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Study of Femoral Nerve Block Versus Adductor Canal Block for Analgesia after Total Knee Arthroplasty

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ABSTRACT

Total knee arthroplasty (TKA) or total knee replacement (TKR) is a common orthopedic procedure and is the gold standard treatment for patients with end-stage knee osteoarthritis who have not responded to other treatments. Present study was aimed to study femoral nerve block versus adductor canal block for analgesia after total knee arthroplasty. Present study was prospective, comparative study, conducted in patients of age group 50-70 years, either gender, ASA physical status class I, II and III patients, posted for unilateral TKA. In present study, 60 patients were randomly allocated into group A (n = 30, received adductor canal block) and group B (n = 30, received femoral nerve block). Group A and B had comparable quadriceps muscle strength measured by MRC grading at 6 hrs (1.91±0.68 vs. 1.89±0.59) and no statistically significant difference was noted. Group A had better quadriceps muscle strength than group B at 12 hrs (2.88±0.45 vs. 2.13±0.64) and at 24 hrs (3.34±0.67 vs. 2.65±0.81), difference was statistically significant ($p<0.001$). Post-operative analgesia measured by VAS scores at baseline (3.7±1.1 vs. 3.6±0.9), after giving the ultrasound guided block at 6 hrs (2.7±0.8 vs. 2.6±0.9), 12 hrs (2.5±0.6 vs. 2.4±0.7) and 24 hrs (2.2±0.7 vs. 2.3±0.6) were comparable between both groups and no statistically significant difference was noted among them. Adductor canal block (ACB) preserved quadriceps muscle strength better than femoral nerve block (FNB), without a significant difference in postoperative analgesia after total knee arthroplasty surgeries.

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Key Words

Adductor canal block, femoral nerve block, total knee arthroplasty, quadriceps

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INTRODUCTION

Total knee arthroplasty (TKA) or total knee replacement (TKR) is a common orthopedic procedure and is the gold standard treatment for patients with end-stage knee osteoarthritis who have not responded to other treatments. TKA is associated with severe postoperative pain and effective postoperative analgesia after TKA remains a challenge. The incidence of moderate to severe pain after TKA is reported to be about 50% and it can contribute to immobility related complications, delay in hospital discharge and may interfere with functional outcome[1].

Effective pain management is essential, as it directly affects the patient's pace of rehabilitation and recovery. Therefore, postoperative pain management is essential for functional recovery and patient satisfaction. Careful planning to mitigate pain helps in early ambulation and physiotherapy, shortening hospital stays, earlier home discharges and better patient satisfaction which reduces the burden on healthcare facilities[2].

Regional analgesia has been introduced successfully into the postoperative pain management after total knee arthroplasty, reducing pain scores, opioid use and adverse effects[3].

An ideal peripheral nerve block (PNB) must provide effective analgesia without motor blockade to facilitate early mobilization and associated with minimum opioid consumption[4,5]. Femoral nerve block (FNB) has excellent postoperative analgesia and is now a commonly used analgesic modality for TKA pain control. However, FNB leads to quadriceps muscle weakness, which impairs early mobilization and increases the risk of postoperative falls[6]. Present study was aimed to study femoral nerve block versus adductor canal block for analgesia after total knee arthroplasty.

MATERIALS AND METHODS

Present study was prospective, comparative study, conducted in department of anaesthesiology and critical at Gmers medical college and hospital-Gotri, Vadodara, Gujarat, India. Study duration was of 2 years (January 2021 to December 2022). Study approval was obtained from institutional ethical committee.

Inclusion criteria:

- Patients of age group 50-70 years, either gender, ASA physical status class I, II and III patients, posted for unilateral TKA, willing to participate in present study

Exclusion criteria:

- Patients with history of psychiatric illness, prior femur surgeries
- Patients with BMI >35 kg m^{-2}
- Patients who refuse for the nerve blocks or spinal anaesthesia
- Patients with history of local anaesthetic allergy, coagulation disorders

Study was explained to patients in local language and written consent was taken for participation and study. Patient's demographic data (age, sex), any co-morbid illnesses (diabetes mellitus, hypertension, prior surgical and anaesthetic experience), laboratory reports, examination findings (pulse rate, noninvasive blood pressure, gait), detailed assessment of airway and all the systems, anthropometry (weight, height and BMI) and ASA physical status classification were noted in case record proforma.

During pre-anaesthetic checkup (PAC), patients were explained about all the modalities of anaesthesia, post-operative analgesia and procedure of peripheral nerve block (PNB). 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.

All patients who fulfilled the inclusion criteria were enrolled and randomised using computer generated chart with allocation ratio of 1:1 into either of the two groups:

- Group A received adductor canal block (15 mL bolus of 0.5% ropivacaine +2 mg dexamethasone) deposited around the saphenous nerve
- Group B received femoral nerve block (15 mL bolus of 0.5% ropivacaine +2 mg dexamethasone) deposited around the femoral nerve

After 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, under sedation with 1-2 mg midazolam ±50 mcg fentanyl.

Outcome observed were quadriceps muscle strength (by MRC grading) and post-operative analgesia (by VAS scores) and requirements of additional analgesic drug if any. The time of performing the block in PACU was taken as 0 hr and outcomes were measured at 6, 12 and 24 hrs along with haemodynamic monitoring.

Data was collected and compiled using microsoft excel, analysed using SPSS 23.0 version. Frequency, percentage, means and standard deviations (SD) was calculated for the continuous variables, while ratios and proportions were calculated for the categorical variables. Difference of proportions between qualitative variables were tested using chi-square test or Fisher exact test as applicable. $p<0.05$ was considered as statistically significant.

RESULTS

In present study, 60 patients were randomly allocated into group A (n = 30, received adductor canal block) and group B (n = 30, received femoral nerve block). Age (years), weight (kg), BMI (kg m^{-2}), gender (male/female), ASA grade (I/II/III), duration of surgery and blood loss were comparable between both groups and no statistically significant difference was noted among them (Table 1).

In present study, group A and B both had comparable quadriceps muscle strength measured by MRC grading at 6 hrs (1.91±0.68 vs. 1.89±0.59) and no statistically significant difference was noted. Group A had better quadriceps muscle strength than group B at 12 hrs (2.88±0.45 vs. 2.13±0.64) and at 24 hrs (3.34±0.67 vs. 2.65±0.81), difference was statistically significant ($p<0.001$) (Table 2).

Post-operative analgesia measured by VAS scores at baseline (3.7±1.1 vs 3.6±0.9), after giving the ultrasound guided block at 6 hrs (2.7±0.8 vs 2.6±0.9), 12 hrs (2.5±0.6 vs 2.4±0.7) and 24 hrs (2.2±0.7 vs 2.3±0.6) were comparable between both groups and no statistically significant difference was noted among them (Table 3).

Table: 1 General characteristics

General characteristics	Group A (n = 30)	Group B (n = 30)	p-value
Age (years)	63.60±6.08	63.52±7.71	0.65
Weight (kg)	69.1±10.5	67.9±8.7	0.72
BMI (kg m^{-2})	23.4±3.1	24.1±2.9	0.75
Gender (M/F)	17/13	16/14	0.81
ASA I/II/III	12/13/5	11/13/6	0.59
Duration of surgery (min)	118.1±32.9	121.5±34.7	0.66
Blood loss (mL)	82.1±26.2	78.5±25.1	0.74

Table 2: MRC grading

	MRC grade		
Post block duration (hrs)	Group A (Adductor canal block) (Mean±SD)	Group B (Femoral nerve block) (Mean±SD)	p-value
6	1.91±0.68	1.89±0.59	0.69
12	2.88±0.45	2.13±0.64	<0.001
24	3.34±0.67	2.65±0.81	<0.001

Table 3: Post-operative analgesia by VAS score

	MRC grade		
Post block duration	Group A (Mean±SD)	Group B (Mean±SD)	p-value
Baseline	3.7±1.1	3.6±0.9	0.72
6 hrs	2.7±0.8	2.6±0.9	0.27
12 hrs	2.5±0.6	2.4±0.7	0.08
24 hrs	2.2±0.7	2.3±0.6	0.59

DISCUSSIONS

Pain management regimens post TKR include oral analgesics, periarticular injection, peripheral nerve blocks (PNBs) and intravenous patient-controlled analgesia. Infiltration techniques may have equivalent analgesic effect than epidural analgesia and peripheral nerve blocks, however there should be awareness of dose dependent toxicity[4].

Epidural analgesia is highly effective and available for postoperative management of acute pain but indwelling epidural catheters entail risks of infection and bleeding as well as complications such as urinary retention and hypotension[7]. Perioperative multimodal analgesia, mainly peripheral nerve block is currently advocated for postoperative analgesia after TKA[8].

Peripheral nerve blocks, including the adductor canal block (ACB) and femoral nerve block (FNB) are broadly accepted as part of a multimodal pain relief protocol in patients undergoing total knee arthroplasty owing to their effectiveness in reducing postoperative opioid application and preserving lower limb motion[9]. PNBs are considered to be an essential part of the current multimodal pain management protocol following knee arthroplasty (KA) as they provide effective and synergistic pain relief[10].

When compared with FNB, ACB has been reported to be associated with similar pain scores and better quadriceps strength postoperatively ensuring better ambulation after TKA[6]. In this context, emerging evidence suggests that adductor canal block (ACB) facilitates postoperative rehabilitation compared with FNB because it primarily provides a sensory nerve block with sparing of quadriceps strength.

A systematic literature review noted that, TKA patients who received ACB, however have better quadriceps strength and consequently are less prone to falls. Patients receiving ACB can be mobilized early and have lower hospital LOS. Mobilization and ambulation, which are both critical for recovery after TKA are both inhibited less by ACB. Although ACB and FNB provide equal analgesia at rest, these findings suggest that ACB may be a preferred option for postoperative analgesia after TKA[11].

Siddiqui *et al*.[12] noted that during the postoperative period, patients in the ACB group could perform all TUG tests significantly faster than those in the FNB group. The mean get-up time in the ACB group was 39.08±5.53 sec whereas that in the FNB group was 44.92±7.10 sec ($p<0.01$). The 3-m walk time was 123.16±15.90 sec in the ACB group and 134.68±13.13 sec in the FNB group ($p<0.01$). The 10-m walk time was 221.24±18.82 sec in the ACB group and 245.24±21.68 sec in the FNB group ($p<0.001$). No significant difference was observed in NRS scores between the groups after the first 24 hrs. The number of opioids available for consumption in both groups was equivalent.

In a study by Gaurav *et al*.[13], mean blood loss was 40.5 mL in group A and 25.7 mL in group B, duration of surgery 84.2 min in group A and 71.3 min in group B, preoperative VAS pain score at rest, mm was 28 in group A and 22 in group B, preoperative VAS pain score at 45 degrees flexion of the knee, mm was 16 in group A and 12 in group B. The quadriceps muscle strength % in group A was 50.2 and in group B was 18.2 and for adductor muscle was 63.1 in group A and 70.6 in group B. A significant difference was observed between both groups ($p<0.05$). Habitual analgesics was paracetamol used by 32% in group A and 14% in group B, weak opioids in 10% in group A and 17% in group B and none 58% in group A and 69% in group B. A significant difference was observed between both groups ($p<0.05$).

ACB can be performed with a high success rate. Anatomical study of adductor canal showed that an adductor canal contained multiple afferent sensory nerves (e.g. saphenous nerve, medial femoral cutaneous and medial retinacular nerve, etc.) but only a single efferent motor nerve (vastus medialis of the quadriceps muscle) that potentially affected motor function. Therefore, ACB may have a minimal effect on quadriceps muscle strength but provides a comparable level of pain relief and early mobilization[14].

Ultrasound imaging is rapidly emerging as a very promising regional anaesthesia tool since the size, depth and precise location of many nerves in their surrounding environment can be determined with correct interpretation of the visual image. The proposed benefits of ultrasound guidance as compared to nerve stimulation for peripheral nerve improved block success rate, reduced block performance time and onset time prolonged duration of blocks and lead to reduction in complications (intravascular injection, local anesthetic toxicity and a failed block)[15-18].

CONCLUSION

Adductor canal block (ACB) preserved quadriceps muscle strength better than femoral nerve block (FNB), without a significant difference in postoperative analgesia after total knee arthroplasty surgeries. Thus, ACB should be preferred for management of postoperative analgesia after total knee arthroplasty surgery. Large sample studies are recommended to confirm present study findings.

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