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Original research article

Adductor canal block (ACB) in patients undergoing ACL reconstruction with conventional analgesia: Degree of motor blockade and sensory blockade

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Abstract

Adductor canal block is almost exclusively sensory block that has been demonstrated to reduce the pain & opioid consumption after knee surgery. A transsartorial landmark-based distal approach to the saphenous nerve block has shown to reduce pain significantly by providing sensory block to the tissues around knee joint. 60 ASA 1 & 2 patients posted elective anterior cruciate ligament reconstruction will be assessed after obtaining the requisite Hospital Ethical Committee approval. Sample size was decided in consultation with a statistician. The mean motor blockade grade in group 1 and group 2 was 4.60 ± 0.60 and 4.53± 0.726 respectively 30MIN after surgery. The difference in the two groups was statistically insignificant (p value = 0.48). The mean sensory blockade in group 1 and group 2 was 0.767 ± 0.070 and 0.56 ± 0.009 respectively 30MIN after surgery. The difference in the two groups was statistically significant (p value = 0.032).

Keywords: Adductor canal block, ACL reconstruction, conventional analgesia

Introduction

Arthroscopic knee surgery can cause significant postoperative pain to potentially delay timely discharge from ambulatory surgical setting.

Analgesia after knee surgery can be provided by multiple method. i.e. non-systemic non-opioid-based methods- local anaesthetic wound infiltration, Spinal anesthesia, epidural anesthesia, intra-articular injection and peripheral nerve block. And Traditional methods for postoperative pain management include opioids administered systemically using I.V PCA (patient control analgesia) [1].

Each of these techniques has advantages and disadvantages. Opioids however, pain relief, specifically on movement, is not always adequately controlled when using PCA, despite moderate–large doses drug. This is associated with side-effects such as postoperative nausea and vomiting (PONV), tiredness, pruritus, headache and constipation [2].

Spinal and epidural are safe but are limited by potentional for hypotension and term of motor blockade which delays the patient ambulation and physiotherapy goals.

Femoral nerve block has been shown to be superior to traditional intraarticular injection of local anaesthesia in some knee surgeries, but motor blockade of the quadriceps with potential risk for falls limits the value of femoral blocks for less invasive ambulatory surgery.

Recently the adductor canal block has been described. It is technique that was first described by Van der Wal. The local anesthetics deposited in adductor canal that provide improved analgesia by blocking saphenous nerve a terminal branch of femoral nerve, provide cutaneous sensation to peripatellar region and medial aspect of lower extremity below knee as well as to articular branches to medial aspect of knee joint. The saphenous separates from femoral nerve in proximal third of thigh, courses through adductor canal with nerve to vastus medialis & emerge from adductor hiatus to divide into infrapatellar branch and sartorial branch [3].

Adductor canal block is almost exclusively sensory block that has been demonstrated to reduce the pain & opioid consumption after knee surgery. A transsartorial landmark-based distal approach to the saphenous nerve block has shown to reduce pain significantly by providing sensory block to the tissues around knee joint [4].

Traditionally, saphenous nerve block have been performed as landmark based technique with marginal rate of success as low as 33%. With the ultrasound, the feasibility of effective saphenous nerve block at

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adductor canal has been shown.
The adductor canal block may provide superior analgesia over traditional distal saphenous nerve blocks for surgical procedures of knee because this block includes saphenous nerve, the nerve to vastus medialis, and potentially the articular contribution of obturator nerve to knee joint. Obturator nerves provide variable sensation to posteromedial aspect of knee before innervating the joint. This obturator nerve provides sensory innervation to posteromedial aspect of knee before giving articular branch to knee joint [5, 6].

Methodology
Study population
60 ASA 1 & 2 patients posted elective anterior cruciate ligament reconstruction will be assessed after obtaining the requisite Hospital Ethical Committee approval. Sample size was decided in consultation with a statistician.

Study design
A prospective, randomized, single blind, controlled study.

Sample size
A sample size of 30 patients each, randomly allocated into two groups, using computerized randomization.
Group 1: with conventional analgesia (tramadol).
Group 2: Adductor canal block with 20ml of 0.75% ropivacaine.

Inclusion criteria
1. ASA 1 &2.
2. Age 18-75yrs.
3. Weight 40-85kgs.
4. Planned electively for ACL reconstruction under spinal anesthesia.
5. Capable of giving an Informed Consent.

Exclusion criteria
1. ASA 3,4 or 5 adults.
2. Age >75years.
3. BMI>35.
4. Incapable of providing informed consent.
5. Have impaired liver or kidney function.
6. H/O alcohol or drug abuse.
7. H/O chronic pain condition or daily intake of analgesics and steroids.
8. Hypersensitivity to amide local anaesthetics.
9. Uncontrolled anxiety.
10. Schizophrenia or bipolar disorder.
11. Peripheral neuropathy.
12. Are ineligible to provide informed consent.

Methodology
Randomisation: After obtaining written informed consent, patients satisfying the inclusion criteria were randomized into 2 groups using a computer generated random number list:
Group 1: Will receive conventional analgesia (tramadol).
Group 2: Will receive Adductor canal block with 20 mL of 0.75% ropivacaine.

Allocation concealment: Group allocation was concealed in sealed, opaque envelopes.
Blinding: A pain nurse who had undergone prior education in assessment of postoperative analgesia and who was unaware of group assignment collected data on each patient. Thus the observer was blinded.

Procedure
One day before surgery
Details of present study process including potential side effects were explained to all patients and relatives. The patients were also informed about the NRS for assessment of pain postoperatively and the satisfaction scores.
Thorough clinical examination & History was taken.

Investigations: CBP, ECG and X ray Chest of patients, Blood sugar, Blood urea and serum creatinine, Serum electrolytes, prothrombin time with International Normalized Ratio (INR) and activated partial

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thromboplastin time, Blood group, 2D-ECHO if required were done. Physician and cardiologist opinion if required were taken.
Patients were kept NBM for 6 hours and oral sedative premedication was given night before surgery. Well informed written consent was obtained.
In the preoperative area, after obtaining institutional approval, the patients were explained about the sequence of anesthetic procedures and a good intravenous access was secured.
Sensory blockade was tested before and after completion of procedure on dichotomous scale:- presence or absence of pin prick sensation along distribution of saphenous nerve. Blocks were considered successful if either the infrapatellar region or medial malleolus was insensitive to pin prick.
Motor blockade was tested using a modified bromage scale.
Onset of motor blockade is defined as time taken to reach modified bromage score1. Duration is defined as time taken for return to modified bromage score 6.

Results

Table 1: Postoperative 24hrs motor blockade in the two groups

Study Parameter Motor Blockade	Group 1 (n=30) Mean	Std. Dev.	Group 2 (n=30) Mean	Std. Dev.	t test	'p' Value	Mann Whitney test	'p' Value
Postop	3.667	0.5467	3.73	0.520	0.484	0.630		
30min	4.600	0.6747	4.46	0.776	0.710	0.480		
1hr	5.667	0.4795	5.33	0.711	2.129	0.038	340	
2hr	6.000	0.000	5.90	0.305	1.795	0.078	405	
4hr	6.000	0.000	6.000	0.000		1.000	450	
8hr	6.000	0.000	6.000	0.000		1.000	450	
12hr	6.000	0.000	6.000	0.000		1.000	450	
16hr	6.000	0.000	6.000	0.000		1.000	450	
20hr	6.000	0.000	6.000	0.000		1.000	450	
24hr	6.000	0.000	6.000	0.000		1.000	450	

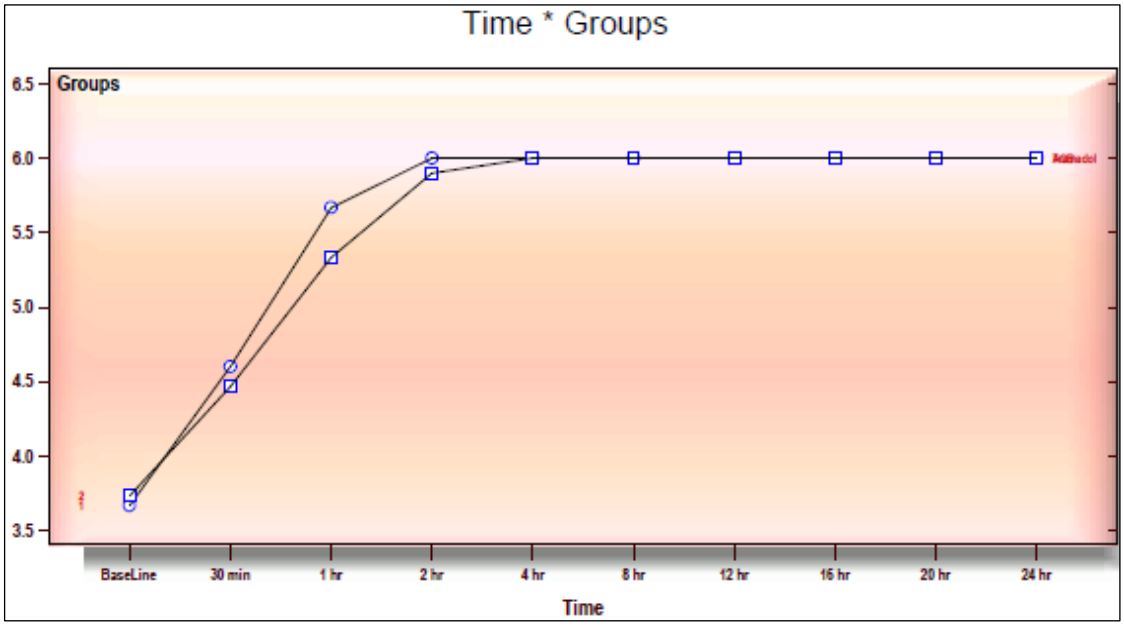

Fig 1: Postoperative 24hrs motor blockade in the two groups

The mean motor blockade grade in group 1 and group 2 was 3.63 ± 0.546 and 3.70 ± 0.5 respectively POSTOP after surgery. The difference in the two groups was statistically insignificant (p value =0.63).
The mean motor blockade grade in group 1 and group 2 was 4.60 ± 0.60 and 4.53± 0.726 respectively 30MIN after surgery. The difference in the two groups was statistically insignificant (p value = 0.48).
The mean motor blockade grade in group 1 and group 2 was 5.66 ± 0.46 and 5.500± 0.624 respectively, 1 hours after surgery. The difference in the two groups was statistically significant (p value = 0.038).
The mean motor blockade grade in group 1 and group 2 was 6.00 ± 0.00 and 5.950 ± 0.220 respectively, 2 hours after surgery. The difference in the two groups was statistically insignificant (p value = 0.8).
The mean motor blockade grade in group 1 and group 2 was 6.00 ± 0.00 and 6.00 ± 0.00 respectively 4 hours after surgery. The difference in the two groups was not statistically insignificant (p value = 1.00).
The mean motor blockade grade in group 1 and group 2 was 6.00 ± 0.00 and 6.00 ± 0.00 respectively, 8 hours after surgery. The difference in the two groups was statistically insignificant (p value = 1.00).

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The mean motor blockade grade in group 1 and group 2 was 6.00 ± 0.00 and 6.00 ± 0.00 respectively, 12 hours after surgery. The difference in the two groups was statistically insignificant (p value = 1.00).
The mean motor blockade grade in group 1 and group 2 was 6.00 ± 0.00 and 6.00 ± 0.00 respectively, 16 hours after surgery. The difference in the two groups was statistically insignificant (p value = 1.00).
The mean motor blockade grade in group 1 and group 2 was 6.00 ± 0.00 and 6.00 ± 0.00 respectively, 20 hours after surgery. The difference in the two groups was statistically insignificant (p value = 1.00)
The mean motor blockade grade in group 1 and group 2 was 6.00 ± 0.00 and 6.00 ± 0.00 respectively, 24 hours after surgery. The difference in the two groups was statistically insignificant (p value = 1.00).

Table 2: Postoperative 24hrs Sensory blockade in the two groups

Study Parameter	Group 1 (n=30)		Group 2(n=30)		t-test	'p'	Mann	'p'
Sensory Blockade	Mean	Std. Dev.	Mean	Std. Dev.		Value	Whitney test	Value
Postop	1.00	0.00	1.00	0.00		1.000	450	
30min	0.7667	0.4302	0.500	0.508	2.193	0.032	330	
1hr	0.133	0.3457	0.200	0.406	0.684	0.497		
2hr	0.000	0.000	0.667	0.253	1.439	0.155	420	
4hr	0.000	0.000	0.000	0.000		1.000	450	
8hr	0.000	0.000	0.000	0.000		1.000	450	
14hr	0.000	0.000	0.000	0.000		1.000	450	
16hr	0.000	0.000	0.000	0.000		1.000	450	
20hr	0.000	0.000	0.000	0.000		1.000	450	
24hr	0.000	0.000	0.000	0.000		1.000	450	

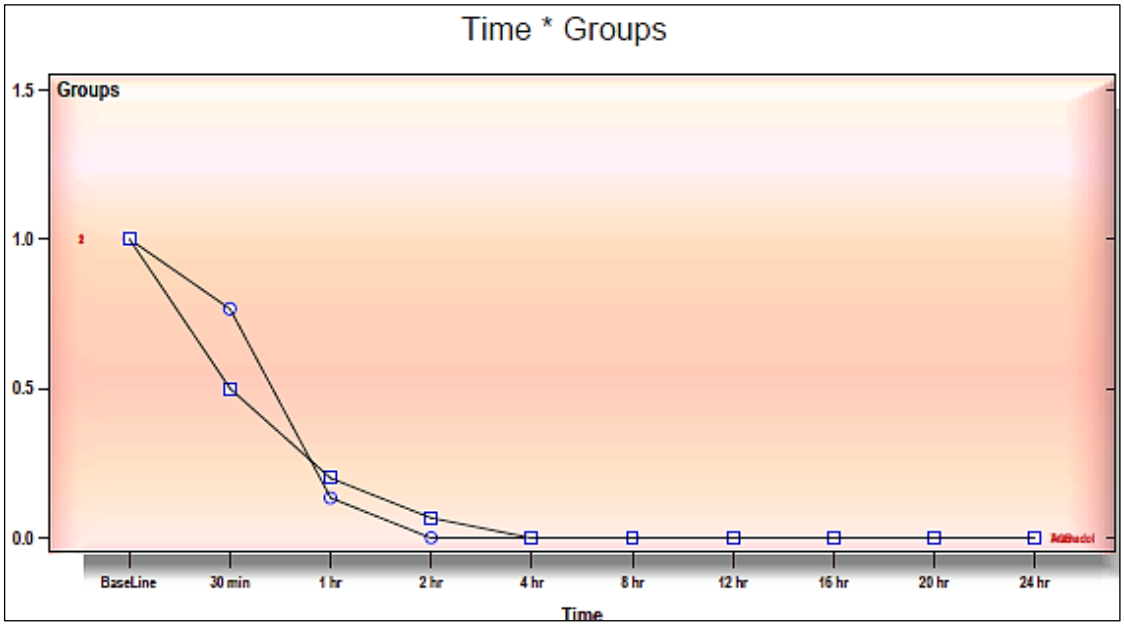

Fig 2: Postoperative 24hrs sensory blockade in the two groups

The mean sensory blockade in group 1 and group 2 was 1.00± 0.00 and 1.00± 0.00respectively POSTOP after surgery. The difference in the two groups was statistically insignificant (p value =1.00).
The mean sensory blockade in group 1 and group 2 was 0.767 ± 0.070 and 0.56 ± 0.009 respectively 30MIN after surgery. The difference in the two groups was statistically significant (p value = 0.032).
The mean sensory blockade in group 1 and group 2 was 0.133± 0.0636 and 0.20 ± 0.074 respectively, 1 hours after surgery). The difference in the two groups was statistically insignificant (p value = 0.497).
The mean sensory blockade in group 1 and group 2 was 0.00 ± 0.00 and 0.066 ± 0.04 respectively, 2 hours after surgery. The difference in the two groups was statistically insignificant (p value = 0.155).
The mean sensory blockade in group 1 and group 2 was 0.00 ± 0.00 and 0.00 ± 0.00 respectively 4 hours after surgery. The difference in the two groups was not statistically significant (p value = 1.000).
The mean sensory blockade in group 1 and group 2 was 0.00 ± 0.00 and 0.00 ± 0.00 respectively, 8 hours after surgery. The difference in the two groups was not statistically significant (p value = 1.00).
The mean sensory blockade in group 1 and group 2 was 0.00 ± 0.00 and 0.00 ± 0.00 respectively, 12 hours after surgery. The difference in the two groups was statistically not significant (p value = 1.00).
The mean sensory blockade in group 1 and group 2 was 0.00 ± 0.00 and 0.00 ± 0.00 respectively, 16 hours after surgery. The difference in the two groups was statistically not significant (p value = 1.00).
The mean sensory blockade in group 1 and group 2 was 0.00 ± 0.00 and 0.00 ± 0.00 respectively, 20 hours after surgery. The difference in the two groups was statistically not significant (p value = 1.00).

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The mean sensory blockade in group 1 and group 2 was 0.00 ± 0.00 and 0.00 ± 0.00 respectively, 24 hours after surgery. The difference in the two groups was statistically not significant (p value = 1.00).

Discussion

Compared with bupivacaine, ropivacaine produces a similar pattern of sensory block, but less motor block when given by some routes. Ropivacaine is less lipophilic than bupivacaine and that, together with its stereo selective properties, contributes to ropivacaine having a significantly higher threshold for cardiotoxicity and CNS toxicity than bupivacaine in animals and healthy volunteers [7].

In general, and in keeping with *in vitro* studies, equal volumes and concentrations of ropivacaine and bupivacaine provide similar onset, quality and duration of sensory block when used for infiltration anaesthesia, peripheral nerve, brachial plexus, or extradural block.

Small unmyelinated C fibers and small myelinated A fibers are responsible for pain transmission Whereas large A fibers transmit motor impulses. *In vitro*, most local anaesthetic drugs block C fibres at approximately the same rate. The rate of A fibre block depends on the physicochemical properties of the individual drugs, high pKa and low lipid solubility favouring block of C fibres before A [8].

The pKa of bupivacaine and ropivacaine are identical but ropivacaine is less fat soluble predicting that ropivacaine will block A fibres more slowly than bupivacaine – this has been confirmed *in vitro*. From this it would be anticipated that ropivacaine would cause less motor block than bupivacaine.

Central nervous system toxicity is directly related to local anaesthetic potency and the convulsant doses of ropivacaine and bupivacaine are similar.

The lower lipophilicity of ropivacaine versus bupivacaine correlated with the lesser cardiodepressant effects of both ropivacaine isomers than of the bupivacaine isomers in animal studies. Cardiovascular toxicity, especially the development of arrhythmias, however is a particular problem with bupivacaine and the R enantiomer is more cardiotoxic than the S- enantiomer. Local anaesthetics exert their direct toxic effect on the heart by blocking sodium influx through sodium channels. This causes depression of the maximal rate of increase (Vmax), of the cardiac action potential and results in delayed conduction, seen on the ECG as prolongation of the PR interval and QRS complex. Re-entrant phenomena and ventricular arrhythmias may occur. Ropivacaine depresses Vmax less than bupivacaine and recovery is quicker after ropivacaine. Convulsant and greater doses of local anaesthetics obviously cannot be given deliberately to humans but some data are available. Ropivacaine was tolerated to a greater dose than bupivacaine and at these doses ropivacaine had less effect than bupivacaine on cardiac conductivity and contractility. After intravenous infusion the clearance of ropivacaine was more rapid than previously determined for bupivacaine [9, 10].

Conclusion

- The mean sensory blockade in group 1 and group 2 was 0.767 ± 0.070 and 0.56 ± 0.009 respectively 30MIN after surgery. The difference in the two groups was statistically significant (p value = 0.032).
- The mean motor blockade grade in group 1 and group 2 was 4.60 ± 0.60 and 4.53± 0.726 respectively 30MIN after surgery. The difference in the two groups was statistically insignificant (p value = 0.48).

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