Original Research Article

Comparative study of adductor canal block versus femoral nerve block for effect on quadriceps muscle strength and postoperative pain in the patients undergoing Total knee replacement surgery

Karri Laxmi Priyanka[1*], Abhiram Nakka[2]

[1]Assistant Professor, [2]Senior Resident, Anaesthesiology, Kamineni Academy of Medical Sciences and Research Centre, LB Nagar, Hyderabad, INDIA.
Email: priyacheez@gmail.com, abhirammikki@gmail.com

Abstract

Background: Total knee replacement (TKR) patients experience severe pain during the early postoperative period[1] as it involves extensive bone resection and soft tissue manipulation. The objective of this prospective, randomized, comparative study is therefore to compare the adductor canal block (ACB) with femoral nerve block (FNB) on quadriceps muscle strength preservation and analgesic efficacy in the patients undergoing TKR. **Material and Methods:** Present study conducted in ppatients of age group 35-70 years, ASA physical status class I, II and III patients posted for unilateral TKR. 50 ppatients were randomized equally by block randomization technique. Group 1 received Adductor Canal Block (15 ml bolus of 0.18% ropivacaine followed by infusion at the rate of 8-10ml/hr), Group 2 received Femoral Nerve Block (15 ml bolus of 0.18% ropivacaine followed by infusion at the rate of 8-10ml/hr) with electromechanical infusion pump for 24 Hours. **Results:** Gender, BMI distribution between two groups doesn't have significant difference. Out of 50 patients in our study 19.6% (9) patients were ASA I, 75% (39) were ASA II and 5.4% (2) patients were ASA III. Heart rate, systolic blood pressure and diastolic blood pressure were measured preoperatively, post-operative at 6-8 hrs, at 12 hrs. and at 24 hrs. The difference in those parameters at any given time was not statistically significant. ACB is similar to FNB with respect to quadriceps muscle strength measured by MRC grading at 6 hours. However ACB is very effective in preserving the quadriceps muscle strength measured by MRC grading at 12 and 24 hours with a statistically significant 'P' value of 0.0001. **Conclusion** Adductor canal block makes early rehabilitation after total knee replacement without the risk of inpatient falls.

Keywords: adductor canal block, femoral nerve block, postoperative analgesia, total knee replacement

***Address for Correspondence:**
Dr Karri Laxmi Priyanka, Assistant Professor, 2Senior Resident, Anaesthesiology, Kamineni Academy of Medical Sciences and Research Centre, LB Nagar, Hyderabad, INDIA.
Email: priyacheez@gmail.com

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INTRODUCTION

Total knee replacement (TKR) patients experience severe pain during the early postoperative period[1] as it involves extensive bone resection and soft tissue manipulation. The postoperative analgesic regimen should aim to reduce morbidity along with enhancing functional recovery as well as provide efficient analgesia with minimal side effects.[2] Amount of pain relief obtained plays a significant factor in the outcome of the surgery as it determines the

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time for ambulation and duration of hospital stay. It also has a major influence on the patient's ability to resume their normal daily activities.[3] Various approaches to the performance of peripheral nerve blocks for postoperative pain control in patients undergoing TKR have been described in the literature; this includes the lumbar plexus block, the femoral nerve block, with or without a concomitant sciatic nerve block and the saphenous nerve block.[4-6] Given excellent pain relief and the opioid sparing effect, femoral nerve block (FNB) is commonly used as an analgesic modality and is considered the standard peripheral nerve block in patients undergoing TKR. However, FNB is followed by a significant decrease in quadriceps muscle strength, resulting in delayed mobilization which is associated with the potential risk of fall.[7,8] In this context, increasing evidence supports the use of an adductor canal block (ACB) that offers almost pure sensory block with minimal motor involvement as part of a multimodal approach to pain control after TKR.[9] However, studies comparing ACB to FNB in terms of analgesic efficacy and functional recovery in patients undergoing TKR remain limited. The objective of this prospective, randomized, comparative study is therefore to compare the ACB with FNB on quadriceps muscle strength preservation and analgesic efficacy in the patients undergoing TKR.

MATERIAL AND METHODS

Present study was prospective randomized comparative study, conducted in Kamineni hospitals, lb nagar, Hyderabad. Study duration was 1 year (May 2018 - May 2019). After obtaining the Institutional ethics committee approval, written informed consent was obtained from all the patients involved in the study.

INCLUSION CRITERIA:

- Patients of age group 35-70 years, ASA physical status class I, II and III patients posted for unilateral TKR

EXCLUSION CRITERIA:

- Patients with ASA physical status class IV
- Patients with history of psychiatric illness, prior femur surgeries
- Patients with BMI >35 kg/m2
- Patients who refuse for the nerve blocks or spinal anaesthesia
- Patients with history of local anaesthetic allergy, coagulation disorders

Patients posted for total knee replacement surgery, during their pre-anaesthetic checkup (PAC), were explained about all the modalities of anaesthesia and analgesia feasible to them and a informed written consent was taken from patients who are willing to participate. All patients were instructed preoperatively on the use of medical research council (MRC) grading for assessment of quadriceps muscle strength, visual analogue scale (VAS) for the measurement of post-operative pain and to request supplementary analgesics if needed.

Patient's demographic data such as name, age, sex, weight, height, ASA physical status classification, any co-morbid illnesses (diabetes mellitus, hypertension, prior surgical and anaesthetic experience) was noted. During general examination, patient's general condition was assessed; weight, height and BMI, pulse rate and non-invasive blood pressure were measured and documented. A detailed assessment of airway and all the systems was carried out and documented. Basic laboratory data were reviewed and documented. After identifying and shifting the patient to operation theatre, standard monitors (ECG, non-invasive blood pressure, pulse oximeter probe) were attached and recordings noted down. Subarachnoid block was performed and 15 mg 0.5% bupivacaine heavy was administered intrathecal in L3-L4 or L4-L5 intervertebral space using 25 gauze Quincke spinal needle. Intraoperative vitals monitoring was standardized for all the patients. Patients in both the groups received posterior capsular infiltration by surgeons during the surgery before placing the implants. All the patients were shifted to post anaesthesia care unit (PACU) and were monitored until the resolution of subarachnoid blockade. After the resolution of subarachnoid blockade, experienced anaesthetist performed the ultrasound guided ACB/ FNB according to the group number named in the sealed envelope. Patients were sedated with 1 to 2mg midazolam ± 50mcg fentanyl during the procedure.

Patients were randomized equally by block randomization technique.

Group 1 received Adductor Canal Block (15 ml bolus of 0.18% ropivacaine followed by infusion at the rate of 8-10ml/hr)

Group 2 received Femoral Nerve Block (15 ml bolus of 0.18% ropivacaine followed by infusion at the rate of 8-10ml/hr)with electromechanical infusion pump for 24 Hours. The primary outcome we observed was quadriceps muscle strength recorded by MRC grading. The secondary outcomes measured were post-operative analgesia recorded by VAS scores and requirements of additional analgesic drug. The time of performing the block in PACU was taken as 0 hour and both the primary and secondary outcomes were measured at 6-8hrs, 12hrs and 24hrs along with haemodynamic monitoring. Data analysis was carried out by SPSS version 25.0. All the continuous variables were expressed as mean ± standard deviation, otherwise median (inter quartile range). All the categorical variables were expressed either as percentage or proportions. Comparison of normally distributed, continuous variables was done by independent sample 't' test. Comparison of

categorical variables was done by either Chi-Square test or Fisher's-Exact test. Comparison of non-normally distributed continuous variables was done by Mann Whitney 'U' test. All P values <0.05 were considered as statistically significant.

RESULTS

Out of 50 patients enrolled in our study 25% (12) were male and 75% (38) were female. Out of 25 patients in ACB group 25% (6) patients were male and 75% (19) patients were female and out of 25 patients in FNB group 25% (7) patients were male and 75% (18) patients were female. Sex distribution between two groups doesn't have significant difference (P=1.000). Out of 25 patients receiving ACB, 18 patients were having BMI between 25.0-29.9 kg/m^2, 7 patients were between 30.0-34.9 Kg/m^2 and none of the patients were between 18.5-24.9 Kg/m^2. Out of 25 patients receiving FNB, 16 patients were between 25.0-29.9 kg/m^2, 9 patients were between 30.0-34.9 kg/m^2 and one of the patient was between 18.5-24.9 kg/m^2. BMI distribution between two groups doesn't have significant difference (P=0.481).

Table 1: General characteristics.

	Group		Total
	Adductor Canal Block	Femoral Nerve Block	
Gender			
Male	6	19	25
Female	7	18	25
BMI			
Normal weight	0	1	1
Overweight	19	14	33
Obesity	7	9	16

Out of 50 patients enrolled in our study 44.6% (22) patients underwent left side total knee replacement and 55.4% (28) patients underwent right side total knee replacement. Out of 50 patients in our study 19.6% (9) patients were ASA I, 75% (39) were ASA II and 5.4% (2) patients were ASA III.

Table 2: Frequency table showing distribution of ASA grade.

ASA physical status	Frequency	Percent
ASA I	9	19.6
ASA II	39	75.0
ASA III	2	5.4

Heart rate, systolic blood pressure and diastolic blood pressure were measured preoperatively, post-operative at 6-8 hrs., at 12 hrs. and at 24 hrs. The difference in those parameters at any given time was not statistically significant.

ACB is similar to FNB with respect to quadriceps muscle strength measured by MRC grading at 6 hours. However ACB is very effective in preserving the quadriceps muscle strength measured by MRC grading at 12 and 24 hours with a statistically significant 'P' value of 0.0001.

Table 3: Variations in MRC grading between two groups

ASA physical status	Frequency		P Value (Unpaird t-test)
6Hrs - 8 Hrs.	1.85 ± 0.368	1.54 ± 0.509	0.019
12 Hrs.	2.85 ± 0.368	2.21 ± 0.415	<0.001
24 Hrs.	3.42 ± 0.504	2.5 ± 0.511	<0.001

ACB is comparable to FNB with respect to post-operative analgesia measured by VAS scores at 6-8, 12 and 24 hours after giving the ultrasound guided block.

Table 4: Variations in VAS scores between two groups at different time points

VAS	Group		P Value
	Adductor Canal Block	Femoral Nerve Block	(Unpaired t-test)
6Hrs - 8 Hrs	2.5 ± 0.812	2.67 ± 0.816	0.473
12 Hrs	2.35 ± 0.629	2.67 ± 0.637	0.08
24 Hrs	2.27 ± 0.874	2.33 ± 0.816	0.79

The difference between two groups for the requirement of additional analgesics at 6-8 hrs., 12 hrs, and 24 hours was not statistically significant.

Table 5: Additional analgesic requirements at 8 hours.

Additional Analgesic Requirements	Group		Total	
	Adductor Canal Block	Femoral Nerve Block		P value
6-8hrs	3	2	5	0.706
12hrs	1	2	3	0.504
24hrs	2	1	3	0.6

DISCUSSION

Adequate post-operative analgesia is very essential for the patients undergoing total knee replacement surgery. The ideal analgesia for TKR should provide strong pain control, limited side effects, with minimal effect on motor power facilitating early postoperative mobilization, balance, and rehabilitation. A clear benefit of regional analgesia/anesthesia (epidural and peripheral nerve blocks) over general anesthesia and/or systemic analgesia has been demonstrated in reducing postoperative pain. Femoral nerve block is successful in achieving the post-operative analgesic requirements after TKR and is considered as a superior analgesic technique compared to epidural analgesia in avoiding epidural analgesia related side effects. However there is an increased incidence of falls associated with the femoral nerve block due to quadriceps weakness. To alleviate this risk of inpatient falls, anesthetists are inclining towards adductor canal block which predominantly produces sensory block and preserves the quadriceps muscle strength. Most important finding of our study is, ACB preserved quadriceps muscle strength better than FNB, with no major differences in pain scores or additional analgesic requirements. As quadriceps muscle strength is greatly reduced (60%–83%) after TKR[10], effective analgesic procedure preserving muscle strength is warranted. The implication of quadriceps weakness is reflected on the ambulation tests, where subjects performed significantly better with an ACB than with FNB[11]. Shah, *et al.*,[12] in their randomized controlled study, compared the efficacy of continuous ACB versus single shot ACB for TKR patients and observed that continuous ACB provides superior analgesia as postoperative VAS score was significantly better at all times in continuous than single shot technique (P <0.001). Jaeger, *et al.*,[13] compared ACB and FNB with respect to post-operative analgesia and quadriceps muscle strength for patients undergoing TKR. Patients in both the groups in their study received ultrasound guided blocks with an initial bolus of 30ml of 0.5% ropivacaine followed by continuous infusion of 0.2% ropivacaine at 8 ml per hour. We observed that even with lesser doses of local anaesthetic drug (0.18% ropivacaine bolus of 15ml followed by infusion at the rate of 8-10 ml per hour) analgesia achieved was similar to their study in terms of VAS scores. Several studies validated ACB as an effective analgesic method, but most studied arthroscopic knee surgery[14,15]. Our study compared ACB with FNB in patients undergoing TKR, a more painful procedure that requires optimal pain relief to hasten mobilization. Jenstrup, *et al.*,[16] demonstrated effectiveness of the ACB on pain and ambulation after TKR, compared with placebo. Strength was not objectively measured and their study involved a high dose of local anesthetic (30ml of 0.75% ropivacaine, 225mg). This large volume of local anesthetic could cause quadriceps weakness from proximal spread. In our study, we used a lower dose of local anesthetic drug (15ml of 0.18% ropivacaine, 27mg as a bolus followed by continuous infusion of the same drug at 8-10ml per hour, 14.4-18 mg/hour) and directly compared ACB with FNB with respect to quadriceps muscle strength and post-operative analgesia. At 12 and 24hrs following the block, quadriceps muscle strength for patients receiving ACB was significantly higher compared with patients receiving FNB. One explanation could be that, lesser volumes of local anaesthetic agent (ropivacaine) limited the proximal spread of drug. In our study, we measured our outcomes only till 24 hours after giving the blocks, because; the duration of action of posterior capsular infiltration[17,18,19] is unpredictable (from 24 hours to 1 week). Considering the minimum duration of action we limited our study to 24 hours. There were no fall episodes in our study population, but peripheral nerve blocks involving the femoral nerve are associated with the risk of falling postoperatively[11] which might be avoided with the ACB. However, given the small sample size of this study (n = 50), it would be difficult to assess fall risk reduction. The incidence of postoperative nausea and vomiting was less in both groups. The effective postoperative blockade of both groups minimized the use of oral opioids and thus limited their notable side effects of nausea and vomiting. Our study proved that adductor canal block is an excellent alternative to femoral nerve block in preserving the quadriceps muscle strength and providing adequate analgesia comparable to femoral nerve block, thereby increasing the patient's ability to participate in the rehabilitation activities and hence facilitates early functional recovery. The increased requirements in effective post-operative pain management for early rehabilitation following total knee replacement surgery, it can be concluded that adductor canal block is an effective alternative to femoral nerve block for less quadriceps weakness, comparable levels of analgesia and faster recovery that leads to decreased morbidity.

CONCLUSION

Adductor canal block provides excellent post-operative analgesia comparable to femoral nerve block. Quadriceps muscle strength is more preserved in adductor canal block when compared to femoral nerve block facilitating the patient for early post-operative mobilization. Adductor canal block makes early rehabilitation after total knee replacement without the risk of inpatient falls.

REFERENCES

1. Ventham NT, Hughes M, O'neill S, Johns N, Brady RR, Wigmore SJ. Systematic review and meta-analysis of continuous local anaesthetic wound infiltration versus epidural analgesia for postoperative pain following abdominal surgery. Br J Surg. 2013 Sep 1;100(10):1280-9.
2. Lundblad H, Kreicbergs A, Jansson KÅ. Prediction of persistent pain after total knee replacement for osteoarthritis. JBJS (Br). 2008 Feb 1;90(2):166-71.
3. Maheshwari AV, Blum YC, Shekhar L, Ranawat AS, Ranawat CS. Multimodal Pain Management after Total Hip and Knee Arthroplasty at the Ranawat Orthopaedic Center. Clin Orthop Relat Res. 2009 Jun; 467(6): 1418–23.
4. Danninger T, Opperer M, Memtsoudis SG. Perioperative pain control after total knee arthroplasty: An evidence based review of the role of peripheral nerve blocks. World J Orthop. 2014 Jul 18;5(3):225-32.
5. Paul JE, Arya A, Hurlburt L, Cheng J, Thabane L, Tidy A, *et al.* Femoral Nerve Block Improves Analgesia Outcomes after Total Knee ArthroplastyA Meta-analysis of Randomized Controlled Trials. Anesthesiology. 2010 Nov 1;113(5):1144-62.
6. Moore DM, O'Gara A, Duggan M. Continuous saphenous nerve block for total knee arthroplasty: when and how? Reg Anesth Pain Med. 2013 Jul-Aug;38(4):370-1.
7. Johnson RL, Kopp SL, Hebl JR, Erwin PJ, Mantilla CB. Falls and major orthopaedic surgery with peripheral nerve blockade: a systematic review and meta-analysis. Br J Anaesth. 2013 Apr;110(4):518-28.
8. Thomas AC, Stevens-Lapsley JE. Importance of Attenuating Quadriceps Activation Deficits after Total Knee Arthroplasty. Exercise and Sport Sciences Reviews. 2012;40(2):95-101.
9. Lund J, Jenstrup MT, Jaeger P, Sorensen AM, Dahl JB. Continuous adductor-canal-blockade for adjuvant post-operative analgesia after major knee surgery: preliminary results. Acta Anaesthesiol Scand. 2011 Jan;55(1):14-9.
10. Mizner RL, Petterson SC, Snyder-Mackler L. Quadriceps strength and the time course of functional recovery after total knee arthroplasty. J Orthop Sports Phys Ther. 2005 Jul;35(7):424-36
11. Ilfeld BM, Duke KB, Donohue MC. The association between lower extremity continuous peripheral nerve blocks and patient falls after knee and hip arthroplasty. Anesth Analg. 2010 Dec;111(6):1552-4.
12. Shah NA, Jain NP, Panchal KA. Adductor canal blockade following total knee arthroplasty—continuous or single shot technique? Role in postoperative analgesia, ambulation ability and early functional recovery: a randomized controlled trial. J Arthroplasty. 2015 Aug 31;30(8):1476-81.
13. Jaeger P, Zaric D, Fomsgaard JS, Hilsted KL, Bjerregaard J, Gyrn J, *et al.* Adductor canal block versus femoral nerve block for analgesia after total knee arthroplasty: a randomized, double-blind study. Reg Anesth Pain Med. 2013 Nov-Dec;38(6):526-32.
14. Abdallah FW, Whelan DB, Chan VW, Prasad GA, Endersby RV, Theodoropolous J, *et al.* Adductor canal block provides noninferior analgesia and superior quadriceps strength compared with femoral nerve block in anterior cruciate ligament reconstruction. Anesthesiology. 2016 May 1;124(5):1053-64.
15. Espelund M, Grevstad U, Jaeger P, Hölmich P, Kjeldsen L, Mathiesen O, *et al.* Adductor canal blockade for moderate to severe pain after arthroscopic knee surgery: a randomized controlled trial. Acta Anaesthesiologica Scandinavica. 2014 Nov 1;58(10):1220-7.
16. Jenstrup MT, Jæger P, Lund J, Fomsgaard JS, Bache S, Mathiesen O, *et al.* Effects of adductor-canal-blockade on pain and ambulation after total knee arthroplasty: a randomized study. Acta Anaesthesiol Scand. 2012 Mar;56(3):357-64.
17. Teng Y, Jiang J, Chen S, Zhao L, Cui Z, Khan MS, *et al.* Periarticular multimodal drug injection in total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc. 2014 Aug;22(8):1949-57.
18. Essving P, Axelsson K, Kjellberg J, Wallgren Ö, Gupta A, Lundin A. Reduced morphine consumption and pain intensity with local infiltration analgesia (LIA) following total knee arthroplasty: a randomized double-blind study involving 48 patients. Acta orthopaedica. 2010 Jun 1;81(3):354-60.
19. Fu P, Wu Y, Wu H, Li X, Qian Q, Zhu Y. Efficacy of intra-articular cocktail analgesic injection in total knee arthroplasty—a randomized controlled trial. Knee. 2009 Aug 31;16(4):280-4.

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