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ORIGINAL ARTICLE

Comparison of Ropivacaine alone Versus Ropivacaine with Dexamethasone on the duration of Analgesia in Ultrasound Guided Adductor Canal Block for Arthroscopic Anterior Cruciate Ligament Reconstruction Surgery

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ABSTRACT

Introduction: Adductor canal block (ACB) has been propounded as best analgesic technique for post-operative pain in knee arthroscopy, especially in ACLR. The goal is to maximise recovery outcomes if adding dexamethasone to ropivacaine in adductor canal blocks for ACL repair improves postoperative pain management.

Objectives: To compare mean VAS of ultrasound-guided ACB with ropivacaine alone and ropivacaine with dexamethasone in ACLR for postoperative pain.

Methodology: This Randomized Controlled Trial was conducted at Department of Anesthesia in Orthopaedics Unit, Ghurki Trust Teaching Hospital, Lahore during February 04, 2023 to August 10, 2023. After approval of hospital Ethical Review Committee, 264 patients fulfilling inclusion criteria were randomly allocated into two groups using lottery method. First rescue analgesic dose of i.v. injection (inj.) nalbuphine 0.1mg/kg (max 8 mg) administered in case of VAS more than 3. if VAS remains >3, a second rescue analgesic i.e. i.v. inj. ketorolac 30mg was injected.

Results: Of 264 patients, 132 were in Group A and 132 were in Group B. In Group A, more than half of cases were females with a mean age of 34.83±9.27 years. In Group B, more than half of cases were males with a mean age of 34.10±9.48 years. The mean postoperative pain was 3.43±.84 in Group A significantly higher than Group B i.e., 2.99±.84 as p<.001.

Conclusion: It was concluded that combining dexamethasone with ropivacaine in adductor canal block considerably reduced average pain score compared to ropivacaine alone in anterior cruciate ligament arthroscopic surgery.

Keywords: Adductor canal block; Ropivacaine; Dexamethasone; Anterior cruciate ligament reconstruction; Postoperative pain; Visual Analog Scale; Ultrasound-guided block; Randomized controlled trial.

INTRODUCTION

Arthroscopic knee surgeries comprise a wide variety of knee interventions. Anterior cruciate ligament reconstruction (ACLR) is one amongst the most common procedures[1] that a patient undergoes either on outpatient basis or with hospital stay. The post ACLR pain can restrict critical landmarks of recovery such as early ambulation, range of motion at the operated knee and duration of hospital stay. Moreover, the effect of insufficient analgesia on the quality of life cannot be undermined[2]. The post-operative pain management plan in the setting of ACLR consists of multimodal analgesia including the systemic as well as non-systemic approach like local anesthetic infiltration, peripheral nerve block, intra-articular injection and neuraxial blockade[3]. Ropivacaine is the preferred local anesthetic for peripheral nerve blocks because of its faster time of onset, higher therapeutic index and lower risk of cardiac toxicity in case of an inadvertent intravascular injection[4]. Dexamethasone has proven to be an effective adjuvant for peripheral nerve block that leads to prolonged analgesia and reduction in pain intensity[5]. Its proposed mechanism of action includes the alteration of inflammatory response by acting systemically. Its local effects may be attributed to its action on glucocorticoid receptors to induce vasoconstriction thus reducing the systemic absorption of local anesthetic and prolongation of its duration of action[6]. Other suggested mechanisms of action include suppression of nociceptive C-fiber transmission of pain signals and direct action on the nerve cell to reduce neural discharge by increasing the activity of inhibitory potassium channel[7]. A study demonstrated that 26 out of 30 patients in ACB group had preserved quadriceps muscle strength as compared to 18 out of 30 patients in FNB group ($p<0.01$)[3]. Another randomized controlled trial (RCT) compared the effect of adding dexamethasone to a local anesthetic in ACB. The difference of duration of sensory block was found to be statistically significant (17.42 ± 5.24 h) in dexamethasone group as compared to (12.52 ± 1.16 h) in control group, $p < 0.001$ [5]. The rationale of this study is to compare the effect of adding dexamethasone to ropivacaine versus ropivacaine alone on ultrasound guided adductor canal block in the patients undergoing arthroscopic anterior cruciate ligament repair. Literature manifests that addition of dexamethasone in a local anesthetic for a peripheral nerve block increases the duration of analgesia which improves the outcome of surgery by early mobilization and rehabilitation. Moreover, no local evidence was found in literature that can help us in the implementation of our proposed protocol i.e. Ropivacaine with dexamethasone in ultrasound guided ACB as a part of multimodal analgesia in the post-operative period. Continuum of study is important to get more effective modality for reduction of post-operative pain and increase the duration of analgesia. This will also help us to enhance our practice and will update local guidelines to prevent post-operative pain in patients undergoing ACLR.

Objective: To compare the mean VAS of ultrasound guided ACB with ropivacaine alone and ropivacaine with dexamethasone in ACLR for post-operative pain.

METHODOLOGY

This Randomized Controlled Trial was conducted at Department of Anesthesia in Orthopaedics Unit, Ghurki Trust Teaching Hospital, Lahore during February 04, 2023 to August 10, 2023. Data were collected thorugh Non-probability consecutive sampling technique.

Sample size: A sample size of 262(132 per group) was calculated using 5% level of significance, 80% power of the test and the

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mean pain score in terms of VAS after 24 hrs of ultrasound guided ACB with bupivacaine alone as 3.87±0.35 and bupivacaine with dexamethasone as 3.7±0.6 [5].

Inclusion Criteria: Patients of aged 18-50 years of either gender, ASA status I and II, scheduled for arthroscopic ACLR, willing to participate in the study.

Exclusion Criteria: Patients with history of allergy to local anesthetics, local infections of skin, anatomical deformities, coagulation disorders, diabetes mellitus, morbid obesity (BMI>35) and not willing to participate in the study.

Data collection: Subsequent to the approval of hospital Ethical Review Committee (ERC), 264 patients (132 in each group) fulfilling the inclusion criteria were briefed about the study. After informed consent, socio-demographic and other relevant clinical information was noted. Patients were randomly allocated in two groups R and D by using lottery method. All patients underwent surgery in General Anesthesia. Once inside the operation theatre, standard ASA monitoring (I & II) was applied to the patient, intravenous cannula was ensured followed by the initiation of intravenous (i.v.) fluid. General anesthesia with supraglottic airway device was administered to the patient. After the completion of surgery and before emergence, ultrasound guided ACB were performed. High frequency linear ultrasound probe was utilized. A 23 Gauge, 90mm Spinal needle was used with in plane technique at mid-thigh level. Drug was injected according to the allocated group. Patients in Group R will be injected 20ml of 0.25% Ropivacaine + 2ml Normal Saline while patients in Group D will be injected 20ml of Ropivacaine + 2ml Dexamethasone (8mg). After complete recovery, patient reversed from general anesthesia and shifted to PACU and later to the ward. Patient's VAS was assessed at 24 hours post-operatively. Duration of analgesia, post-op opioid consumption and duration of post-operative hospital stay was recorded. First rescue analgesic dose of i.v. injection (inj.) nalbuphine 0.1mg/kg (max 8 mg) was administered in case of VAS more than 3. If VAS remains >3, a second rescue analgesic i.e. i.v. inj. ketorolac 30mg was injected. In case, VAS still remains >3 a third rescue analgesic i.e. i.v. inj. paracetamol 1gm was given.

Data analysis: All the data were entered and analyzed using SPSS software version 22. For quantitative variables like age, BMI, and VAS for post-operative pain, mean and standard deviation while categorical variables such as gender and ASA frequency and gender, BMI, ASA, Time at which 1st rescue analgesia was given percentages were calculated. Data were stratified with age, (VAS < 3) and duration of postoperative hospital stay to see the effect modifier. Post-stratification independent sample t-test was applied. A p-value ≤0.05 was considered as significant. A T-test was applied to compare the mean pain score in both groups.

RESULTS

A total of 262 patients were added in the study, Group A had 62 males (47.0%) and 70 females (53.0%), while Group B had 74 males (56.1%) and 58 females (43.9%). The mean age was similar, with Group A at 34.83 ± 9.27 years and Group B at 34.10 ± 9.48 years (p=0.529). The mean BMI was slightly lower in Group B (24.79 ± 4.38 kg/m²) compared to Group A (25.86 ± 4.46 kg/m²), showing a statistically significant difference (p=0.049). The mean time for surgery completion was 2.99 ± 0.82 hours in Group A and 2.84 ± 0.82 hours in Group B (p=0.157). The time for first rescue analgesia was similar between groups (11.76 ± 2.24 hours in Group A vs. 11.49 ± 2.19 hours in Group B, p=0.331). ASA status distribution was nearly identical in both groups. Notably, the VAS pain score was significantly lower in Group B (1.06 ± 0.84) compared to Group A (3.43 ± 2.99), with a highly significant p-value of 0.000, indicating superior pain control with dexamethasone.

Among males, the mean pain score was 3.42 ± 1.08 in Group A and 3.14 ± 0.82 in Group B, but the difference was not statistically significant (p=0.108). However, among females, Group B had a significantly lower pain score (2.79 ± 0.83) compared to Group A (3.45 ± 1.06) with a p-value of 0.000. Regarding age, younger patients (18-30 years) in Group B experienced significantly lower pain scores (3.00 ± 0.91) compared to Group A (3.49 ± 0.98, p=0.014). Similarly, in the 31-50 age group, Group B had a lower pain score (2.99 ± 0.80) than Group A (3.41 ± 1.10, p=0.005). BMI-based analysis revealed that patients with BMI ≤27 had significantly lower pain scores in Group B (3.03 ± 0.83) compared to Group A (3.43 ± 1.03, p=0.006). Likewise, those with BMI >27 also showed lower pain scores in Group B (2.89 ± 0.89) than in Group A (3.43 ± 1.12, p=0.016).

Table 1: Comparison of Demographic and Clinical Characteristics of Anterior Cruciate Ligament (ACL) Patients Between Two Groups (N=264)

Parameter	Group A (Ropivacaine Alone) (n=132)	Group B (Ropivacaine with Dexamethasone) (n=132)	Statistical Test Results
Gender Distribution			
Male	62 (47.0%)	74 (56.1%)	
Female	70 (53.0%)	58 (43.9%)	
Total	132 (100%)	132 (100%)	
Age (years) (Mean ± SD)	34.83 ± 9.27	34.10 ± 9.48	t=0.630, df=262, p=0.529
Body Mass Index (BMI) (kg/m²) (Mean ± SD)	25.86 ± 4.46	24.79 ± 4.38	t=1.977, df=262, p=0.049
Time When Surgery Ended (hours) (Mean ± SD)	2.99 ± 0.82	2.84 ± 0.82	t=1.419, df=262, p=0.157
Time at First Rescue Analgesia Given (hours) (Mean ± SD)	11.76 ± 2.24	11.49 ± 2.19	t=0.973, df=262, p=0.331
ASA Status			
II	44 (33.3%)	42 (31.8%)	
III	44 (33.3%)	46 (34.8%)	
III	44 (33.3%)	44 (33.3%)	
Total	132 (100%)	132 (100%)	
VAS Pain Score (Mean ± SD)	3.43 ± 2.99	1.06 ± 0.84	t=3.719, p=0.000 (significant at 5% level)

Note: Group A received Ropivacaine alone, while Group B received Ropivacaine with Dexamethasone.

Table 2: Mean Comparison of Pain Scores Across Gender, Age, and BMI Categories

Category	Subcategory	n	Study Group	Mean Pain Score	S.D.	t-test	p-value
Gender	Male	62	Group-A	3.42	1.08	1.620	0.108
	Male	74	Group-B	3.14	0.82		
	Female	70	Group-A	3.45	1.06	3.886	0.000*
	Female	58	Group-B	2.79	0.83		
Age (years)	18-30	43	Group-A	3.49	0.98	2.512	0.014*
	18-30	52	Group-B	3.00	0.91		
	31-50	89	Group-A	3.41	1.10	2.825	0.005*
	31-50	80	Group-B	2.99	0.80		
BMI (kg/m²)	≤27	79	Group-A	3.43	1.03	2.778	0.006*
	≤27	96	Group-B	3.03	0.83		
	>27	53	Group-A	3.43	1.12	2.447	0.016*
	>27	36	Group-B	2.89	0.89		

Table 3: Mean Comparison of Pain Scores in Study Groups

Time/ASA Status	Study Group A (n)	Mean Pain Score A	S.D A	Study Group B (n)	Mean Pain Score B	S.D B	t-test	p-value
1-2 hours	45	3.40	1.16	56	2.96	0.87	2.094	0.039*
3-4 hours	87	3.44	1.02	76	3.01	0.82	3.009	0.003*
8-12 hours	74	3.51	1.10	85	3.04	0.84	3.047	0.003*
>12 hours	58	3.33	1.02	47	2.91	0.86	2.220	0.029*
ASA II	44	3.25	1.10	42	2.93	0.81	1.547	0.126
ASA III	44	3.82	1.02	46	3.00	0.92	4.006	0.000*
ASA III	44	3.23	1.00	44	3.05	0.81	0.948	0.346

Statistically significant at $p < 0.05$.

Patients in Group B consistently reported lower pain scores compared to Group A. For surgeries lasting 1-2 hours, the mean pain score was significantly lower in Group B (2.96 ± 0.87) than in Group A (3.40 ± 1.16) with a p-value of 0.039. Similarly, for surgeries lasting 3-4 hours, Group B had a significantly lower pain score (3.01 ± 0.82) compared to Group A (3.44 ± 1.02, p=0.003). Pain scores were also significantly reduced in Group B for the 8-12 hour duration (3.04 ± 0.84 vs. 3.51 ± 1.10, p=0.003) and for surgeries lasting more than 12 hours (2.91 ± 0.86 vs. 3.33 ± 1.02, p=0.029). Regarding ASA status, there was no significant difference in pain scores between groups for ASA II patients (p=0.126) or the second set of ASA III patients (p=0.346). However, in one ASA III subgroup, Group B had a significantly lower pain score (3.00 ± 0.92) than Group A (3.82 ± 1.02, p=0.000).

DISCUSSION

According to Wulf, arthroscopic anterior cruciate ligament repairs (ACLR) are routinely done as day cases. They could avoid immediate discharge, nevertheless, due to the mild significant postoperative pain they are linked to. Numerous analgesic techniques, such as neuro-axial and peripheral neuron blocks, and central and intra-articular anesthetics have been studied. Several randomized clinical trials have indicated that femoral nerve block (FNB) can effectively relieve pain following ACL surgery[6-9]. But this blocking strategy has drawn criticism because it weakens the quadriceps muscle, which could delay mobilization and increase the possibility of falling. The femoral nerve below the thigh is again blocked with an adductor canal block (ACB), which preserves most of the quadriceps' strength during early ambulation and rehabilitation because the motor stimulation of the quadriceps group has previously departed the nerve[10]. After total knee replacement, ACB of the saphenous and obturator muscles was proven to lessen pain and morphine use. The optimal analgesic approach for discomfort following surgery in knee arthroscopy, particularly after ACL repair, has thus been hypothesized to be ACB. Numerous pathways may be involved, even if the exact mechanism of dexamethasone's activity as a local anaesthetic adjuvant (LA) is still not fully understood. Some researchers contend that a localized vasoconstriction impact reduces the digestion of local anaesthetics[11]. Reduced nociceptive C-fiber function can additionally have a systemic anti-inflammatory effect after vascular absorption of the drug due to a direct impact on glucocorticoid receptors and inhibitory potassium channel function[12]. A study demonstrated that 26 out of 30 patients in the ACB group had preserved quadriceps muscle strength as compared to 18 out of 30 patients in the FNB group ($p<0.01$). In our study, the mean postoperative pain was 3.43±.84 in Group A (ropivacaine alone) significantly higher than Group B (ropivacaine with dexamethasone) 2.99±.84 and There is a significant difference in average pain score between the two groups as $p<.001$. Ibrahim et al conducted a study based on the effect of adding dexamethasone to bupivacaine on the duration of postoperative analgesia in patients undergoing knee arthroscopy using ultrasound-guided adductor canal block[13-15]. The findings indicated that at 24 hours, postoperative pain in the control group was 3.87±0.35 and in the Dexamethasone group as 3.7±0.6, so there was no significant difference observed in postoperative pain in both groups[16]. We speculated that the use of dexamethasone in conjunction with LA for peripheral nerve stimulation could lengthen the postoperative In our randomized managed trial, we examined the effects of adding dexamethasone to 20 ml of bupivacaine 0.5% for ACB against normal saline (control group) in patients performing arthroscopic ACLR while under spinal anaesthesia[17-19].

CONCLUSION

It was concluded that combining dexamethasone with ropivacaine in adductor canal block considerably reduced the average pain score compared to ropivacaine alone in anterior cruciate ligament arthroscopic surgery. As a result, this safe and successful approach to treating anterior cruciate ligament arthroscopic surgery should be suggested.

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