*Original Research Article*

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# Adductor Canal Block: A Prospective Case Series Report in Unilateral Total Knee Arthroplasty

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**Abstract**

*Introduction*: Total knee arthroplasty is associated with moderate to severe pain and effective analgesia is essential to facilitate post operative recovery. This non randomised case series examined the analgesic effect of adductor canal block as a central tool in an integrated multi modal analgesia.

*Material and Methods*: We used adductor block to manage postoperative pain in 43 patients presenting to our service for unilateral primary total knee arthroplasty. We recorded pain scores, opioid usage and any adverse side effect.

*Result*: Pain control was generally satisfactory. Very few patients required fentanyl infusion as a rescue analgesia. Vomiting was reported but other side effects such as hypotension, itching, fall etc were unremarkable.

*Conclusion*: Adductor block was practical, safe and effective method of analgesia for pain relief in patients who have undergone unilateral total knee replacement.

**Keywords:** Adductor canal block, Analgesia, Total knee arthroplasty.

## Introduction

Total knee arthroplasty (TKA) is associated with relatively severe pain and difficult to manage. It has been demonstrated that about 60% of patients have severe pain and 30% of patients have moderate pain post TKA.[1] The pain after TKA does not only impose restriction on early mobilization but also increase the rate of immobility related complications such as deep vein thrombosis. Effective analgesia post TKA is of extreme importance to the postoperative patients, which can improve the patient's satisfaction. To relieve the pain and improve the effect of TKA, the most common analgesic methods are patient controlled intravenous analgesia(PCIA), epidural analgesia, femoral nerve block(FNB).[2,3]

However, PCIA needs a large amount of opioids and is relevant to more adverse events than FNB, and patients who receive epidural analgesia had a higher rate of hypotension and urinary retention.[4] FNB may weaken the strength of quadriceps and increase the incidence of falling.[5,6] TKA patients who fell were more likely to go on to suffer additional major cardiac, pulmonary, thromboembolic and other organ-systems complications with higher 30 day mortality compared with TKA patients who did not fall.[3]

With the advent and development of ultrasonography, the adductor canal as an aponeurotic structure in the middle third of the thigh can be seen clearly. Through this new technology, adductor canal block (ACB) can be successfully implemented and thus can be performed to the knee surgery to relieve pain. This method selectively

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blocks the sensory nerve but does not block the motor neuron. So this can relieve pain, meanwhile it does not weaken the strength of quadriceps and adductor, thus reducing the incidence of fall.[7]

## Material and Methods

Ethical approval of this study was unnecessary because it was a review of existing literature and did not involve any handling of individual patient data. The study was carried out at Sant Parmanand Hospital, New Delhi. Our institute is a tertiary referral centre providing care for all major orthopaedic surgery with an active joint arthroplasty programme. Patients scheduled for TKA with spinal anesthesia between May 2016 to May 2017 were included. Eligible participants were patients scheduled for primary TKA with spinal anesthesia aged between 45 years and 80 years with an American society of anesthesiologist physical status classification of 1 to 3. Exclusion criteria were inability to cooperate, inability to speak Hindi or English, allergy to any drug used in the study, alcohol or drug abuse, daily intake of strong opioids, rheumatoid arthritis and if the spinal anesthesia had resolved before conducting the block.

Premedication consisted of 0.25 mg Alprazolam and Panmid DSR given 2 hrs preoperatively. Spinal anesthesia was induced with 2 to 2.5 ml of 0.5% hyperbaric bupivacaine at the L3/4, L4/5 or L2/3 interspace. Sedation and intraoperative fluid therapy were administered at the discretion of anesthesiologist. All patients received a femoral tourniquet perioperatively. At the conclusion of surgery all patients received periarticular injection of

1 Bupivacaine 0.5% 20 ml

2 Amikacin 0.5 gm 01 ml

3 Clonidine 75 mcg 0.5 ml

4 Adrenaline 0.5 mg 0.5 ml

5 Saline 78 ml

ACB was performed in the Post Anesthesia Care unit, immediately postoperative. For the ACB we performed an ultrasound survey at the medial part of the thigh, halfway between anterior superior iliac spine and the medial part of patella. In a short axis view, we identified the femoral artery underneath the Sartorius muscle with the vein just inferior and the saphenous nerve just lateral to the artery. The needle was introduced in-plane and 2-3 ml of saline was used to ensure correct placement of the needlein the vicinity of saphenous nerve in the adductor canal. The catheter was than introduced and advanced 1 to 2 cm beyond the tip of the needle. The correct spread of bupivacaine bolus injection in a semi-circular form around the artery was observed. 8 ml of 0.5% bupivacaine as a bolus dose was administered via the adductor canal catheter. Thereafter 8 ml of 0.25% bupivacaine was administered through the adductor canal catheter at 8 hour interval. This dose was repeated earlier if the patient complained of pain. Fentanyl infusion was started as a rescue analgesia if the pain persisted. In addition the patient also received injection Paracetamol, 1 gm iv thrice daily and injection Flexilor, 8 mg iv twice daily.

## Measurements

Pain assessment: All patients in the study had their pain scores assessed initially at 4 hours and then every 8 hrs by the anesthesiologist. Pain was assessed using VAS, a numerical rating scale from 0-10 (with 0 representing no pain and 10 representing the worst possible pain) at 4 hours, 12 hours, 24 hours and 36 hours. Zero time was taken from first adductor top up immediately after the insertion of adductor canal catheter.

Opioid usage: Fentanyl infusion was used as a rescue analgesia if the patient had VAS score 4 or more.

Adverse events: All patients were closely attended to by the nursing close supervision by the anesthesiologist for any adverse event like vomiting, itching, hypotension, fall. Patients were encouraged to report any such adverse event immediately.

### *Statistical Analysis*

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Age | 41 | 53.00 | 82.00 | 66.5122 | 6.74211 |
| Valid N (listwise) | 41 | | | | |

| | | Frequency | Percent |
|---|---|---|---|
| Valid | Male | 14 | 31.8 |
| | Female | 30 | 68.2 |
| | Total | 44 | 100.0 |

| Descriptive | | | | | |
|---|---|---|---|---|---|
| | Sex | | | Statistic | Std. Error |
| Age | Male | Mean | | 70.0000 | 2.09978 |
| | | 95% Confidence Interval for Mean | Lower Bound | 65.3784 | |
| | | | Upper Bound | 74.6216 | |
| | | 5% Trimmed Mean | | 69.8889 | |
| | | Median | | 67.0000 | |
| | | Variance | | 52.909 | |
| | | Std. Deviation | | 7.27386 | |
| | | Minimum | | 60.00 | |
| | | Maximum | | 82.00 | |
| | | Range | | 22.00 | |
| | | Interquartile Range | | 14.00 | |
| | | Skewness | | .617 | .637 |
| | | Kurtosis | | -.979 | 1.232 |
| | Female | Mean | | 65.0690 | 1.12619 |
| | | 95% Confidence Interval for Mean | Lower Bound | 62.7621 | |
| | | | Upper Bound | 67.3759 | |
| | | 5% Trimmed Mean | | 65.1877 | |
| | | Median | | 65.0000 | |
| | | Variance | | 36.781 | |
| | | Std. Deviation | | 6.06472 | |
| | | Minimum | | 53.00 | |
| | | Maximum | | 75.00 | |
| | | Range | | 22.00 | |
| | | Interquartile Range | | 8.50 | |
| | | Skewness | | -.288 | .434 |
| | | Kurtosis | | -.623 | .845 |

| Item Statistics | | | |
|---|---|---|---|
| | Mean | Std. Deviation | N |
| V4 | 2.05 | .899 | 43 |
| V12 | 1.65 | .613 | 43 |
| V24 | 1.35 | .482 | 43 |
| V36 | 1.21 | .412 | 43 |
| V48 | 1.12 | .324 | 43 |

| Reliability Statistics | |
|---|---|
| Cronbach's Alpha | N of Items |
| 0.734 | 5 |

| Cronbach's alpha | Internal consistency |
|---|---|
| $\alpha \geq 0.9$ | Excellent |
| $0.9 > \alpha \geq 0.8$ | Good |
| $0.8 > \alpha \geq 0.7$ | Acceptable |
| $0.7 > \alpha \geq 0.6$ | Questionable |
| $0.6 > \alpha \geq 0.5$ | Poor |
| $0.5 > \alpha$ | Unacceptable |

| Rescue | | | | | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| Valid | | 41 | 93.2 | 93.2 | 93.2 |
| | Fenta in | 3 | 6.8 | 6.8 | 100.0 |
| | Total | 44 | 100.0 | 100.0 | |

**Descriptives**

**VAS**

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum | Maximum |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| 1 | 43 | 2.05 | .899 | .137 | 1.77 | 2.32 | 1 | 5 |
| 2 | 44 | 1.66 | .608 | .092 | 1.47 | 1.84 | 1 | 3 |
| 3 | 44 | 1.36 | .487 | .073 | 1.22 | 1.51 | 1 | 2 |
| 4 | 44 | 1.20 | .408 | .062 | 1.08 | 1.33 | 1 | 2 |
| 5 | 44 | 1.11 | .321 | .048 | 1.02 | 1.21 | 1 | 2 |
| Total | 219 | 1.47 | .666 | .045 | 1.39 | 1.56 | 1 | 5 |

**Anova**

**VAS**

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 25.046 | 4 | 6.261 | 18.723 | .000 |
| Within Groups | 71.566 | 214 | .334 | | |
| Total | 96.612 | 218 | | | |

**Multiple Comparisons**

**Dependent Variable: VAS**

| | (I) Vas_Code | (J) Vas_Code | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| LSDl4e l;f | 1 | 2 | .387* | .124 | .002 | .14 | .63 |
| | | 3 | .683* | .124 | .000 | .44 | .93 |
| | | 4 | .842* | .124 | .000 | .60 | 1.09 |
| | | 5 | .933* | .124 | .000 | .69 | 1.18 |
| | 2 | 1 | -.387* | .124 | .002 | -.63 | -.14 |
| | | 3 | .295* | .123 | .017 | .05 | .54 |
| | | 4 | .455* | .123 | .000 | .21 | .70 |
| | | 5 | .545* | .123 | .000 | .30 | .79 |
| | 3 | 1 | -.683* | .124 | .000 | -.93 | -.44 |
| | | 2 | -.295* | .123 | .017 | -.54 | -.05 |
| | | 4 | .159 | .123 | .198 | -.08 | .40 |
| | | 5 | .250* | .123 | .044 | .01 | .49 |
| | 4 | 1 | -.842* | .124 | .000 | -1.09 | -.60 |
| | | 2 | -.455* | .123 | .000 | -.70 | -.21 |
| | | 3 | -.159 | .123 | .198 | -.40 | .08 |
| | | 5 | .091 | .123 | .462 | -.15 | .33 |
| | 5 | 1 | -.933* | .124 | .000 | -1.18 | -.69 |
| | | 2 | -.545* | .123 | .000 | -.79 | -.30 |
| | | 3 | -.250* | .123 | .044 | -.49 | -.01 |
| | | 4 | -.091 | .123 | .462 | -.33 | .15 |

| Multiple Comparisons | | | | | | | |
|---|---|---|---|---|---|---|---|
| Dependent Variable: VAS | | | | | | | |
| | (I) Vas_Code | (J) Vas_Code | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
| | | | | | | Lower Bound | Upper Bound |
| Bonferroni | 1 | 2 | .387* | .124 | .020 | .04 | .74 |
| | | 3 | .683* | .124 | .000 | .33 | 1.03 |
| | | 4 | .842* | .124 | .000 | .49 | 1.19 |
| | | 5 | .933* | .124 | .000 | .58 | 1.28 |
| | 2 | 1 | -.387* | .124 | .020 | -.74 | -.04 |
| | | 3 | .295 | .123 | .174 | -.05 | .65 |
| | | 4 | .455* | .123 | .003 | .10 | .80 |
| | | 5 | .545* | .123 | .000 | .20 | .90 |
| | 3 | 1 | -.683* | .124 | .000 | -1.03 | -.33 |
| | | 2 | -.295 | .123 | .174 | -.65 | .05 |
| | | 4 | .159 | .123 | 1.000 | -.19 | .51 |
| | | 5 | .250 | .123 | .438 | -.10 | .60 |
| | 4 | 1 | -.842* | .124 | .000 | -1.19 | -.49 |
| | | 2 | -.455* | .123 | .003 | -.80 | -.10 |
| | | 3 | -.159 | .123 | 1.000 | -.51 | .19 |
| | | 5 | .091 | .123 | 1.000 | -.26 | .44 |
| | 5 | 1 | -.933* | .124 | .000 | -1.28 | -.58 |
| | | 2 | -.545* | .123 | .000 | -.90 | -.20 |
| | | 3 | -.250 | .123 | .438 | -.60 | .10 |
| | | 4 | -.091 | .123 | 1.000 | -.44 | .26 |

*. The mean difference is significant at the 0.05 level.

## Results

The mean pain scores for subjects with ACB (n=43) was 2.05 after 4 hours, 1.65 after 12 hours, 1.35 after 24 hours, 1.21 after 36 hours and 1.12 after 48 hours. This result demonstrates that adductor canal block provides adequate postoperative pain relief in unilateral total knee arthroplasty patients.

## Discussion

The adductor canal is a musculoaponeurotic space in the thigh, extending from the apex of the femoral triangle to the adductor hiatus, between the vastus medialis muscle anterolaterally and the adductor longus and adductor magnus muscles posteromedially. It is roofed in the entire length by the vastoadductor membrane.[8–10] It contains several nerve branches that supply sensory innervations to the knee, including consistently the saphenous nerve (which innervates the infrapatellar skin and anterior knee capsule) and a distal branch of the motor nerve to the vastus medialis (which provides sensory innervation to the superomedial aspect of the knee and knee capsule.[11] In addition other small sensory nerves involved in analgesia of the knee course frequently, although not consistently, through this space. The adductor canal is therefore an attractive location to provide sensory innervations to the knee with potential limited effect on motor function.

Adductor canal block (ACB) is a relatively new alternative for post-TKA pain management. Regional anesthesia is deposited within an adductor canal that can be easily visualized at the middle third of the thigh with use of ultrasonography. Consequently, 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.[8–10] Therefore, ACB may have a minimal effect on quadriceps muscle strength, but provides a comparable level of pain relief and early mobilization.

All blocks were performed postoperatively under spinal anesthesia. This was done due to 2 reasons:

1. To avoid entrapment of the catheter between the nerve and the tourniquet.

2. To avoid dislodging of the catheter during surgery.

The local anesthetic were administered as repeated boluses through a catheter to ensure spread of local anesthetics throughout the aponeurotic canal. This is because adequate adductor canal block blocks more than just the saphenous nerve in the adductor canal. In addition to the saphenous nerve, the adductor canal also contains the nerve to vastus medialis, the medial femoral cutaneous nerve, the medial retinacular nerve and finally the articular branches from the obturator nerve, which enters the distal part of the canal.

The dose administered was 8 ml injected into the adductor canal. The volume was kept low because increasing the volume caused the drug to spread proximally to the anterior and posterior divisions of the femoral nerve outside the canal thereby increasing the risk of motor blockade.

We used integrated multimodal analgesic protocols, as defined by the American Society of Anesthesiologist practise guidelines on perioperative pain management, use two or more analgesic modalities with different mechanism of actions to provide superior analgesia and limit side effects and adverse events.[12] Regional analgesic technique is usually at the centre of these multi modal protocols in a background of NSAIDS and low dose opioids. There is anascent but growing case being made in the contemporary literature to support ACB as the most appropriate regional analgesic technique to be the core of multimodal analgesic protocol for TKA due to its decreased potential for quadriceps weakness.[13,14]

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