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Post -operative analgesia after total knee arthroplasty - A retrospective study.

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Abstract

Introduction: Total knee replacement (TKR) is a procedure often associated with intense post operative pain. If the pain is not adequately controlled, this can cause limitation in the range of motion (ROM) and can lead to a poor functional outcome. Effective pain relief is essential to initiate early rehabilitation and postoperative recovery. Delayed mobilization may cause adhesions, capsular contractions and muscle weakness.

There are various analgesic regimens used in the perioperative setting in patients following TKR. They include opioid analgesics, NSAIDS, patient-controlled analgesia (PCA) with intravenous morphine, patient controlled epidural analgesia, local infiltration analgesia (LIA)[1] and various nerve blocks.

Epidural analgesia has traditionally been used for post operative pain management following TKR.

Administration of local anaesthetics through the epidural space is associated with a risk of motor blockage and difficulty in mobilizing the patient[2]. Epidural analgesia with an indwelling catheter can provide prolonged pain relief but can also lead to adverse effects like urinary retention, infection, meningitis and various degree of nerve damage.

Although femoral nerve block is an established method of pain relief in patients after TKR, it is associated with a weakening of the quadriceps muscle[3]. Thus it leads to a functional impairment and a risk of falling[4,15.]

Adductor block is a relatively new block that has been proposed as an advance to the existing gold standard for analgesia after TKR, the femoral nerve block. This nerve block causes blockage of the sensory branch of the femoral nerve -the saphenous nerve, and the only motor nerves to be blocked are the nerve to vastus medialis and the posterior branch of the obturator nerve. Hence it results in lesser reduction in quadriceps muscle strength and lesser adverse effects of conventional analgesics like opiods, epidural analgesia and NSAIDS[5]. We undertook this study to compare the efficacy of continuous femoral nerve block with continuous adductor canal block for post -operative analgesia after total knee replacement.

Keywords: Total knee arthroplasty, analgesia, femoral nerve block, adductor canal block, saphenous nerve

Aim of the study

The aim of this retrospective randomized study was to compare the qualitative pain relief in patients who received continuous ultra sound guided adductor canal block using 0.2% ropivacaine versus patients who received continuous femoral nerve block local with 0.2% ropivacaine during the first 24 hrs. following total knee replacement.

Objective of study

1. To determine the duration of analgesia in each group before the occurrence of break through pain (time to first analgesic request).
2. To compare the pain scores between the two groups.
3. To evaluate the morphine consumption in each group.

Inclusion criteria

ASA I and ASA II patients

Age 18-75 yrs. of either sex

Weight between 50-100 kg

Willingness to participate in the study and be contacted preoperatively where the procedure would be explained in detail in a language known to them.

Exclusion criteria

Age < 18 yrs. or > 75 yrs.

Patients with history of hypersensitivity to amide local anaesthetics.

Patients undergoing elective bilateral TKR

Patients who are physically dependent on opioids

Patients who are pregnant or breast feeding

Patients with peripheral neuropathy

Patients who refused to participate in the study

Definition of pain and mechanism of action of local anesthetics

Definition of pain

The international association of study of pain (IASP) defines pain as an unpleasant sensory or emotional experience associated with potential or actual tissue damage or defined in terms of such damage[6,7,8]

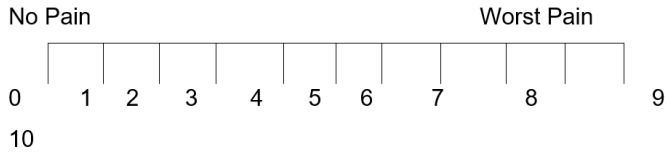
Assessment of pain

Simple descriptive pain scale

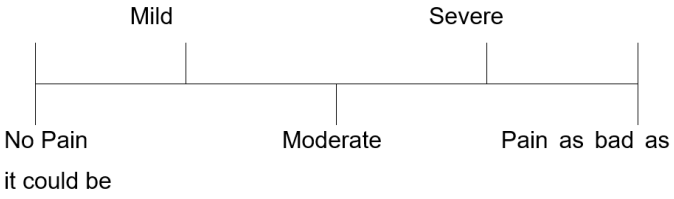
It is a four-point scale (keele) scale grading pain as slight, moderate, severe and agonizing.

Visual analogue scale (VAS)

Of the various methods used to measure pain the VAS scale seems most sensitive. It ranges from no pain to worst pain possible[9]



Graphic Rating Method for measuring Pain



Non-Verbal Methods

It is based on the visible manifestations of pain, facial signs as grimacing used as indicators of pain.

Mc Gill Pain Questionnaire[10]

The most important requirement of a pain scale is that it must be valid, reliable, consistent and above all useful. The Mc Gill questionnaire appears to meet all these requirements and provides a relatively rapid way of measuring subjective pain experience. The Mc Gill Pain Questionnaire has been used in many studies of pain. In a study by Melzacks and Perry, in 1975, chronic pain of pathological origin was measured by this method.

Materials and Methods

This study was carried out to compare the qualitative pain relief in patients receiving continuous adductor canal block using 0.2% ropivacaine versus continuous femoral nerve block using 0.2% ropivacaine during the first 24 hours following TKR.

After taking an approval from the institutional ethics committee, and after an informed consent from the patients, this study was carried out in the Department of Anesth esiology in association with the Department of Ortho paedics at Care Hospitals, Banjara Hills, Hyderabad between April 2020-April 2021.

Design of the study

This study is a randomized, retro spective comparative study.

This study was conducted on 60 patients (both males and females). The patients were randomized into two groups of 30 patients each. The randomization was done using a closed envelope method.

The sample size was calculated (as per normal Gaussian distribution) in consultation with a statistician, after conducting a pilot study with ten patients in each group. Thirty was the smallest number required in each group for statistically significant results.

Group a

Received ultrasound guided continuous adductor canal block using 15 ml 0.2 % ropivacaine as bolus and then 6ml / hr. infusion at the end of surgery.

Group F

Received ultra sound guided continuous femoral nerve block using 15 ml 0.2 % ropivacaine as bolus and then 6ml / hr. infusion at the end of surgery

All the patients received spinal anesthesia with 3ml of 0.5% sensor Caine (heavy) using 25 G spinal needle .

Procedure

Spinal anesthesia was administered in all patients for TKR using a 25G Quincke needle at levels (L3-L5) with 15 mg of 0.5(3 ml) of hyperbaric bupivacaine. A sensory level of T 10 dermatome was aimed. All patients received supplemental oxygen through face mask at 5 lit/min

Immediately at the end of the surgery, the adductor canal block was performed under ultrasound guidance (sonosite L 38) using a linear high frequency probe and a catheter was placed for continuous infusion in patients belonging to group A.

The patients in group F received femoral nerve block under ultrasound guidance and catheter was placed for continuous block.

The medial aspect of the thigh was prepared with sterile antiseptic solution for the block. The area for the block was covered with a sterile hole towel. The probe was covered with tegaderm. After dipping the probe in a solution of povidone iodine, the probe was placed at the medial aspect of mid-thigh, with the leg being slightly externally rotated. The femoral artery was identified in short axis in the adductor canal, underneath the Sartorius muscle. A 100 mm insulated stimuplex needle was then inserted in plane from the lateral side of the transducer, to direct the needle medially and position the needle tip beneath the Sartorius muscle just lateral to the femoral artery next to the saphenous nerve. Then 10 ml of 0.2% ropivacaine was injected real time, after aspiration of the syringe to rule out a vascular puncture, while visualizing the spread of the local anesthetic around the saphenous nerve. The injection is seen as an expansion of the adductor canal anterolateral to the femoral artery and deep to the roof of the adductor canal. The catheter is then inserted around 3 -4 cm beyond the needle for continuous infusion and position confirmed by injecting rest of the drug.

For the femoral nerve block, after cleaning and draping the probe, femoral nerve was identified lateral to the femoral artery at the level of inguinal crease and 10 ml of 0.2% ropivacaine injected lateral to the femoral nerve below the fascia iliac a. Catheter was inserted above the

femoral nerve and position confirmed by injecting the remaining drug.

After the surgery the patients were shifted to the post anesthesia care unit where all patients were monitored for 24 hrs. after surgery. The monitoring parameters included periodic measurement of their heart rate, blood pressure, oxygen saturation, respiratory rate, and the visual analogue scale. The patients in both groups received intravenous injection of Paracetamol 1gm three times a day. All patients were given rescue analgesia with injection Morphine 3mg intravenously when the VAS score > 3.

The effect of the anesthetic agents on the following parameters were observed:

Monitoring

The pulse rate (PR), mean arterial pressure (MAP), respiratory rate (RR), oxygen saturation (SPO2) and the VAS score of the patients were monitored post operatively every 15min.,30min,1hr,2hrs,4hrs,6hrs,10 hrs,12hrs,18hrs and 24hrs following TKR.

Duration of analgesia

The duration of analgesia in each group was assessed. The duration of analgesia in the study was defined as the time from the end of surgery to the development of break through pain (VAS > 3).

Morphine requirement

Both the groups received intravenous Morphine 3 mg. for treating breakthrough pain. The morphine requirement in each patient was documented during the first 24 hrs. after surgery.

Statistical analysis

Data were collected, tabulated, coded, and analyzed. Numerical variables were presented as mean and standard deviations. In case of numerical variables, the unpaired t- test was used to compare the two groups. The ANOVA test was used to analyze the difference between the numerical variables over a time. A difference with p value < 0.05 was considered statistically significant.95% confidence intervals were calculated.

Statistical software

The statistical software Win do stat Version 9.2 from Indo stat Services, Hyderabad was used for the analysis of data. Microsoft Word and Excel have been used to generate graphs and tables.

Table 1: Observations regarding age

	N	Mean (yrs) age	S.D	T Value	P Value
Block A	30	61.0	6.5	0.174	0.86
Block F	30	61.3	6.7		

The average age of patients who received the adductor canal block was 61 yrs. while the age of patients who received femoral nerve block alone was 61.3 yrs. The p value of 0.86 signified that there was no statistical difference in the age of the patients between the two groups.

Table 2: Observation regarding sex

Group	Male	Female Value	Total	P value
Block A	12	18	30	0.44
Block F	15	15	30	

The above table reveals the sex distribution of the two groups. The group that received adductor block had 12 males and 18 females while the group receiving femoral nerve block had 15 males and 15 females. The p value of 0.44 revealed that there is no significance regarding sex distribution between the two groups.

Table 3: Observation regarding pre operative pulse rate

Group	Mean Pulse Rate / min.	S.D	T value	P	N
Block A	71.3	8.1	1.6	0.10	30
Block F	68.6	4.8			30

The mean preoperative pulse rate of the patients in the two groups is represented by the table above. The mean pulse rate in the group A was 71.3/min while the mean rate in the group F was 68.6/min. The p value of 0.10 signified that there was no statistical difference regarding preoperative pulse rate between the two groups.

Table 4: Observation with regard to systolic blood pressure

Group	Mean Systolic B.P(mm Hg)	S.D	N	T value	P value
Block A	126.46	15.14	30	2.12	0.03
Block F	117.66	16.95	30		

The mean preoperative systolic blood pressure of the patients in group A was 126.46 mm Hg while the mean systolic blood pressure of the patients in group F was 117.66 mm Hg. A p value of 0.03 signified that there is statistical difference in the two groups with regard to their preoperative systolic blood pressure

Table 5: observations regarding pre operative diastolic b. p

Group	Mean Diastolic B.P	N	S.D	T value	P value
Block A	75.33	30	10.08	2.05	0.04
Block F	69.66	30	11.29		

The mean preoperative diastolic blood pressure of patients in group A was 75.3 mm Hg while the mean diastolic pressure in group F was 69.6 mm Hg. The T value was 2.05 that corresponded to a p value of 0.04. Thus, this indicated that there is a statistical difference between the two groups with regard to the preoperative diastolic blood pressure

Table 6: Observation regarding asa status

ASA Grade	Block A	Block F	N	S.D	T value	p value
1	6	4	30	0.4	0.6	0.49
2	24	26	30	0.3		

The number of patients belonging to ASA 1 were 6 in group A, while their number in group F was 4. The number of patients belonging to ASA 2 were 24 in group A while they were 26 in group F. The p value with regards to the ASA grade was 0.49 indicating that there is no statistical significance with regard to the ASA status between the two groups

Table 7: Comparision of pulse rate at various time intervals

	Block A	Block F	t-test	Prob
0 min	81.400	75.833	5.807	0.000
15 min	75.100	75.100	0.000	1.000
30 min	70.333	77.333	3.893	0.000
1 Hour	67.767	67.467	0.191	0.850
2 Hours	67.233	69.500	1.666	0.101
4 Hours	75.400	78.900	2.606	0.012
6 Hours	72.500	73.400	0.712	0.479
10 Hours	71.833	77.000	7.073	0.000
12 Hours	75.567	67.633	11.967	0.000
18 Hours	73.233	74.067	0.739	0.463
24 Hours	76.533	72.133	4.178	0.000

The pulse rate of the patients from the end of surgery till 24hrs postoperatively was measured in the two groups at a period of 0,15 min, 30min, 1hr, 2hrs, 4hrs, 6hrs, 10hrs, 12hrs, 18 hrs. and 24hrs.The above table shows that there is a statistical difference regarding pulse rate, between the two groups at 0min,30 min, 4 hrs,10 hrs,12 hrs and 24 hrs after surgery.

Table 8: Comparision of mean arterial pressure

	Block A	Block F	t-test	Prob
0 min	99.267	98.933	0.236	0.814
15 min	82.400	89.333	6.385	0.000
A30 min	92.800	96.800	1.285	0.204
1 Hour	90.367	86.833	1.244	0.219
2 Hours	89.333	87.133	0.633	0.529
4 Hours	78.867	90.967	5.901	0.000
6 Hours	91.767	84.400	2.039	0.046
10 Hours	82.533	74.700	3.826	0.000
12 Hours	72.133	82.833	4.091	0.000
18 Hours	90.000	89.367	0.205	0.838
24 Hours	80.233	75.333	2.676	0.010

The mean arterial pressure in the study and control group was measured from the immediate post operative to 24hrs post operatively. The MAP was measured at 0min, 15min, 30min, 1hr, 2hrs, 4hrs, 6hrs, 10hrs, 12hrs, 18hrs and 24hrs.The p value ranged between 0.0 to 0.8. The difference in the MAP was found to be statistically significant between the two groups at 15min, 4hrs, 6hrs, 10hrs, 12hrs and 24hrs postoperatively

Table 9: Comparision of time required for breakthrough pain (vas>3)

Group	Mean till VAS>3(hrs)	N	S.D	t value	p
Block A	14.1	30	7.5	5.9	0.00
Block F	5.3	30	3.0		

The mean time to develop breakthrough pain, which in the study was defined as the time from the end of surgery to the development of VAS score > 3 was measured in both groups. The mean time for break through pain in the adductor canal group was 14.1hrs while in the femoral nerve block group it was 5. 3hrs.The p value of 0.0 indicates a statistically significant difference between the two groups.

Table 10: Comparision of morphine requirement

Group	Morphine requirement(mg)	N	S.D	t value	p
Block A	3.8	30	3.4	4.93	0.00
Block F	8.6	30	4.0		

The patients in both groups were given intravenous morphine 3mg on the development of breakthrough pain. The mean morphine requirement in the group A was

3.8mg while the requirement of morphine in the group F was 8.6mg. A p value of 0.0 indicates that there is a statistically significant difference in the two groups with respect to morphine requirement. The patients in the adductor canal block group were found to have lesser requirement of morphine.

Discussion

Total knee replacement is a surgery associated with severe post operative pain. There are several traditional multi modal analgesic regimes available for management of post operative pain after TKR. Among them the adductor canal block is relatively new technique in the management of pain after TKR. Femoral nerve block has been used extensively for post -operative analgesia after total knee replacement with quadriceps weakness as the major limiting factor.

This was a rando mized, retro spective, non-blinded, comparative study which was carried out at Care Hospitals, Banjara Hills, Hyderabad. The study included 60 patients who were randomized into two groups of 30 patients each. The adductor canal block group (group A) patients received an ultrasound guided adductor canal block with 0.2% ropivacaine 15ml immediately at the end of surgery followed by the catheter placement .The patients in the femoral nerve block group (group F) received an ultrasound guided femoral nerve block with 0.2% ropivacaine 15ml immediately at the end of surgery followed by the catheter placement.

The age, sex, ASA grading and duration of surgery has been found to be comparable in the two groups using the student t test. The statistical significance between the two groups regarding their preoperative systolic blood pressure (p value of 0.03) and diastolic blood pressures (p value of 0.04) can be attributed to a variety of factors like pre-existing hypertension, anxiety.

Postoperatively the pulse rate, blood pressure including MAP, oxygen saturation and respiratory rate were recorded at periodic intervals. The statistical significance in the readings of MAP, pulse rate and respiratory rate observed between the two groups at varied times postoperatively, during the 24-hr. period, can be attributed to various factors like pre-existing hypertension, blood loss during surgery. These variables require further studies to validate their significant

The main result obtained from this study is that continuous adductor canal block administered immediately at the end of surgery prolonged the duration of analgesia postoperatively. The mean time required to develop breakthrough, defined as the time from the end of surgery to the development of a VAS score of > 3, in the group A was found to be 14.1 hrs. with a S.D of +_ 7.5hrs, while in the group F it was found to be 5.3hrs with S.D +- 3hrs.The p value of 0.00 confirms that this difference is of statistical significance. Thus it can be concluded that administration of adductor canal block in patients after TKR, helps prolong the duration of post operative analgesia compared to administration of femoral nerve block This conclusion is consistent with the results obtained in a study conducted by Anderson et al [11]where they found that the administration of adductor canal block with 15 ml 0.75% ropivacaine in addition to LIA in patients following TKR, prolonged the duration of postoperative analgesia. The time for development of breakthrough pain in their study was 10.5hrs in the block group compared to 3.4hrs in patients who received LIA alone. The difference in their study though was the insertion of a catheter in the adductor canal through which the study medication was administered twice a day for 48hrs.

A study published by Jaeger et al[12], evaluated the effect of adductor canal block on postoperative pain in patients

after revision TKR. This was a randomized double blinded placebo-controlled study conducted in a group of 30 patients. All patients under went TKR under general anesthesia. All the patients in this study received a standardized multi modal analgesic regime of oral acetaminophen 1gm and 0.2mg/kg morphine during surgery. The block was administered at the end of surgery before reversing general anesthesia. A catheter was placed in the adductor canal under USG guidance and ropivacaine 30ml 0.75% was given in the study group followed by a continuous infusion of 0.2% ropivacaine at 8ml/hr, while the second group received saline infusion. The results were a significant reduction in pain in the ropivacaine group at 4hrs after surgery on active knee flexion. The morphine consumption though was similar in the two groups

A study published by Grevstad et al[13] in BJA evaluated the effect of adductor canal block on 60 patients with established pain (VAS score >60) on the first and second postoperative day after TKR. The patients underwent TKR under general or spinal anesthesia. All the patients received a standard multimodal analgesic regime of celecoxib and acetaminophen preoperatively, LIA as described by Kerr and Kohan[1] intraoperatively and acetaminophen, ibuprofen, gabapentin, and opioids as required post operatively. Each group received two injections of 20 ml 0.75% ropivacaine or 20 ml isotonic saline. The results of the study were a 32mm reduction in VAS score during active knee flexion 45 min after block in favour of the ropivacaine group. Thus, adductor canal block can be a promising option as a rescue analgesic for acute pain after TKR.

The secondary endpoint to be determined in our study was the morphine consumption in each group. In my study the mean morphine consumption in group A was 3.8mg with a S. D of + -3.4mg, while the morphine consumption in group F was 8.6mg with a S. D of + -4. 0mg.The t value of 4.9 with a corresponding p value of 0.00 indicate a significant statistical difference between the two groups.

The patients who received LIA and adductor canal block had lesser requirement of intravenous morphine to treat break through pain compared to patients who received LIA alone. Thus, adductor canal block administration has opioid sparing effects in the study group

A study published by Jenstrup et al[14] evaluating the effects of continuous adductor canal block versus placebo, in a group of 75 patients after TKR concluded that the patients who received the adductor canal block had significantly lower pain scores on active knee flexion. In addition, the patients in the block group also had significantly lower post operative morphine requirement compared to the placebo group.

Limitations

One of the limitations in this study was that it was a non-blinded study. Efforts though were taken to avoid selection bias by having identical set of patients in the two groups regarding their age, sex and ASA grade. The VAS scores in this study were evaluated only at rest and not on active or passive knee flexion. The ambulation of the patients following surgery during the first 24 hrs. were also not analyzed as per the surgical team's ambulation policy.

Conclusion

Adductor canal block when used along with local infiltration analgesia as part of the analgesic regime in patients following total knee replacement, helps prolong the duration of post operative analgesia and reduces the opioid requirement post operatively.

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