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Continuous Femoral Nerve Block versus Continuous Adductor Canal Block in Management of Post Operative Pain in Patients Undergoing Unilateral Total Knee Replacement Surgeries. A Comparative Study

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ABSTRACT

Background: Femoral Nerve Block (FNB) and Adductor canal blocks are peripheral nerve blocks for postoperative pain management of TKR. However, FNB leads to quadriceps muscle weakness, which impairs early mobilization and increases the risk of postoperative falls. 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. **Objective:** The current study aims to compare post operative management of pain and risk of falls in patients who underwent TKR using femoral nerve block and adductor canal block.

Methodology: A comparative study was done in 124 patients posted for TKR during February 2022 to December 2022 in a tertiary care teaching hospital. Patients were assigned to either of two groups by sealed envelope method. **Group "FNB"-** bolus of 20 mL of 0.2% ropivacaine was given through femoral catheter. Then infusion of 5ml of 0.2% ropivacaine per hour. **Group "ACB" -** bolus of 20 mL of 0.2% ropivacaine was given through adductor canal catheter. Then infusion of 5ml of 0.2% ropivacaine per hour. Outcomes measured were tinetti score for gait and balance, MMT (manual muscle testing), and pain scores (Visual analogue scale- VAS) before and after physical therapy (PT) sessions.

Results: VAS score in POD2 (48 hrs), POD 7 and POD 14 was slightly low in Group ACB which was significant. Risk of fall was significantly more in patients of group FNB when compared to group ACB at 48 (50%/30.6%) and 72 hours (33.9%/ 16.1%). Mean grade of MMT was significantly more in group ACB when compared to group FNB on POD 1, (2.7/1.7) POD2 (3.2/1.9) and POD3(4.41/4.11).

Conclusion: Continuous ACB provides better ambulation with equivalent analgesia to continuous FNB for TKR patients.

Keywords: Femoral nerve block, adductor canal Block, Tinetti score, Quadriceps strength, MMT testing.

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INTRODUCTION

Total Knee Replacement (TKR) helps relieve pain and restore motion in patients with severe knee Arthritis. But the most common concern associated with TKR is post operative pain which needs early pain relief and pain free postoperative patient care, which is a concern for both the patient and the anaesthetist. An important basis to achieve long term pain relief and functional recovery after the joint surgery involves sufficient peri operative analgesia.[1] Adequate analgesia affects the overall hospital stay and early rehabilitation of the patient after surgery.[2,3]

Post-operative pain is associated with multiple adverse physical and psychological consequences, which hinder postoperative mobilisation, increase the incidence of post-operative complications and potentially influence the overall outcome.[4] Contemporary pain management regimens following TKR include oral analgesics, periarticular injection, peripheral nerve blocks (PNBs), and intravenous patient-controlled analgesia.[5-8] Of the peripheral nerve bocks Femoral nerve block (FNB) was most commonly used.

Recently, FNB is gaining popularity with the increasing use of ultrasound. FNB is found to be enough to provide adequate analgesia after knee surgeries and can be used as a good alternative to central neuraxial blocks.[9] However, FNB leads to quadriceps muscle weakness, which impairs early mobilization and increases the risk of postoperative falls. 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.[10]

The current study aims to compare post operative management of pain and risk of falls in patients who underwent TKR using FNB and ACB.

MATERIAL &METHODS

A comparative study was done in a tertiary care teaching hospital, after obtaining approval from Institutional Ethics Committee. Study was done in patients posted fornTotal knee replacement during February 2022 to December 2022.

Inclusion and Exclusion criteria: Patients between the age range of 20-65 years, • a diagnosis of knee osteoarthritis according to the criteria of the American College of Rheumatology[8]; • an American Society of Anesthesiology (ASA) physical status of I–II[9]; • no intra-articular treatment with any drug during the past 3 months; • no history of prior knee surgery and BMI < 30 were included in the study. Patients with bleeding disorders, infection at the site of block, history of chronic analgesic usage, allergy to local anaesthetics and duration of surgery more than 150 minutes, severe chronic medical diseases or chronic disabling diseases were excluded from the study. Duration of surgery was defined as time taken from incision to skin closure.

For sample size calculation, mean and SD of Visual analogue scale (VAS)[11] of postoperative pain in the study by Priyanka K et al was considered, which were 2.35 (0.629) and 2.67 (0.637) for adductor canal block and femoral nerve block respectively.[12]To get a power of 80% and a confidence interval of 95% using the formula.[13]

$n= (Z\alpha + Z\beta)^2 SD^2 \times 2 / d^2$

Where, Zα=1.96, Zβ=0.84, SD=standard deviation, d=effect size 0.31. From this the sample size (n) needed was found to be 62 in each group.

124 patients who were posted for TKR were selected by purposive sampling method. Patients were assigned to either of two groups by sealed envelope method.

Group "FNB"- bolus of 20 mL of 0.2% ropivacaine was given through femoral catheter. Then infusion of 5ml of 0.2% ropivacaine per hour

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Group "ACB" -bolus of 20 mL of 0.2% ropivacaine was given through adductor canal catheter. Then infusion of 5ml of 0.2% ropivacaine per hour

Method of Study

After obtaining written informed consent, Pre anaesthetic check-up and routine investigations were done.

Preoperatively

- Nil per oral status was confirmed.
- The procedure was explained and the patient was informed to communicate about perception of any pain or discomfort during the surgery which can be recorded using visual analogue scale.
- Patients were premedicated with tab diazepam 10 mg and tab ranitidine 150 mg orally.

Procedure

Intra venous (IV) access was obtained using 18 gauge (G) IV cannula and Lactated Ringer's solution 500 ml was infused intravenously. In the operating room, monitoring procedures, were started to record baseline ECG, PR, BP, RR, and SpO_2 till the end of the surgery.

All patients were operated under spinal anaesthesia without any additional regional anaesthesia technique. TKR was performed through the traditional anterior medial parapatellar approach using a Scorpio non- restrictive geometry posterior- stabilised system (Stryker HowmedicaOsteonics, NJ, USA) fixed with cement without patellar replacement. Duration of surgery and the total intraoperative blood loss, were recorded. After the completion of surgery and before the analgesia of spinal wore off completely, 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.

Fluid therapy was maintained with lactated Ringer's solution (10mL/kg/hr) and vitals monitored. After surgery, FNB and ACB was commenced. Sensory block was assessed and confirmed using pinprick and cold sensation. Tinetti score[13] for gait and balance, MMT, and VAS pain scores before and after physical therapy(PT) sessions were recorded. The MMT was done with patients in the sitting position. The patients were asked to extend their knee against gravity from a flexed position. Grading was from 0 to 5. If the patient was able to extend the knee to full extension against gravity, it was scored 3 of 5. If he or she was able to hold the knee in extension against resistance, the test was scored as 5 of 5. If the patient was unable to generate any contraction, the score was 0 of 5. The grading 0 to 2 of 5 was based on how much patients were able to move a limb (gravity eliminated) throughout the range of motion. When VAS score was > 4 tramadol 50mg IV was given.

Rescue analgesics requirement during first and second POD was assessed. Femoral catheters and adductor canal catheters were periodically checked to rule out migration or infection at the site of insertion and were removed 72 hours post-surgery. Incidences of side-effects such as hypotension, dizziness, nausea, vomiting, urinary retention, respiratory depression were recorded.

Statistical Analysis

Data collected in a structured questionnaire, entered and analysed using SPSS 22 with $P<0.05$ as statistically significant. Statistical tests used were chi-square test and t test.

RESULTS

The mean age of the patients was 51.9 years. Majority of the patients were females (62.9%). Out of 124 patients 40.3% belong to ASA grade I and 59.7% belong to ASA grade II. Varus (70.2%) was the most common type of deformity in the patients. Out of 124 patients 65.3%

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of patients were either overweight or obese. Comorbidities were present in 36.3% of patients (like hypertension, diabetes, thyroid and COPD). The patients in both the groups were similar with respect to age, gender, ASA classification, Type of deformity, BMI, Comorbidities, duration of surgery and estimated blood loss (table 1).

Table 1: Distribution of patients in Group FNB versus Group ACB

Parameters		**Group FNB(n=62)**	**Group ACB(n=62)**	**Total (n=124)**	**P value**
Age (mean ± SD)		50.2± 7.7	52.7±7.5	51.9± 8.7	T test- 1.831/p value- 0.069
gender	Male	20 (43.5%)	26 (56.5%)	46 (37.1%)	X^2 – 1.2441/ p-value 0.265
	Female	42 (53.8%)	36 (46.2%)	78 (62.9%)	
ASA Classification	Grade I	26 (52%)	24 (48%)	50 (40.3%)	X^2 – 0.134/ p-value 0.7148
	Grade II	36 (48.6%)	38 (51.4%)	74 (59.7%)	
Deformity	Varus	43 (49.4%)	44 (51.6%)	87 (70.2%)	X^2 – 1.374/ p-value 0.503
	Valgus	8 (42.1%)	11 (57.9%)	19 (15.3%)	
	No deformity	11 (61.1%)	7 (28.9%)	18 (14.5%)	
BMI	Normal	21 (48.8%)	22 (51.2%)	43 (34.7%)	X^2 – 0.034/ p-0.850
	Overweight and obese	41 (50.6%)	40 (49.4%)	81 (65.3%)	
Pre operative VAS score		7.1±1.9	7.5±2.9	7.4± 2.3	T test- 0.908/ p value- 0.3654
Comorbidities	Absent	38 (48.1%)	41 (51.9%)	79 (63.7%)	X^2 – 0.3139/ p-value 0.575
	Present	24 (55.6%)	21 (44.4%)	45 (36.3%)	
Duration of surgery (in minutes)		89.7 ± 15.3	94± 12.7	92.7 ± 15.8	T test- 1.703/ p value- 0.091
Estimated blood loss (in ml)		303.2 ± 32.1	312 ± 19.1	310.1± 62.3	T test- 1.855/ p value- 0.066

Table 2: Visual analogue scale score for pain at rest in Group FNB versus Group ACB

Baseline post operative Time	**Group FNB (mean ± SD)**	**Group ACB (mean ± SD)**	**T test/ p value**
6 hours	5.62± 2.1	5.45± 3	1.365/ 0.715
12 hours	4.89±1.18	4.62± 1.12	1.307/ 0.194
24 hours	4.68± 1.15	4.45± 1.03	1.173 / 0.243
48 hours	3.56±0.52	3.40±0.31	2.081/ 0.0395
72 hours	2.43±0.25	2.30±0.30	2.621/0.001
POD 7	1.87± 0.43	1.62±0.62	2.609/0.010
POD 14	1.7±0.11	1.41±0.12	14.027/0.0001

The Visual analogue scale score for pain at rest were high initially and decreased with time. There was no significant difference in VAS score in both the groups at 6 hrs,12 and 24 hours. In POD2 (48 hrs), POD 3, POD 7 and POD 14 VAS score was slightly low in Group ACB which was significant.

Table 3: Visual analogue scale score for pain during activity in Group FNB versus Group ACB

At Time in hours	Group FNB (mean ± SD)	Group ACB (mean ± SD)	T test/ p value
6 hours	8.29 ± 0.91	8.21±0.76	0.5313/ 0.596

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12 hours	7.69±1.82	7.45 ± 0.81	0.949/0.3447
24 hours	6.92± 1.21	6.45± 1.29	2.092/ 0.0385
48 hours	5.81±0.66	5.23±0.45	5.717/ 0.0001
72 hours	4.41±0.54	4.11±0.35	3.671/0.0004
POD 7	3.2±0.61	1.9±0.21	15.867/0.0001
POD 14	2.7±0.61	1.7±0.18	12.3805/0.0001

The Visual analogue scale score for pain during activity was high initially and decreased with time. There was no significant difference in VAS score during activity in both the groups at 6 hrs, and 12 hours. At 24 hrs and On POD 2, POD 7 and POD 14 VAS score was slightly low in Group ACB which was significant. (table 3).

Table 4: Physical therapy end point Assessment of Group FNB versus Group ACB

Physical therapy end point Assessment	Sub group	Group FNB (n=62)	Group ACB(n=62)	p value
Tinetti score	at 24 hours	12.79 ± 1.92	13.56±2.76	0.0738
	at 48 hours	15.63± 6.2	17.89± 5.4	0.0324
	at 72 hours	18.69±6.82	21.45 ± 5.81	0.0167
Risk of falls (Tinetti score <19)	at 24 hour	45/62 (72.6%)	35/62(56.4%)	1.224
	at 48 hour	31/62 (50%)	19/62 (30.6%)	0.028
	at 72 hour	21/41 (33.9%)	10/53 (16.1%)	0.022
Manual muscle extension testing	at 24 hour	1.7±0.18	2.7±0.61	3.671/0.0004
	At 48 hour	1.9±0.21	3.2±0.61	15.867/0.0001
	At 72 hour	4.11±0.35	4.41±0.54	12.3805/0.0001

Mean of Tinette score was significantly more in Group ACB compared to group FNB at post op 48 (17.89/15.63) and (72-hour 21.45/18.69). Risk of falls was considered present when tinette score was <19, Risk of fall was significantly more in patients of group FNB when compared to group ACB at 48 (50%/30.6%) and 72 hours (33.9%/ 16.1%). Mean grade of Manual muscle extension was significantly more in group ACB when compared to group FNB on POD 1, (2.7/1.7) POD2 (3.2/1.9) and POD3(4.41/4.11).

Table 5: Adverse events of patients in Group FNB versus ACB

Side effects	Group FNB (n=62)	Group ACB (n=62)
Nausea/Vomiting	3 (4.8%)	6(9.6%)
Pruritis	0(0%)	0(0%)
Respiratory depression	0(0%)	0(0%)
Urinary retention	0 (0%)	0(0%)
Hypotension/ Dizziness	0(0%)	0(0%)
Deep vein Thrombosis	2(3.2%)	1(1.6%)
Incision complications	4(6.4%)	3 (4.8%)

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Out of 62 patients 9 (14.5%) patients in Group FNB had side effects whereas 10 (16.1%) patients in group ACB have side effects. (Table 5).

Table 6: Rescue analgesia and Adverse events of patients in Group FNB versus ACB

Parameters	In POD 1,2,3	Group FNB(n=62)	Group ACB(n=62)	Total (n=124)	X^2/P value
Rescue analgesia received	Received	44(56.4%)	34(43.6%)	78(62.9%)	3.456/0.063
	Not received	18(39.1%)	28(60.9%)	46(37.1%)	
Adverse events	Reported	9(47.3%)	10(52.6%)	19(24%)	0.803/0.062
	Not reported	53(50.5%)	52(49.5%)	105(76%)	

Only 43.6% of patients belonging to group ACB, received rescue analgesia which was less when compared to patients in group FNB (56.4%) which was not significant. Adverse events were more reported in patients belonging to ACB (52.6%) when compared to patients in Group FNB (47.3%) which was not significant. (Table 6).

DISCUSSION

Recent trends in pain management protocols following TKR emphasises on effective analgesia with limited motor involvement as postoperative faster recovery is desired by both anaesthetist and patient. FNB though can provide excellent analgesic effect has a disadvantage of reduced quadriceps strength, which hampers early mobilization and increases the risk of postoperative falls. Thus, ACB which produces a predominantly sensory block with greater quadriceps strength preservation can be a good alternative to FNB.[15]

In this study patients were comparable in both the groups with respect to age, gender, comorbidities, per operative VAS score, type of deformity, duration of surgery and estimated blood loss.

In this study, there was no significant difference in VAS score at rest before PT in both the groups at 6 hrs,12 and 24 hours. In POD2 (48 hrs), POD 3, POD 7 and POD 14 VAS score was slightly low at rest in Group ACB which was significant. There was no significant difference in VAS score during activity in both the groups at 6 hrs, and 12 hours. At 24 hrs and on POD 2, POD 3, POD 7 and POD 14 VAS score was slightly low on activity in Group ACB which was significant. Where as in study by Elkassabany N M et al, there was no difference in pain scores measured by the physical therapist before and after sessions of PT at 24 and 48 hours.[16]

In study by Hasabo E et al, no significant difference was found between the 2 interventions regarding pain control (MD = 0.06, 95% CI [−0.06, 0.17], P = .33) up to 2 days postoperatively.[17] In metanalysis by Wageh et al, they revealed that groups receiving femoral nerve blocks experience a significant decrease in pain scores. [18] Unlike in study by Fujita et al where there were no significant differences between the two groups in pain level on POD 1–3 (NRS of FNB and ACB; 3.8 and 3.6 [p = 0.6] on POD 1, 3.4 and 3.6 [p = 0.52] on POD 2, 3.2 and 3.0 [p = 0.64] on POD 3.[19]

In this study, mean of Tinette score was significantly more in Group ACB compared to group FNB at post op 48 (17.89/15.63) and 72 hour (21.45/18.69). Risk of fall was significantly more in patients of group FNB when compared to group ACB at 48 (50%/30.6%) and 72 hours (33.9%/ 16.1%), which indicates that quadriceps muscle strength was better preserved in patients given ACB. In study by Elkassabany et al, no difference was detected in the

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proportion of "high fall risk" patients on POD1 {(21/31) in the ACB group versus 24/31 in the FNB group [P = 0.7]} or POD2 {(7/31 in the ACB versus 14/31 in the FNB group [P = 0.06]}.[16]

Similarly in study by Hasabo E A et al, Adductor canal block showed better preservation of quadriceps muscle strength (MD = 0.28, 95% CI [0.11, 0.46], P = .002), and better mobilization up to 2 days postoperatively.[17] In study by Karkhur et al, patients administered adductor canal block had better quadriceps power, longer ambulation distance, and shorter length of hospital stay.[20] In meta-anlysis by Wageh et al, adductor canal block groups have a significantly lower rate of quadriceps muscle weakness than FNB groups.[18]

In study by Hasabo et al, they further stated that, the better mobilization results of adductor canal block did not translate into a significant difference in the risk of falls or patients' satisfaction; however, adductor canal block patients had less mean length of hospital stay than the patients with femoral nerve block.[17]

In study by Fujita et al, episodes of near-falls with knee-buckling were witnessed in 14 (39%) cases in the FNB group and in 4 (11%) in the ACB group ($p = 0.0068$).[19]

In this study, mean grade of MMT was significantly more in group ACB when compared to group FNB on POD 1, (2.7/1.7) POD2 (3.2/1.9) and POD3(4.41/4.11). In study by Fujita et al, MMT values for the quadriceps in patients who were able to ambulate with parallel bars on POD 1 in 30 cases in the ACB group was 2.82 ± 0.88 (95% CI: 2.49–3.14), significantly higher than the 1.97 ± 0.87 (95% CI: 1.48–2.45) in 15 cases in the FNB group.[19] In study by Elkassabany et al, MMT grades were significantly higher on POD1 in the ACB group when compared with the FNB (P = 0.001) No statistical difference was found by POD2 (P > 0.99).[16]

Only 43.6% of patients belonging to group ACB, received rescue analgesia which was less when compared to patients in group FNB (56.4%) which was not significant. The findings in our study were similar to study by Elkabassy et al, Fujita et al and Karkhur et al, unlike in metanalysis by Wageh et al, which revealed that groups receiving femoral nerve blocks experience a significant decrease analgesic medication usage.[18]

In study by Elkassabany N M et al, Opioid requirements in 24 hours were similar between the 2 groups, calculated on the mornings of POD1 and POD2, P = 0.9 and P = 0.4, respectively.[16] In study by Fujita Y et al, Cases per number of rescue analgesia till POD3 were not significantly different between the two groups (Cases of FNB and ACB; 20 and 26 on 0 analgesia, 8 and 5 on 1 analgesia, 6 and 6 on 2 analgesia, 2 and 0 on 3 analgesia, [$p = 0.357$]).[19] In study by Karkhur et al, the opioid consumption was found to be comparable with both the interventions on the first and second postoperative day.[20] In study by Hasabo E et al, no significant difference was found between the 2 interventions opioid consumption (SMD = 0.08, 95% CI [−0.06, 0.22], P = .28) up to 2 days postoperatively.[17]

CONCLUSION

Our study demonstrated that continuous ACB provides better ambulation with equivalent analgesia to continuous FNB for TKR patients. Our study shows the safety and efficacy of continuous ACB as well as the importance of close monitoring for the fall prevention.

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