ORIGINAL ARTICLE

Effectiveness of Two Different Volumes of Bupivacaine in Adductor Canal Block for Postoperative Analgesia after Anterior Cruciate Ligament Reconstruction

Md. Bablu Hossain[1], Md. Abdullah Tarek Bhuyian[2], Md. Mosharraf Hossain[3], Nurjahan Begum[4], Sakera Sultana[5], Debabrata Banik[6]

DOI:https://doi.org/10.62848/bjpain.v3i1.8793

Received: 02 January, 2023
Accepted: 05 April, 2023

Abstract

Background: Anterior cruciate ligament (ACL) injury is corrected by arthroscopic procedure and knee arthroscopy causes severe pain. Adductor canal block (ACB) with local anesthetic solution e.g., with bupivacaine produces excellent analgesia and addition of dexamethasone provides prolong pain free period. Systemic steroidal and nonsteroidal analgesic requirement is reduced significantly. Motor function improves early and reduced tendency to fall.

Objective: The study aims to see the effectiveness of different volumes of bupivacaine in adductor canal block for postoperative analgesia after anterior cruciate ligament reconstruction operation.

Methods: This prospective,quasiexperimental study was conducted in the Department of Anaesthesia, Analgesia and Intensive Care Medicine in collaboration with the Department of Orthopaedic Surgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, between October 2020 and September 2021. A total of 50 patients with ACL injury were recruited in this study and were randomized into two groups (A & B); each group had 25 patients. Group A received 15ml 0.25% bupivacaine and 0.2mg/ml dexamethasone, while group B received 20ml of 0.25% bupivacaine and 0.2mg/ml dexamethasone solution. The visual analogue scale (VAS) ranging from 0 to 10 was used to assess postoperative pain at 1 hour, 2 hour, 3 hour, 6 hour, 9 hour,12 hour, 15 hour,18 hour, 21 hour and 24 hour. Patients were assessed for the duration of analgesia by returning of pain. Injection ketorolac 30mg was given intravenously as rescue analgesic when if any patient needed. Motor functions were assessed after 24 hours by Medical Research Council (MRC) criteria to see quadriceps weakness. Postoperative complications were also observed.

Results: The VAS score was significantly lower in both group A and Group B at all time intervals except at the 18th hour. After onset of block, motor power decreased in both group but after 24 hours motor power came back to normal. There was no significant difference between two groups in case of onset of sensory block (12.51±3.78 min. vs. 11.24±3.85 min.), mean time of first analgesic requirement (16.75±2.45 hours vs. 17.35±2.70 hours) and low analgesic requirements (39.6±6.7mg vs. 36.8±5.4 mg) in the first 24 hours (P>0.05). Patients in both groups did not have high incidence post-operative complications like nausea (12% vs. 8%), vomiting (8% vs. 12%), dizziness (8% vs. 4%). In group A, 60% of patients were satisfied and 20% were very satisfied, while in group B, 56% of patients were satisfied and 28% of the patients were very satisfied with the therapy given to them. No statistically significant difference was observed (P>0.05).

Conclusion: Our data suggest that adductor canal block (ACB) with either 15ml or 20ml of 0.25% bupivacaine improved postoperative analgesia in ACL reconstruction surgery. Both 15ml and 20ml of local anaesthetics in adductor canal provided similar effectivity in pain relief. Moreover, it preserved quadriceps motor strength. Hence, ACB could be a good option in patients undergoing ACL reconstruction.

Keywords: Anterior cruciate ligament reconstruction, adductor canal block, local anaesthetic, postoperative analgesia

Citation: Hossain MB, Bhuyian MAT, Hossain MM, Begum N, Sultana S, Banik D. Effectiveness of Two Different Volumes of Bupivacaine in Adductor Canal Block for Postoperative Analgesia after Anterior Cruciate Ligament Reconstruction. Bangladesh J. Pain 2023; 3(1): 16-21. doi:10.62848/bjpain.v3i1.8793

1. Anaesthesiologist, Department of Anaesthesiology, ICU and Critical Care Medicine, Rangpur Medical College Hospital, Rangpur, Bangladesh

2. Assistant Professor, Department of Anaesthesia, Analgesia, Palliative and Intensive Care Medicine, Dhaka Medical College Hospital, Dhaka, Bangladesh

3. Anaesthesiologist, National Institute of Cancer Research and Hospital, Dhaka- 1212

4. Resident, Department of Reproductive Endocrinology and Infertility, Bangabandhu Sheikh Mujib Medical University, Dhaka

5. Assistant Surgeon, Nilokhi Union Sub Centre, Homna, Cumilla

6. Professor, Department of Anaesthesia, Analgesia and Intensive Care Medicine, Bangabandhu Sheikh Mujib Medical University ,Dhaka, Bangladesh

Correspondence:
Md. Bablu Hossain
babluss34@gmail.com

Introduction

Appropriate pain management provides better surgical outcome after arthroscopic anterior cruciate ligament injury repair. Many orthopedic procedures involve significant soft tissue and bony dissection, requiring potent analgesic medication for adequate postoperative pain management.[1] Anterior cruciate ligament (ACL) injury is increasing day by day and surgical reconstruction is being performed in many centers in Bangladesh. Pain management after ACL reconstruction surgery is of crucial importance for restoring optimal knee function.[1,2] Patients can undergo the rehabilitation program with a controlled pain threshold in order to prevent knee stiffness and thigh muscle hypotrophy.[3] Ultrasound guided peripheral nerve block provides excellent analgesia as it is placed within or near the vicinity of nerve fiber blocking sensory neurotransmission of action potential.[4] Peripheral nerve blocking provides good control of hemodynamic status. Peripheral nerve block can be given safely even in cardiac function compromised patients.[4] Adductor canal block (ACB) provides post-operative analgesia following anterior cruciate ligament injury repair, so we could avoid opioids and its adverse effects as well as NSAIDs.[2,5] Early initiation of physiotherapy remains crucial for functional outcome as peripheral nerve block provides longer duration of pain relief.[4,6] Even in renal compromised patients, peripheral nerve block e.g., adductor canal block can be given in ACL reconstruction surgery ensuring safety.[6] One important advantage of ultrasound guided adductor canal block is that it facilitates direct vision of the nerve so that accurate delivery of drug is possible and thus, it enhances patients' comfort and satisfaction.[6-8] As through ACB pain can be reduced without hampering motor functions, an early discharge can be possible, which may result in low hospital cost for the patient.[1,5] Hence, ultrasound guided adductor canal block is a new dimension of treatment procedure. However, there is no reports on effectiveness of ACB in ACL reconstruction in our country. Therefore, more studies in the country are needed to identify the optimum volume of local anaesthetics to ensure adequate analgesia after ACL reconstruction surgery. Aiming at that direction, we proposed this study to see the effectiveness of different volumes of local anaesthetics in adductor canal block for postoperative analgesia after anterior cruciate ligament reconstruction operation in a tertiary level specialized hospital of the country.

Methods

This prospective, quasiexperimental study was conducted in the Department of Anaesthesia, Analgesia and Intensive Care Medicine in collaboration with the Department of Orthopaedic Surgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, between October 2020 and September 2021. Patients aging between 18 and 50 years, American Society of Anesthesiologists (ASA) physical classification I & II and scheduled for elective unilateral ACL reconstruction surgery were included in this study. Those who have history of allergy to local anaesthetics, history of chronic pain in the lower extremities, neuropathy or neurological deficits involving the lower extremities and significant psychiatric or mental disorder were excluded. Then, they were randomly divided into two groups with 25 patients in each group A and group B.

Adductor canal block (ACB) was performed in each patient in supine position by using ultrasound at mid-thigh level and block assessment were performed[4]. An investigator assessed the accuracy of block. Subarachnoid block was given with the patients either sitting or lateral recumbent position. Injection bupivacaine 12.5mg were given intrathecally in all patients after performance of the ACB. A fixed dose of study solution was prepared by injection bupivacaine 100 mg that was 20ml of 0.5% bupivacaine and 18ml distilled water was mixed with injection dexamethasone (4mg/ml) 2ml. A total of 40ml of solution was prepared. From this solution, patients of group A and group B was given 15ml and 20ml respectively. Haemodynamic parameters were recorded both intra-operatively and post operatively. After operation, the patients were observed whether and when they complain of pain (observations were at 3hours, 6hour, 9hours, 12hour, 15hours, 18hours, 21hours and 24hours following surgery and pain was assessed by using (VAS) score. Injection ketorolac 30mg intravenously was given as rescue analgesic to the patients if there was a demand or VAS score was found ≥4. Besides, the quadriceps muscle strengths

were assessed by Medical Research Council (MRC), before performance of the block, after performance of block, at 6hour, 12hour and after 24hour. Thus, we evaluated the postoperative analgesic effect of adductor canal block with 15ml and 20ml 0.25% bupivacaine both contain dexamethasone for scheduled in patients undergoing ACL reconstruction under subarachnoid block.

Every patient's data were collected and recorded on a separate data sheet. Then, all necessary data were entered into and analyzed using SPSS version 24.0 (IBM SPSS, Chicago, IL, USA). Statistical analysis was performed by using Student's t-test or chi-square ($\chi 2$) test for mean±SD of onset time of block, the total duration of analgesia after the block, mean VAS, mean analgesic requirement, quadriceps muscle strength score and mean arterial pressure and the mean duration of surgery. After analyses of all data, P value <0.05 was considered statistically significant.

Results

The mean age of the patients was 35.4±8.5 years in group A and 37.6±7.4 years in group B. Maximum patient had ASA Class I (60% vs. 56%) in both groups. On consideration of BMI, the patients had average (28.8±3.5 vs. 26.2±3.9) in both groups. The duration of surgery was 49.8±10.6 minutes in group A, while 51.4±11.9 minutes in group B. No statistically significant difference was observed in any of the characteristics of patients between two groups (P>0.05) (**Table-I**).

Table-I: Demographic characteristics of the patients and duration of surgery

Characteristics	Group A (n=25)	Group B (n=25)	P value
Age (in years)	35.4±8.5	37.6±7.4	0.68
BMI (kg/m2)	28.8±3.5	26.2±3.9	0.72
Gender			
Male	18(72%)	16(64%)	0.69
Female	7(28%)	9(36%)	0.65
ASA			
Class I	15(60%)	14(56%)	0.71
Class II	10(40%)	11(44%)	0.67
Duration of surgery (in minutes)	49.8±10.6	51.4±11.9	0.73

Values are expressed as Mean±SD and percentages (within parenthesis) over column in total; P value reached from chi-square test and Student's t-test as applicable.

Considering the baseline vital signs, i.e., heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), oxygen saturation on pulsatile capillary (SpO2) and respiratory rate (RR) in two groups were measured prior to surgical operation and no difference was observed in any of the characteristics between two groups (P>0.05) (**Table-II**).

Table-II: Comparison the baseline vital signs between two groups

Baseline Vitals	Group A (n=25)	Group B (n=25)	P value
HR	87.6±8.7	86.8±8.5	0.63
SBP	128.4±11.4	126.7±10.8	0.69
DBP	78.6±8.3	77.6±8.6	0.68
MAP	90.5±5.8	88.7±6.3	0.76
SpO2	99.3±0.4	99.1±0.5	0.84
RR	17.5±2.7	16.2±2.5	0.71

Values are expressed as Mean±SD; P value reached from Student's t-test.

The VAS scores were found low in both groups at all-time intervals except the 18th hours in postoperative care. VAS score was observed high (≥4) in both group in the 18th hour. The scores were higher at that time point where the patients usually complaint of pain. However, no significant difference was observed in Visual Analogue Scale (VAS) between two groups during the postoperative period (P>0.05) (**Table-III**).

Table-III: Visual Analogue Scale (VAS) during postoperative period between two groups

VAS score	Group A (n=25)	Group B (n=25)	P value
Hour 1	0.45±0.21	0.48±0.25	0.23
Hour 3	0.78±0.31	0.74±0.35	0.33
Hour 6	0.92±0.57	0.95±0.64	0.38
Hour 9	1.14±0.58	1.08±1.38	0.27
Hour 12	1.32±1.15	1.23±1.05	0.32
Hour 15	1.95±1.38	1.58±1.42	0.36
Hour 18	4.28±1.56	4.02±1.46	0.28
Hour 21	2.69±1.76	2.36±1.55	0.21
Hour 24	2.37±1.75	2.21±1.45	0.18

Values are expressed as Mean±SD; P value reached from Student's t-test.

There was no significant difference between two groups in case of onset of sensory block which were (12.51±3.78 minutes vs.11.24±3.85 minutes), mean

time of 1st analgesic requirement (16.75±2.45 hours vs. 17.35±2.70 hours) and analgesic requirements (39.6±6.7 mg vs. 36.8±5.4 mg) in the first 24 hours (P>0.05) (**Table-IV**).

Table-IV: Assessment of analgesia related variable of the patients

Variables	Group A (n=25)	Group B (n=25)	P value
Onset of sensory block (in minute)	12.51±3.78	11.24±3.85	0.76
Time of 1st analgesic requirement (in hour)	16.75±2.45	17.35±2.70	0.73
Total analgesic consumption (in mg)	39.6±6.7	36.8±5.4	0.81

Values are expressed as Mean±SD; P value reached from chi-square test.

After onset of block, motor power decreased in both groups; however, after 24 hours motor power came back to near normal. Overall, the differences in the Medical Research Council (MRC) grading were not statistically significant between two groups at any time interval (P >0.05) (**Fig. I**).

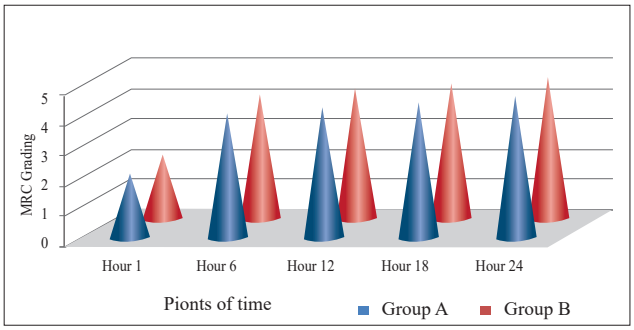

Fig. I: Medical Research Council (MRC) grading of patients during postoperative period (n=50)

Patients in both groups did not have high incidence post-operative complications; nausea (12% vs. 8%), vomiting (8% vs. 12%), dizziness (8% vs. 4%) were observed in group A and group B respectively. No patient had any incident of local anaesthetic related systemic toxicity. The difference was also not significant (P >0.05) (**Table-V**).

Table-V: Complications during postoperative period

Complication	Group A (n=25)	Group B (n=25)	P value
Nausea	3(12%)	2(8%)	0.149
Vomiting	2 (8%)	3(12%)	0.167
Dizziness	2 (8%)	1 (4%)	3(6%)

Values expressed as frequencies and percentages (in parentheses); P value reached from Student's t-test.

The level of satisfaction was much higher in group B. In group B, 65% of patients were satisfied with the therapy that they had given and 25% of the patients were highly satisfied with the same therapy. However, in group A, 60% of patients were satisfied with the therapy, while 10% were dissatisfied and 10% were very dissatisfied. No statistically significant difference was observed between two groups (P>0.05) (**Table-VI**).

Table-VI: Level of satisfaction of the studies groups

Level of satisfaction	Group A (n=25)	Group B (n=25)	P value
Very Satisfied	5(20%)	7(28%)	0.073
Satisfied	15(60%)	14(56%)	0.080
Dissatisfied	2(8%)	3(12%)	0.087
Very Dissatisfied	3(12%)	1(4%)	0.071

Values expressed as frequencies and percentages (in parentheses); P value reached from chi-square test.

Discussion

The anterior cruciate ligament (ACL) reconstruction is one of the most frequently performed orthopaedic procedures.[2,3] The ability to perform ACL reconstruction is largely dependent on an effective analgesic regimen that minimizes the role of systemic analgesics yet provides adequate postoperative pain control and eliminates the need for overnight stay or readmission.[1] Adductor canal block (ACB), a distal block of the femoral nerve performed in the mid-thigh, is becoming an attractive alternative to femoral nerve block (FNB) as the peripheral nerve block of choice for ACL reconstruction operation.[2,3] By virtue of the distal anatomical location where it is performed, ACB offers an important advantage, namely preserving the strength of the quadriceps femoris muscle, while providing pain relief to the knee that is comparable to other procedures like femoral nerve block (FNB).[9,10]

Postoperative quadriceps strength in group A was similar to group B, and this might be due to the low levels of postoperative pain which were observed to be similar in both groups. The motor preservation was also suggestive that ACB did not interfere with quadriceps strength, as noted in previous studies that demonstrated significant quadriceps motor sparing in ACB compared with FNB.[11-14] In this study, we assessed motor power of quadriceps muscles during post-operative period by Medical Research Council (MRC) grading, in which no significant differences were observed between two groups during postoperative period. After onset of block motor power decreased in both groups; however, after 24 hours, it came back to near normal grading.

One of the major concerns of the study was the possibility of motor weakness after analgesic block. Therefore, patients were assessed prior to the block, in the preanesthetic room, and after surgery. In this study, 0.25% bupivacaine was used; one group received 15ml and other group had 20ml; however, both groups received 0.2mg/ml dexamethasone in conjugation. There was no significant difference in case of motor block in between the groups. Dexamethasone significantly prolongs analgesia and motor block duration with 0.25% bupivacaine in other regional blocks like supraclavicular brachial plexus nerve block. Vieira et al. studied effects of 20ml of 0.5% bupivacaine on interscalene brachial plexus block in combination with 8mg dexamethasone and observed analgesia duration for 24.3 and 13.9 hours, respectively.[15] Tandoc et al. conducted a similar study with 40 ml of 0.5% bupivacaine and concluded that the duration of analgesia was significantly prolonged with 4mg dexamethasone up to 21.6 hours, with 8mg dexamethasone up to 25.2 hours, while the control group had 13.3 hours only.[16] Herman et al. also concluded that in ACB, dexamethasone prolonged the duration of block as compared to control (bupivacaine only) and decrease opioid consumption.[6]

The study has some limitations as well. Here in this study, the sensory block was evaluated by testing the loss of pinprick sensation. Therefore, variation in subjective evaluation among patients might have affected the accuracy of the results.[17] We did not evaluate the duration of bupivacaine 0.5% without adjuvant in ACB, as because Jæger et al. found that increasing the dose of lidocaine by a constant volume of 20ml had no effect on ACB duration.[18] A number of other factors which might have had an influence on the requirement of rescue analgesia, such as age and gender,[19] experience of the operating surgeon and the anaesthesiologist administering the block. Those factors were not compared in the present study. Future studies designed with larger samples in multi-centre trial should investigate whether a reduction in volume may lead to better preservation of muscle strength, but the analgesic effect, block duration, and effect on other nerves (i.e., medial femoral cutaneous nerve) should also be considered.

Conclusion

To summarize, our data suggest that adductor nerve block (ACB) with either 15ml or 20ml of 0.25% bupivacaine improved postoperative analgesia in ACL reconstruction surgery. Both 15ml and 20ml of local anaesthetics in adductor canal provided similar effectivity in pain relief. Moreover, it preserved quadriceps motor strength. Hence, ACB could be a good option in patients undergoing ACL reconstruction.

Declaration

Ethics approval

The study was approved by Institutional Review Board (IRB) of Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh.

Author contributions

Conception and development of the idea *MBH, DB*
Writing: MBH, MMH
Data analysis *MBH, MATB, MMH*
Data collection *MBH, NB, SS*
Review and Editing *MATB, DB*

Funding Funded by Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh as research grant.

Conflict of interests None

References

1 Miller MD, Kew ME, Quinn CA. Anterior Cruciate Ligament Revision Reconstruction. J Am Acad Orthop Surg. 2021;29(17):723-31.

2 Abdallah FW, Whelan DB, Chan VW, Prasad GA, Endersby RV, Theodoropolous J, et al. Adductor canal block provides noninferior analgesia and superior quadriceps strength

compared with femoral nerve block in anterior cruciate ligament reconstruction. Anesthesiology. 2016;124(5):1053-64.

3 Machi AT, Sztain JF, Kormylo NJ, Madison SJ, Abramson WB, Monahan AM, et al. Discharge readiness after tricompartment knee arthroplasty: adductor canal versus femoral continuous nerve blocks-a dual-center, randomized trial. Anesthesiology. 2015;123(2):444-56.

4 Zhang W, Hu Y, Tao Y, Liu X, Wang G. Ultrasound-guided continuous adductor canal block for analgesia after total knee replacement. Chin Med J (Engl). 2014;127(23):4077-81.

5 Karkhur Y, Mahajan R, Kakralia A, Pandey AP, Kapoor MC. A comparative analysis of femoral nerve block with adductor canal block following total knee arthroplasty: A systematic literature review. J Anaesthesiol Clin Pharmacol. 2018;34(4):433-8.

6 Herman J, Urits I, Eskander J, Kaye A, Viswanath O. Adductor canal block duration of analgesia successfully prolonged with perineural dexmedetomidine and dexamethasone in addition to IPACK block for total knee arthroplasty. Cureus. 2020;12(9):e10566.

7 Wang D, Yang Y, Li Q, Tang SL, Zeng WN, Xu J, et al. Adductor canal block versus femoral nerve block for total knee arthroplasty: A meta-analysis of randomized controlled trials. Sci Rep. 2017;7:40721.

8 Krishna KV, Jayachandra T. Postoperative analgesia after arthroscopic anterior cruciate ligament reconstruction: A comparison between intra-articular ropivacaine injection and adductor canal block, A prospective cohort study. Int J Orthop Sci. 2020;6(3):715-9.

9 Stevens-Lapsley JE, Balter JE, Kohrt WM, Eckhoff DG. Quadriceps and hamstrings muscle dysfunction after total knee arthroplasty. Clin Orthop Relat Res. 2010;468(9):2460-8.

10 Lund J, Jenstrup MT, Jaeger P, Sørensen AM, Dahl JB. Continuous adductor-canal-blockade for adjuvant post-operative analgesia after major knee surgery: preliminary results. Acta Anaesthesiol Scand. 2011;55(1):14-9.

11 Kwofie MK, Shastri UD, Gadsden JC, Sinha SK, Abrams JH, Xu D, et al. The effects of ultrasound-guided adductor canal block versus femoral nerve block on quadriceps strength and fall risk: a blinded, randomized trial of volunteers. Reg Anesth Pain Med. 2013;38(4):321-5.

12 de Sa D, Shanmugaraj A, Weidman M, Peterson DC, Simunovic N, Musahl V, et al. All-inside anterior cruciate ligament reconstruction – A systematic review of techniques, outcomes, and complications. J Knee Surg. 2018;31(9):895-904.

13 Kim DH, Lin Y, Goytizolo EA, Kahn RL, Maalouf DB, Manohar A, et al. Adductor canal block versus femoral nerve block for total knee arthroplasty: A prospective, randomized, controlled trial. Anesthesiology. 2014;120(3):540-50.

14 Memtsoudis SG, Yoo D, Stundner O, Danninger T, Ma Y, Poultsides L, et al. Subsartorial adductor canal vs femoral nerve block for analgesia after total knee replacement. Int Orthop. 2015;39(4):673-80.

15 Vieira PA, Pulai I, Tsao GC, Manikantan P, Keller B, Connelly NR. Dexamethasone with bupivacaine increases duration of analgesia in ultrasound-guided interscalene brachial plexus blockade. Eur J Anaesthesiol. 2010;27(3):285-8.

16 Tandoc MN, Fan L, Kolesnikov S, Kruglov A, Nader ND. Adjuvant dexamethasone with bupivacaine prolongs the duration of interscalene block: A prospective randomized trial. J Anesth. 2011;25(5):704-9.

17 Davis JJ, Bond TS, Swenson JD. Adductor canal block: more than just the saphenous nerve? Reg Anesth Pain Med. 2009;34(6):618-9.

18 Jæger P, Koscielniak-Nielsen ZJ, Hilsted KL, Fabritius ML, Dahl JB. Adductor canal block with 10 ml versus 30 ml local anesthetics and quadriceps strength: A paired, blinded, randomized study in healthy volunteers. Reg Anesth Pain Med. 2015;40(5):553-8.

19 Fischer HB, Simanski CJ, Sharp C, Bonnet F, Camu F, Neugebauer EA, et al. A procedure-specific systematic review and consensus recommendations for postoperative analgesia following total knee arthroplasty. Anaesthesia. 2008;63(10):1105-23.