, one study has compared obturator nerve block with sciatic nerve block in addition to femoral nerve blocks in both group found inferior analgesia in obturator group compared to sciatic group [69] whereas, another recent study comparing combined ultrasound guided femoral and obturator nerve block versus femoral nerve block and 3rd group with LIA found a large and significant reduction in the pain and analgesic requirement in patients receiving both femoral and obturator nerve blocks. [70] Further study is needed to defined and map the contribution of obturator nerve in postoperative pain in TKA.

Multimodal Analgesia after TKA:

The combination of two or analgesic drugs and or techniques that act via different mechanism will leads to additive or synergistic analgesia while minimising side effects of each drug [71]. Its a holistic approach for postoperative pain with a goal to maximize the analgesic effect and minimize the side effects of the medications [72-75]. There are varieties of regimen have been described by some international consensus groups [73-75]. typical multimodal analgesia protocol consist of preoperative patient education, pre-emptive analgesics, preference to regional anaesthesia and nerve blocks, periarticular infiltration of local anaesthetic, round the clock regular analgesics and a standardised programm for postoperative rehabilitation and functional recovery [76-78]. Commonly used drugs in multimodal analgesia regimen are acetaminophen, cox-inhibitor or non-steroidal anti-inflammatory drugs, opioid and their derivatives, gabapentinoid, dexamethasone, ketamine etc [79-85].

Authors Preferred Method

Our practice involve, pre-emptive analgesia with 75 mg pregabalin night before and 2 hour before the surgery along with celecoxib 200 mg orally 2 hr before surgery. Most of our TKA are done under General Anaesthesia with laryngeal mask airway- on spontaneous ventilation. Post-induction before incision- femoral nerve block with dilute short acting local anaesthetic (1% lignocaine 10-15 ml) - this is to cover the tourniquet pain and intra-op analgesia along with femoral nerve block we do selective tibial nerve block with 10 ml of 0.5% levobupivacaine. Single dose of intravenous dexmethasone 8 mg given before incision for both preventing postoperative nausea vomiting and to provide postoperative analgesia.

Maintenance of anaesthesia is done with sevoflurane (0.7-1 MAC) in oxygen with air and low dose remifentanil 200-300 mcg per hour. Intravenous Paracetamol 1 gm along with tramadol 100 mg towards the end of the surgery which are repeated in postoperative period (paracetamol 6th hourly and tramadol 8th hrly). After completion of surgery before extubation -adductor canal block with 20 ml of 0.5% levobupivacaine to provide the prolong postoperative analgesia. As our protocols involve injecting lower concentration and short acting local anaesthetic for femoral nerve block, there is

no real femoral block -associated motor weakness and patients are able to begin weight bearing and physical therapy within 6- 8 hours after surgery. Patients are started on oral analgesics therapy in the form of paracetamol, celecoxib, tramadol and are discharged home once pain relief is satisfactory on 2nd postoperative day.

Conclusion

Quality analgesia and early rehabilitation are fundamental for early functional recovery after TKA which are desired by both patient and surgeon. The combination of pre-emptive and multimodal analgesia and technically well delivered regional nerve blocks and postoperative physical therapy are 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 overall length of hospitalisation and cost.

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