Original Article

Comparative Evaluation of Dexamethasone and Dexmedetomidine as Adjuvants to 0.2% Ropivacaine in Adductor Canal Block for Lower Limb Surgeries

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Abstract

Background: The adductor canal block (ACB) is a commonly used method for postoperative analgesia following lower limb surgeries. Adjuvants added to local anesthetics enhance efficacy and prolong the duration of analgesia, thereby decreasing the postoperative analgesic requirements. The present study aimed to determine the efficacy of dexamethasone and dexmedetomidine as adjuvants to 0.2% ropivacaine in ACB. **Material and Methods:** This prospective observational study was done on n=60 cases undergoing lower limb surgeries under spinal anesthesia. The selected cases were randomly allotted to two equal groups, viz., Group D received 20 ml of 0.2% ropivacaine with dexamethasone (8 mg). Group DM 20 ml of 0.2% ropivacaine with dexmedetomidine (1 µg/kg). The outcomes analysed were duration of analgesia and Visual Analog Scale (VAS) scores. The other outcomes determined were total analgesic consumption, time for first rescue analgesia, and adverse effects. **Results:** The results showed that the overall duration of analgesia was significantly longer in Group DM as compared to Group D (16.9 ± 3.5 versus 12.4 ± 2.8 hours), and the p-values were significant. The assessment of VAS scores revealed that group DM had significantly lower VAS scores up to 12 hours postoperatively. The total paracetamol consumption was reduced in Group DM compared to Group D (1.2 g vs 2.4 g and p<0.001). The frequency of requirements for rescue analgesics was higher in Group D as compared to DM (93.3% vs 60.0% and p=0.012). **Conclusion:** This study found that the efficacy of dexmedetomidine was superior to dexamethasone with 0.2% ropivacaine in Adductor canal block following lower limb surgeries. Dexmedetomidine provides prolonged analgesia, pain control and decrease analgesic requirements compared to dexamethasone and both drugs showed comparable safety profile.

Keywords: Ropivacaine, Dexmedetomidine, Dexamethasone, Postoperative analgesia, Lower Limb Surgeries.

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Introduction

Postoperative pain control following lower limb surgeries including knee operations and orthopedic lower limb procedures is crucial because it affects the overall outcome of the procedure, early mobilization, and rehabilitation. Effective analgesia is therefore necessary for reducing the opioid consumption and their adverse effects. Recent multimodal analgesia strategies such as adductor canal block (ACB) have gained popularity because it provides effective sensory blockade also preserves the strength of quadriceps muscle and thereby helping in early ambulation.[1] Ropivacaine is long-acting amide local anesthetic commonly used for ACB because of its favorable safety profile and reduced cardiotoxicity as compared to bupivacaine. However, given that when it is used alone the duration of anesthesia is limited and in order to increase the duration and enhance its analgesic quality adjuvants have been used commonly. The addition of adjuvants is known to decrease analgesic requirements and enhance patients' satisfaction.[2] Dexmedetomidine is a highly selective α2-adrenergic agonist. It is often utilized as an adjuvant in regional anesthesia. It produces its analgesic and sedative actions which are mediated through central and peripheral actions inhibiting release of norepinephrine and modulation of pain pathways. Few studies have found that addition of dexmedetomidine to ropivacaine in ACB produces increased duration of analgesia and decreases postoperative opioid consumption and improves pain scores without significant adverse effects.[3,4] It also helps in reducing the concentration of local anesthetic required, thereby enhancing safety margins.[5] Dexamethasone is a synthetic adrenocortical steroid with potent anti-inflammatory actions. It is also used as an adjuvant in peripheral nerve blocks. Its mechanism of action appears to be by inhibiting inflammatory mediators reducing ectopic neuronal discharge and producing vasoconstrictive actions that increases the availability of local anesthetic for prolonged actions. It has

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been found that perineural dexamethasone has been reported to significantly extend the duration of analgesia and decrease postoperative pain when combined with local anesthetics.[6] Its use in ACB has been associated with prolonged analgesic duration and decreased requirement for rescue analgesics. Recent pieces of evidence have indicated that use of adjuvants with ropivacaine produces synergistic actions and enhances analgesic efficacy. In a randomized controlled trial evaluating the adjuvants for ACB in cases of total knee arthroplasty found significantly reduced opioid consumption and better pain control with use of ropivacaine and dexamethasone as compared to dexamethasone alone.[7] Although the data evaluating the efficacy of dexamethasone and dexmedetomidine as adjuvants is existing, however, its combination with low dose ropivacaine (0.2%) in ACB is very limited. Therefore, the aim of the current study was to evaluate dexmedetomidine and dexamethasone as adjuvants to 0.2% ropivacaine in adductor canal block in patients undergoing lower limb surgeries to evaluate the efficacy, duration of analgesia, pain relief and safety profile.

Materials and Methods

This prospective comparative observational study was conducted in the Department of Anesthesiology, Medical College, Hyderabad. Institutional Ethical approval was obtained for the study. Written consent was obtained from all the participants of the study after explaining the nature of the study and possible outcomes in the vernacular language.

Inclusion criteria

1. Patients undergoing elective lower limb surgeries under spinal anesthesia
2. Males and females
3. Aged 18 – 60 years
4. ASA I and II
5. Signed informed consent

Exclusion criteria

1. Allergy to any of the drugs used for local anesthetics
2. Infection at the site of injection
3. Significant renal impairment
4. Hepatic diseases
5. Cardiac disease
6. History of Neurological Disorders
7. History of opioid use

Based on the inclusion and exclusion criteria, a sample of n=60 cases was selected based on the convenience sampling method. A computer-generated random number was used for allotting the patients to one of the two groups of n=30 cases each. The allocation was done by using sealed opaque envelopes, and the study drugs were prepared by an anesthesiologist not involved in patient management or data collection to ensure blinding.

Group D: Received an adductor canal block with 20 ml of 0.2% ropivacaine combined with dexamethasone 8 mg.

Group DM: Received adductor canal block with 20 ml of 0.2% ropivacaine combined with dexmedetomidine 1 µg/kg.

Patients were kept nil by mouth (NBM) as per standard protocol, and no premedication was given. In the operating room, routine monitoring (non-invasive blood pressure, electrocardiogram, pulse oximetry) was established. The patient's vital signs were noted. The patient was then positioned in the sitting position, and spinal anesthesia was administered in the form of 0.5% hyperbaric bupivacaine at the L3-L4 interspace. Post-surgery, an ultrasound-guided adductor canal block was performed under strict aseptic precautions. A high-frequency linear ultrasound probe was placed at the mid-thigh level and was used to locate the femoral artery within the adductor canal. A 22-G nerve block needle was inserted in-plane. Once the negative aspiration, the drug solution was administered around the saphenous nerve.

Visual Analogue Scale (VAS) was used for assessing pain at 0, 2, 4, 6, 12, and 24 hours after surgery. The primary outcome was duration of analgesia, which was measured as the time from injection of the block until the time the first request for rescue analgesia was made (VAS score ≥ 4). Secondary outcome measures were the total amount of analgesics used during 24 hours, VAS at various time points, and occurrence of side effects such as nausea, vomiting, bradycardia, hypotension, and sedation. Rescue analgesia was administered in the form of intravenous paracetamol 1 g if the VAS was ≥ 4. Heart rate and blood pressure were monitored intraoperatively and at postoperative time intervals.

Statistical analysis: The data from the patients were collected, segregated, refined, and uploaded to an MS Excel spreadsheet and analyzed by IBM SPSS Statistics Version 26 (Armonk, USA). The continuous variables were represented as mean, standard deviation, and percentages. The categorical variables were analyzed by an independent t-test for comparison of means and a Chi-square test for analysis between the two groups. The values of p (<0.05) were considered significant.

Results

[Table 1] depicts the demographic and baseline characteristics of the cases included in the study. A critical analysis of the table showed that the mean age of the two groups was comparable, and no statistically significant differences were found, indicating good randomization. Similarly, the sex distribution also showed that the p-values were not significant. The mean body weight was comparable between the groups (68.4 ± 9.5 kg vs 67.2 ± 10.1 kg) and p = 0.52. ASA physical status distribution between the two groups remained similar. This showed that no confounding factors exist between the two groups at the beginning of the study, and all the differences in the groups will be attributed to the interventions.

Table 1: Demographic and baseline characteristics of the cohort

Parameter	Group D (Dexamethasone) [n=30]	Group DM (Dexmedetomidine) [n=30]	P value
Age in years	45.6 ± 12.3	47.1 ± 11.8	0.36
Sex (M/F)	18/12	16/14	0.64
Weight (Kg)	68.4 ± 9.5	67.2 ± 10.1	0.52
ASA status I/II	20/10	22/8	0.59

[Table 2] shows the comparison of the duration of analgesia recorded in the two groups. The mean duration of surgery was found to be similar between the two groups (95.4 ± 18.7 versus 98.52 ± 20.1 minutes) with no statistical difference. However, as far as the duration of analgesia was concerned, the results showed that Group DM had a significantly prolonged duration compared to Group D (16.9 ± 3.5 hours versus 12.4 ± 2.8 hours), and the p-values were found to be significant. This indicated that dexmedetomidine as an adjuvant to 0.2% ropivacaine in an adductor canal block provides a significantly longer duration of postoperative analgesia.

Table 2: Primary Outcome-Duration of analgesia

Parameter	Group D (Dexamethasone) [n=30]	Group DM (Dexmedetomidine) [n=30]	P value
Duration of Surgery (min)	95.4 ± 18.7	98.52 ± 20.1	0.213
Duration of Analgesia (hours)	12.4 ± 2.8	16.9 ± 3.5	<0.001*
*Significant			

[Table 3] shows the postoperative pain scores (VAS) at different intervals of time. At baseline, the scores in the two groups were found to be identical, indicating uniform starting conditions. After 2 hours, we found Group DM had significantly lower pain VAS scores compared to Group D (0.6 ± 0.5 versus 1.2 ± 0.8) the p value was found to be significant. A similar trend was found to exist between the two groups at the intervals of 4 hours, 6 hours, and 12 hours, and Group DM consistently demonstrated lower VAS scores, with p values remaining significant at these time intervals. In the 24-hour interval, the values of Group DM were slightly better than those of Group D, although they did not reach the level of significance. These findings indicate that dexmedetomidine provides superior analgesia, especially in the early postoperative period up to 12 hours.

Table 3: Postoperative pain scores (VAS) at different time intervals

Time in hours	Group D (Dexamethasone) [n=30]	Group DM (Dexmedetomidine) [n=30]	P value
Baseline	0.0 ± 0.0	0.0 ± 0.0	1.00
2 hours	1.2 ± 0.8	0.6 ± 0.5	0.002*
4 hours	2.5 ± 1.1	1.4 ± 0.9	<0.001*
6 hours	3.8 ± 1.3	2.2 ± 1.0	<0.001*
12 hours	4.2 ± 1.5	2.8 ± 1.2	<0.001*
24 hours	3.0 ± 1.4	2.4 ± 1.1	0.07
* Significant			

Analgesic consumption and rescue analgesic requirements between the two groups are given in [Table 4]. Overall analysis of the table showed that the total paracetamol consumption in Group DM was lower, 1.2g, compared to Group D, 2.4g, and the p-value was found to be significant. It was also noted that a significantly lower proportion of patients in Group DM were requiring rescue analgesia 60% compared to 93.3% of Group D, and differences were found to be significant by Chi-square analysis (p=0.012). In addition, the time to first rescue analgesia was significantly prolonged in Group DM (16.9 ± 3.5 hours) compared to Group D (12.4 ± 2.8 hours) (p < 0.001). The results indicate that dexmedetomidine provides analgesic efficacy and decreases the analgesic requirements in the postoperative period.

Table 4: Analgesic consumption and rescue analgesic requirements

Time in hours	Group D (Dexamethasone) [n=30]	Group DM (Dexmedetomidine) [n=30]	P value
Total paracetamol consumption in 24 h (g)	2.4 ± 0.8	1.2 ± 0.54	<0.001*
Number of patients requiring rescue analgesia	28 (93.3%)	18 (60.0%)	0.012*
Time to first rescue analgesia (hours)	12.4 ± 2.8	16.9 ± 3.5	<0.001*
* Significant			

[Table 5] depicts the adverse effects of the two groups of study. The overall incidence of adverse effects in both groups was comparable, with no statistical significance. The total adverse reactions in Group D were 11/30 (36.7%) and for Group DM 17/30 (56.7%), and the p-value was not significant. Nausea (13.3% vs 10.0%; p = 0.69) and vomiting (6.7% vs 3.3%; p = 0.55) were similar in both groups. Although bradycardia (13.3% vs 3.3%), hypotension (10.0% vs 6.7%), and sedation (20.0% vs 6.7%) were more frequent in Group DM, these differences were not statistically significant (p > 0.05). These results indicated that while dexmedetomidine may be associated with a higher incidence of hemodynamic changes and sedation effects, these effects were not clinically significant in this study.

Table 5: Adverse effects

Time in hours	Group D (Dexamethasone) [n=30]	Group DM (Dexmedetomidine) [n=30]	P value
Nausea	4 (13.3%)	3 (10.0%)	0.69
Vomiting	2 (6.7%)	1 (3.3%)	0.55
Bradycardia	1 (3.3%)	4 (13.3%)	0.16
Hypotension	2 (6.7%)	3 (10.0%)	0.64
Sedation (Ramsay scores ≥3)	2 (6.7%)	6 (20.0%)	0.13

Discussion

The aim of this study was to demonstrate the efficacy of adjuvants dexmedetomidine and dexamethasone added to 0.2% ropivacaine in adductor canal block (ACB), for postoperative analgesia in cases undergoing lower limb surgeries. We recruited 60 cases of elective lower limb surgeries from our hospital during the study period. They were randomly allotted two equal groups. The postoperative pain scores, and requirements of rescue analgesics were recorded. The overall distribution of cases in both the groups appeared comparable as shown in [Table 1]. This indicated that the process of randomization was achieved and the changes in the patients will occur due to usage of drugs and no confounding bias existed. The duration of analgesia was recorded in [Table 2]. The results showed that dexmedetomidine group had prolonged duration of analgesia compared to dexamethasone group (16.9 ± 3.5 hours) compared to (12.4 ± 2.8 hours) for dexamethasone group, the p values were found to be significant. Dexmedetomidine being a highly selective α2-adrenergic agonist produces analgesia by inhibiting the release of norepinephrine and causes hyperpolarization of peripheral neurons thereby increasing the duration of local anesthetic action.[8] In comparison dexamethasone primarily acts as anti-inflammatory agent decreased perineural edema which contribute to prolonging block duration however, to lesser extent.[6] Brummett et al. in a similar study found that perineural dexmedetomidine significantly prolongs the duration of sensory nerve blockade when combine with ropivacaine.[8] Abdulla et al,[9] demonstrated that dexmedetomidine enhances both duration and quality of peripheral nerve blocks. Our findings in this study are in agreement with these studies. A meta-analysis has found that dexmedetomidine is useful in prolonging analgesia and reducing opioid consumption in peripheral nerve blocks,[11] The assessment of postoperative visual analogue scale (VAS) scores indicated that patients in dexmedetomidine group had significantly lower scores as compared to dexamethasone group [Table 3], up to 12 hours postoperatively. This early effective pain control is important for early mobilization and rehabilitation in lower limb surgeries. Although, there was no statistically significant difference at the end of 24 hours which is in concordance with pharmacodynamic profile of these drugs reported in previous studies. [12,13] The main analgesic used for postoperative pain control was paracetamol. The total paracetamol consumption in this study was found to be lower in dexmedetomidine group indicating its superior analgesic efficacy. Our findings are in concordance with previous studies that have shown opioid sparing effects of dexmedetomidine when used as adjuvant in regional anesthesia. [13,14] The prolonged time for first request to rescue analgesia in this study is in concordance with the similar actions of dexmedetomidine by previous studies. Dexamethasone has also shown to prolong analgesia as compared to plain local anesthetic as reported by previous studies however, it appears that these actions of dexamethasone are inferior to that of dexmedetomidine as found in this study. Choi et al,[6] have shown that dexamethasone prolongs the duration of peripheral nerve block but is sensitive to technique and drug combinations used for the procedure. Parrington et al,[15] in a similar study have found prolonged analgesia with dexamethasone although the magnitude of prolongation was lesser than dexmedetomidine. Other studies on peripheral nerve blocks including interscalene block have found dexamethasone has ability to significantly prolong the analgesic duration which supports its effective role as an adjuvant to local anesthetics. [16,17] The assessment of safety profile of both groups showed comparable incidence of adverse effects. Bradycardia and sedation were more common in dexmedetomidine group [Table 5]; however, the differences were not significant as compared to dexamethasone group. The overall severity of adverse reactions was mild and clinically manageable. These observations are in agreement with previous studies which have shown that dexmedetomidine because of its sympatholytic actions cause mild hemodynamic changes and bradycardia although severity is less with appropriate dose.[9] The incidence of nausea and vomiting was almost comparable in both groups which showed both adjuvants were well tolerated. As with any other study there were few limitations of this study which must be kept in mind before generalizing the results. The first limitation was because of its sample size which was less due to time constraints. The second was because this was a single center study which may induce selection bias. Overall, the results of this study support the preferential use of dexmedetomidine in multimodal analgesia protocols whenever feasible for better postoperative recovery.

Conclusion

Within the limitations of the current study, it can be concluded that dexmedetomidine appears to be an effective adjuvant compared to dexamethasone with 0.2% ropivacaine in the adductor canal block. Dexmedetomidine provides a significantly prolonged duration of analgesia, early postoperative pain control, and reduced requirement for rescue analgesics compared to dexamethasone. The overall visual analogue scores in the early postoperative period were better for the dexmedetomidine group. Dexamethasone also demonstrated effective analgesic prolongation, but to a lesser extent. The incidences of adverse reactions were similar in both groups. Therefore, this study supports the evidence that dexmedetomidine must be preferred whenever possible in multimodal analgesia protocols for better postoperative pain control and recovery.

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Conflicts of interest

There are no conflicts of interest.

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