

# Assessment of Postoperative Opioid - Free Analgesia in Total Knee Replacement Patients: An Observational Study of Ultrasound - Guided Single Injection 4 - in - 1 Nerve Block

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**Abstract:** ***Introduction:** Lower limb surgeries necessitate optimal outcomes with minimal morbidity, highlighting the importance of central neuraxial and regional anesthesia techniques for reducing perioperative complications. Total Knee Replacement (TKR) surgery, vital for addressing advanced knee conditions, underscores the need for effective postoperative pain management beyond traditional opioid reliance. **Methods:** A prospective observational study was done. Eight ASA 1 and 2 TKR patients received an USG - guided 4in1 block. SAB with Inj Bupivacaine Heavy 0.5% was administered, and an epidural catheter was inserted for supplementary analgesia. Patients were positioned supine with the ipsilateral leg in Frog leg position. A high - frequency probe identified the vastus medialis, followed by visualization of the superficial femoral artery and genicular descending artery. Nerve to vastus medialis was targeted using PNS with 5ml mixture of Inj Bupivacaine 0.25% and Inj Dexmedetomidine. Subsequently, 35ml of the mixture was administered in - plane to the perivascular region, ensuring arterial displacement. **Results:** After 24 hours, patients reported pain scores  $\leq 5$ , prompting IV Inj Paracetamol (15mg/kg). None required epidural or opioid rescue analgesia. Ambulation ranged from 8 to 12 hours post - procedure. **Conclusion:** The study indicates promising efficacy of USG - guided 4in1 block for TKR patients, yet highlights the necessity for further extensive research to validate and refine its long - term efficacy and safety.*

**Keywords:** Lower limb surgeries, anesthesia techniques, Total Knee Replacement, postoperative pain management, USG - guided 4in1 block

## 1. Introduction

An ever increasing number of lower limb surgeries, e. g. total knee arthroplasty, arthroscopic knee surgeries, lower limb fracture fixations and ankle and foot surgeries etc., demand better outcomes with minimal morbidity and mortality and early mobilization and discharge. The central neuraxial and regional anesthesia and analgesia techniques significantly reduce perioperative morbidity and mortality. (1, 2, 3)

Total Knee Replacement (TKR) surgery stands as a crucial intervention for individuals grappling with advanced knee osteoarthritis and other debilitating knee conditions. However, effective management of postoperative pain remains a paramount concern. Traditionally, reliance on opioid medications for pain relief post - TKR has been standard practice, despite their associated risks and adverse effects.

Sensory innervation of knee:

- 1) Extra articular: Anterior group of sensory nerves
- a) Medial femoral cutaneous N. - Branch of Saphenous Nerve
- b) Medial Retinacular N. - Terminal branch of NVM
- c) Infrapatellar branch of Saphenous Nerve

- 2) Intra articular: Posterior group of sensory nerves  
Popliteal nerve plexus – A. Tibial Nerve B. Posterior branch of Obturator nerve

The regional anesthesia techniques used for knee and below knee surgeries have been extensively studied and have provided excellent options for perioperative care for every age group of patients. (4, 5) Various studies have confirmed the early recovery with adductor canal block over femoral nerve block, with motor sparing effect for knee surgeries. (6)

The nerves relevant for post operative analgesia in TKR patients are [7, 8]:

- Saphenous Nerve
- Nerve to Vastus medialis (NVM)
- Tibial Nerve (branch of Sciatic Nerve)
- Posterior branch of Obturator Nerve

### Outcome Measures:

To measure the efficacy of the Single Injection USG guided 4 in 1 nerve block on:

- 1) Visual analog pain score on different intervals of time.
- 2) Earliest need of rescue analgesia in terms of epidural or opioids.
- 3) Earliest time of ambulation.

## 2. Methodology

A prospective observational study was done in Ortho OT of a tertiary care hospital of eastern India. A total of 8 patients were included for the study.

A USG machine with a linear probe, a PNS machine and needle, Inj Bupivacaine 0.5%, Inj Dexmedetomidine, distilled water, and sterile syringes were used.

## 3. Procedure

Prior to the procedure, informed consent was obtained from each patient.

An USG - guided 4in1 block was performed on 8 consenting ASA 1 and 2 patients scheduled for TKR. An IV line was secured, and essential monitoring equipment was attached. Subsequently, patients received SAB with Inj Bupivacaine Heavy 0.5%, and an epidural catheter was inserted to provide additional analgesia if necessary. Throughout the procedure, patients were positioned supine, with the

ipsilateral leg placed in external rotation, abduction, and knees flexed (Frog leg position).

A linear high - frequency probe (6 - 13Hz) was positioned over the medial condyle of the femur to identify the vastus medialis, which was then scanned proximally. The probe was then moved proximally until the superficial femoral artery became visible at the adductor hiatus. Continuing further proximally, the genicular descending artery branching out from the superficial femoral artery was visualized, marking the injection point.

The nerve to the vastus medialis was targeted using PNS, confirmed by observing twitching of the vastus medialis muscle with 5ml of a mixture containing Inj Bupivacaine 0.25% and Inj Dexmedetomidine (1mcg/kg). The needle was guided laterally to medially in - plane with the perivascular region, and 35ml of the aforementioned mixture was administered, ensuring visualization of the superficial femoral artery being pushed.

## 4. Results

**Table 1:** Patient details & Pain score post TKR surgery

Patient details		Pain score at end of -				Ambulation period (in hours)	Rescue Analgesia
Age (in years)	Gender	4 Hours	8 Hours	12 Hours	24 Hours		
64	Male	0	0	1	4	10hr	No
55	Female	0	0	2	5	11hr	No
62	Female	0	1	3	4	10hr	No
56	Male	0	0	1	4	9hr	No
50	Male	0	0	1	4	9hr	No
46	Female	0	0	2	5	12hr	No
54	Male	0	1	1	4	9hr	No
62	Male	0	0	1	3	8hr	No

After 24 hours, patients reported a pain score of 5 or less, warranting the initiation of IV analgesics in the form of Inj Paracetamol (15mg/kg). None of the patients necessitated rescue analgesia via the epidural catheter or opioids. Furthermore, patients achieved a minimum ambulation time of 8 hours, with some reaching a maximum ambulation time of 12 hours.

## 5. Discussion

Peripheral nerve blocks have emerged as a preferred choice over central neuraxial blocks, such as epidural analgesia, due to their demonstrated superiority in postoperative analgesia. (9) Studies indicate that peripheral nerve blocks not only enhance pain control but also mitigate adverse effects like urinary retention and hypotension, leading to improved patient satisfaction and rehabilitation, particularly in knee and below knee surgeries. (10, 11, 12)

While epidural analgesia has long been regarded as the gold standard for postoperative pain management in lower limb surgeries, various nerve blocks have demonstrated comparable analgesic efficacy with fewer side effects.

Research by Pharm et al. highlights that a combination of femoral and sciatic nerve blocks significantly reduces postoperative opioid requirements. (13) Additionally, the adductor canal block has shown superiority over femoral

nerve block in providing analgesia, while also preserving quadriceps strength.

Combining an Adductor canal block and Sciatic nerve block has been shown to yield superior outcomes compared to administering each block individually. However, due to the differing patient positions required for these blocks, combining them was previously deemed impractical.

To address this challenge, Roy et al. proposed a feasible solution in the form of a single USG - guided injection 4 - in - 1 block. This innovative approach was employed to evaluate the efficacy of these blocks for postoperative analgesia in patients undergoing TKR. (14)

Once the nerve to the vastus medialis (NVM) is identified using PNS, it is blocked, and the needle is advanced in - plane to the perivascular space for drug injection. Subsequently, the drug disperses proximally into the adductor canal and distally into the popliteal fossa, effectively blocking the other three nerves involved.

The USG - guided single injection technique offers several advantages, making it safer and more feasible for patients. Firstly, its single injection method enhances patient compliance by simplifying the procedure. Additionally, it reduces time to ambulation and provides a prolonged period of postoperative analgesia, thereby minimizing the need for

rescue analgesia such as epidural boluses. This reduction in rescue interventions contributes to lowering complications associated with central neuraxial blockade, such as hypotension, shivering, bladder distension, and paralytic ileus.

Moreover, the technique decreases the requirement for opioid analgesics, which subsequently lowers the risk of opioid - related respiratory depression, reduced intestinal motility, nausea, vomiting, urinary retention, and prolonged dependence. By minimizing the reliance on opioids, the USG - guided single injection approach enhances patient safety and comfort throughout the postoperative period.

## 6. Conclusion

Through this observational study, we evaluated the effectiveness of the USG - guided 4in1 block in 8 patients undergoing TKR. Our findings suggest that this approach offers effective postoperative analgesia, promoting a comfortable and early ambulation during the recovery period without the need for opioids.

While our results are promising, we acknowledge the need for further extensive studies to validate these findings and explore potential refinements or enhancements to the technique. Such research can provide additional insights into the long - term efficacy, safety, and broader applicability of the USG - guided 4in1 block in orthopedic surgical settings.

## References

- [1] Rodgers A, Walker, Schug S, McKee A, Kehlet H, van Zundert A, et al. . Reduction of postoperative mortality and morbidity with epidural or spinal anaesthesia: results from overview of randomised trials. *BMJ*.2000; 321 (7275): 1493. [PubMed]
- [2] Cousins M, Bridenbaugh P, eds. *Neural blockade in clinical anesthesia and management of pain*. 2nd ed. Philadelphia: J B Lippincott, 1988.
- [3] Kehlet H Modification of responses to surgery by neural blockade: clinical implications. In: Cousins M, Bridenbaugh P, eds. *Neural blockade in clinical anesthesia and management of pain*. 2nd ed. Philadelphia: J B Lippincott, 1988; 145 - 88.
- [4] Bauer MC, Pogatzki - Zahn EM, Zahn PK. Regional analgesia techniques for total knee replacement. *Curr Opin Anaesthesiol*.2014; 27 (5): 501-6. doi: 10.1097/ACO.000000000000115. [PubMed]
- [5] Kadic L, Boonstra MC, DE Waal Malefijt MC, Lako SJ, VAN Egmond J, Driessen JJ. Continuous femoral nerve block after total knee arthroplasty? *Acta Anaesthesiol Scand*.2009; 53 (7): 914-20. doi: 10.1111/j.1399 - 6576.2009.01965. [PubMed]
- [6] Abdallah FW, Whelan DB, Chan VW, Prasad GA, Edersby RV, Theodoropolous J, et al. Adductor Canal Block Provides Non - inferior Analgesia and Superior Quadriceps Strength Compared with Femoral Nerve Block in Anterior Cruciate Ligament Reconstruction. *Anesthesiology*.2016; 124: 1053 - 64. doi: 10.1097/ALN.0000000000001045. [PubMed]
- [7] Burckett St Laurant D, Peng P, Giron Arango et al. The nerves of adductor canal and innervations of the

- knee: *Anatomic study. Reg Anesth pin med*.2016; 41 (3): 321 - 7. doi: 10.1097/AAP.000000000000389 [PubMed]
- [8] Dello AL (2014) Partial knee joint Denervation for Knee pain: a review. *Orthop Muscul syst* 3: 167 [PubMed]
- [9] Enneking FK, Wedel DJ. The art and science of peripheral nerve blocks. *Anesth Analg*.2000; 90 (1): 1 - 2 [PubMed]
- [10] Capdevila X, Barthelet Y, Biboulet P. Effects of perioperative analgesic technique on the surgical outcome and duration of rehabilitation after major knee surgery. *Anesthesiology*.1999; 91 (1): 8 - 15 [PubMed]
- [11] Singelyn FJ, Deyaert M, Jorist D et al. Effects of intravenous patient - controlled analgesia with morphine, continuous epidural analgesia and continuous three - in - one block on post operative pain and knee rehabilitation after unilateral total knee arthroplasty. *Anesth Analg*.1998; 87 (1): 88 - 92 [PubMed]
- [12] Ganapathy S, Wasserman RA, Watson JT et al. Modified continuous femoral three - in - one block for post operative pain after total knee arthroplasty *Anesth Analg*.1999; 89 (5): 1197 - 202 [PubMed]
- [13] Pham Dang C, Gautheron E, Guilley J et al. The value of adding sciatic block to continuous femoral block for analgesia after total knee replacement. *Reg Anesth Pain Med*.2005; 30 (2): 128 - 33. [PubMed]
- [14] Ritesh Roy, Gaurav Agrawal et al. Ultrasound guided 4 in 1 block, single injection technique for complete postoperative analgesia for knee and below knee surgeries; *Anaesthesia Pain and intensive care*; Vol 22 (1) Jan - March 2018.