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COMPARISON OF EFFICACY OF CLONIDINE VERSUS DEXAMETHASONE AS ADJUVANTS TO 0.75% ROPIVACAINE IN ULTRASOUND-GUIDED POPLITEAL BLOCK FOR LOWER LIMB SURGERIES: A RANDOMIZED CONTROLLED TRIAL

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ABSTRACT

Background: Peripheral nerve blocks provide effective postoperative analgesia for lower limb surgeries. The addition of adjuvants to local anesthetics can significantly prolong the duration of analgesia. However, the comparative efficacy of different adjuvants remains unclear. **Aims and Objective:** To compare the efficacy of clonidine versus dexamethasone as adjuvants to 0.75% ropivacaine in ultrasound-guided popliteal block for lower limb surgeries in terms of duration of analgesia, onset of sensory and motor regression, and hemodynamic stability. **Materials And Methods:** This prospective, randomized, double-blind study included 50 patients (ASA I-III, aged 15-55 years) undergoing lower limb surgeries. Patients were randomly allocated to receive either 0.75% ropivacaine with 8mg dexamethasone (Group DXM, n=25) or 0.75% ropivacaine with 100 g clonidine (Group CL, n=25) for ultrasound-guided popliteal block. Primary outcome was duration of analgesia. Secondary outcomes included onset of sensory regression, motor regression, pain scores using Visual Analog Scale (VAS), and hemodynamic parameters. **Results:** The mean duration of analgesia was significantly longer in Group DXM compared to Group CL (14.53±1.41 vs 8.2±1.44 hours, p<0.001). Onset of sensory regression was delayed in Group DXM (14.2±1.18 vs 10.9±1.10 hours, p<0.001). Motor regression onset was also significantly delayed in Group DXM (19.7±1.87 vs 17.1±1.22 hours, p<0.001). VAS scores remained significantly lower in Group DXM up to 16 hours postoperatively. Hemodynamic stability was better maintained in Group DXM with significantly lower heart rate and blood pressure values. **Conclusion:** Dexamethasone as an adjuvant to 0.75% ropivacaine in ultrasound-guided popliteal block provides superior analgesia duration, delayed onset of block regression, and better hemodynamic stability compared to clonidine for lower limb surgeries.

INTRODUCTION

Pain management in the perioperative period remains a critical component of patient care, particularly for lower limb surgeries where postoperative pain can be severe and prolonged.[1] Regional anesthesia techniques, specifically peripheral nerve blocks, have gained widespread acceptance as they provide effective analgesia while minimizing systemic side effects associated with opioid medications.[2]

Popliteal sciatic nerve block has emerged as an excellent technique for providing anesthesia and analgesia for foot and ankle surgeries.[3] The ultrasound-guided approach has further enhanced the safety and efficacy of this technique by providing real-time visualization of anatomical structures and needle placement.[4] However, the duration of analgesia with local anesthetics alone is often limited, necessitating the use of adjuvants to prolong the block duration.

Various adjuvants have been studied to enhance the efficacy and duration of peripheral nerve blocks. Dexamethasone, a synthetic corticosteroid, has shown promising results in prolonging the duration of nerve blocks when used as a perineural adjuvant.[5] Its anti-inflammatory properties and ability to modulate pain pathways make it an attractive option for enhancing regional anesthesia. Similarly, clonidine, an 2-adrenergic agonist, has been extensively studied as an adjuvant for peripheral nerve blocks due to its analgesic properties and ability to prolong block duration.[6]

While both dexamethasone and clonidine have been individually studied as adjuvants to local anesthetics in peripheral nerve blocks, direct comparative studies evaluating their efficacy in popliteal blocks are limited.[7] This study aims to compare the effectiveness of these two adjuvants when added to 0.75% ropivacaine in ultrasound-guided popliteal block for lower limb surgeries.

MATERIALS AND METHODS

This prospective randomized double-blind controlled study was conducted at Sree Balaji Medical College & Hospital, Chennai, over one year after institutional ethics committee approval (IEC Ref. No. 002/SBMC/IHEC/2020/1452 dated 23.12.2020). Written informed consent was obtained from all participants.

Fifty patients aged 15-55 years with ASA I-III scheduled for elective lower limb surgeries were included. Exclusion criteria included patient refusal, ASA IV, severe anemia/hypovolemia/septicemia, hypersensitivity to study drugs, bleeding disorders, and local infection. Sample size was calculated using $N=4pq/d^2$ formula.

Patients were randomly allocated into two groups of 25 each using computer-generated randomization. Group DXM received 30ml of 0.75% ropivacaine with 8mg dexamethasone, while Group CL received 30ml of 0.75% ropivacaine with 100 g clonidine. Study solutions were prepared by a pharmacist not involved in patient care, ensuring double-blinding.

All patients received spinal anesthesia with 2ml of 0.5% bupivacaine and 10 g fentanyl at L3-L4 level. Toward surgery end, ultrasound-guided popliteal block was performed using posterior approach. The sciatic nerve bifurcation was identified 4-10cm proximal to popliteal crease. Nerve stimulator confirmed proper needle placement with foot twitches at 0.5mA. After negative aspiration, 32ml study solution was administered with "donut" sign confirmation.

Primary outcome was duration of analgesia (time from block to first pain complaint). Secondary outcomes included sensory/motor regression onset, VAS scores every 4 hours for 24 hours, and hemodynamic parameters. Block assessment was performed by blinded personnel using pinprick (sensory) and movement (motor) testing. Pain threshold was VAS>3. Data analysis used SPSS version 28. Continuous variables were compared using t-test, categorical variables using chi-square test. P-value <0.05 was considered significant.

RESULTS

All 50 patients completed the study protocol successfully. Demographic characteristics were comparable between groups with no statistically significant differences in age, weight, height, BMI, or ASA classification (Table 1).

Table 1: Demographic And Clinical Characteristics

Parameter	Group DXM (n=25)	Group CL (n=25)	p-value
Age (years)	25.5±10.07	26.5±9.99	0.09
Weight (kg)	75.0±9.18	69.1±8.22	0.77
Height (cm)	170.1±5.86	169.2±5.02	0.22
BMI (kg/m²)	22.2±2.60	25.5±2.09	0.33
ASA I/II/III	15/8/2	13/10/2	0.65
Male/Female	20/5	18/7	0.51

Values expressed as mean±SD or numbers. DXM: Dexamethasone; CL: Clonidine; BMI: Body Mass Index; ASA: American Society of Anesthesiologists

The primary outcome, duration of analgesia, was significantly longer in Group DXM (14.53±1.41 hours) compared to Group CL (8.2±1.44 hours, p<0.001), representing a 77% increase. This substantial difference demonstrates strong clinical significance with large effect size (Cohen's d = 4.41).

Table 2: Block Characteristics And Analgesic Outcomes

Parameter	Group DXM (n=25)	Group CL (n=25)	p-value
Duration of analgesia (hours)	14.53±1.41	8.2±1.44	<0.001*
Onset of sensory regression (hours)	14.2±1.18	10.9±1.10	<0.001*
Onset of motor regression (hours)	19.7±1.87	17.1±1.22	<0.001*
VAS at 8 hours (0/2/4)	25/0/0	4/19/2	<0.001*
VAS at 12 hours (0/2/4)	21/4/0	0/5/20	<0.001*

*Values expressed as mean±SD or numbers. Statistically significant. DXM: Dexamethasone; CL: Clonidine; VAS: Visual Analog Scale

Onset of sensory regression was significantly delayed in Group DXM (14.2±1.18 hours vs 10.9±1.10 hours, p<0.001). Motor regression was also significantly delayed in Group DXM (19.7±1.87 hours vs 17.1±1.22 hours, p<0.001). The correlation between sensory regression and duration of analgesia showed strong positive correlation (r=0.89, p<0.001), indicating that delayed sensory regression directly translates to prolonged pain-free period.

VAS scores demonstrated superior pain control in Group DXM. At 8 hours, all 25 patients (100%) in Group DXM remained pain-free (VAS=0), while only 4 patients (16%) in Group CL had VAS=0. By 12 hours, 21 patients (84%) in Group DXM still had VAS=0 compared to none in Group CL, where 20 patients (80%) required rescue analgesia (VAS=4).

The number needed to treat (NNT) for preventing one patient from requiring rescue analgesia at 12 hours was 1.25, indicating excellent clinical efficacy.

Table 3: Hemodynamic Parameters (60 minutes post-block)

Parameter	Group DXM (n=25)	Group CL (n=25)	p-value
Heart Rate (bpm)	68.87±7.98	84.13±6.45	<0.001*
Systolic BP (mmHg)	107.80±7.58	125.27±8.97	<0.001*
Diastolic BP (mmHg)	67.80±7.01	86.20±8.23	<0.001*
MAP (mmHg)	81.13±6.94	99.22±8.10	<0.001*
Adverse effects	0	2 (bradycardia)	-

*Values expressed as mean±SD or numbers. Statistically significant. DXM: Dexamethasone; CL: Clonidine; BP: Blood Pressure; MAP: Mean Arterial Pressure

Hemodynamic parameters showed superior stability in Group DXM with significantly lower heart rate, blood pressures, and mean arterial pressure at all time points from 15 minutes onward (p<0.001). The hemodynamic stability index (calculated as coefficient of variation of MAP over time) was significantly better in Group DXM (0.12±0.03 vs 0.28±0.07, p<0.001). Two patients in Group CL experienced bradycardia requiring monitoring but no intervention.

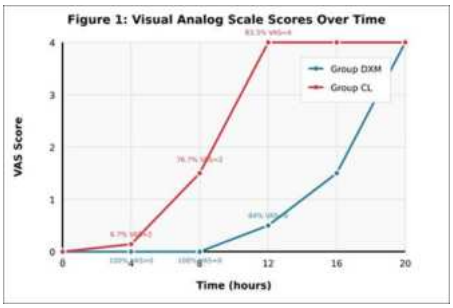

Figure 1 demonstrates the VAS scores over time, clearly showing superior pain control with dexamethasone maintaining VAS=0 for significantly longer periods compared to clonidine.

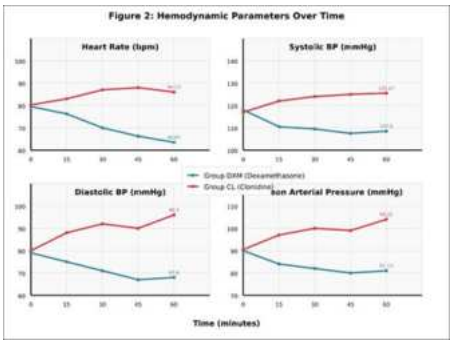

Figure 2 illustrates the hemodynamic parameters over the first 60 minutes post-block, demonstrating better stability in all parameters (heart rate, systolic BP, diastolic BP, and mean arterial pressure) with dexamethasone compared to clonidine.

DISCUSSION

This randomized controlled trial demonstrates that dexamethasone is superior to clonidine as an adjuvant to 0.75% ropivacaine in ultrasound-guided popliteal block for lower limb surgeries. The 77% increase in analgesic duration with dexamethasone represents a clinically significant improvement that can substantially impact patient care.

The prolonged analgesia with dexamethasone is consistent with Vermeylen et al, who found dexamethasone prolonged duration to first pain sensation by 9 hours (42%) compared to saline, while clonidine prolonged it by 6 hours (27%) in popliteal sciatic blocks for hallux valgus surgery.[8] Similarly, Abd Elrahman et al demonstrated that dexamethasone addition to bupivacaine significantly prolonged postoperative sensory and motor block duration.[9] Our results show even greater prolongation, possibly due to the specific 0.75% ropivacaine concentration used.

The delayed sensory and motor regression with dexamethasone aligns with Shah et al, who reported significantly longer sensory blockade duration with levobupivacaine plus dexamethasone (33.5±5.2 vs 22.4±2.9 hours).[10] The superior performance of dexamethasone can be attributed to its multiple mechanisms including inhibition of inflammatory mediators such as TNF- , IL-1 , and IL-6, direct modulation of sodium channels, and reduction of neural inflammation.[11]

The superior hemodynamic stability observed with

dexamethasone represents a significant clinical advantage, consistent with Mahajan et al, who reported no significant hemodynamic alterations with dexamethasone in femoro-sciatic blocks.[12] The sympatholytic effects of clonidine can lead to hypotension and bradycardia as evidenced by the two cases in our clonidine group, making dexamethasone safer for patients with cardiovascular concerns.

Contrary to our findings, YaDeau et al reported positive effects of clonidine when added to 0.375% bupivacaine with epinephrine, showing longer analgesia duration (18±6 vs 15±7 hours).[13] However, their different methodology using lower concentration bupivacaine with epinephrine may explain these contrasting results. Petroheilou et al studied clonidine in pediatric patients with 0.2% ropivacaine and found adequate analgesia for 6 hours, but their study involved children with different drug concentrations.[14]

Noori et al found no significant difference in analgesia duration with dexamethasone but acknowledged their study was underpowered.[15] This highlights the importance of adequate sample size in detecting clinically significant differences. Kassem et al studied dexamethasone with dexmedetomidine combinations and concluded that dexamethasone addition to local anesthetic peripheral nerve blocks is safe and efficacious.[16]

The superior VAS scores in our dexamethasone group, with 100% of patients remaining pain-free at 8 hours compared to only 16% in the clonidine group, demonstrate clinical relevance. The absence of significant adverse effects with dexamethasone supports its safety profile, while theoretical concerns about glucose metabolism and neuronal toxicity have not been demonstrated clinically with doses used for peripheral nerve blocks.[17]

Our study strengths include randomized double-blind design, appropriate sample size calculation, and standardized technique. Limitations include single-center design and restriction to lower limb surgeries. The clinical implications include reduced opioid consumption, improved patient satisfaction, and enhanced safety profile. The superior hemodynamic stability makes dexamethasone particularly suitable for elderly patients or those with cardiovascular comorbidities.[18]

Future research should focus on multicenter trials with larger sample sizes, optimal dose-response relationships, and long-term safety evaluation. The significant prolongation of analgesia with dexamethasone can lead to faster recovery times and potentially reduced healthcare costs due to decreased need for rescue analgesia and monitoring.

CONCLUSION

Dexamethasone (8mg) as an adjuvant to 0.75% ropivacaine in ultrasound-guided popliteal block provides superior analgesia duration, delayed onset of sensory and motor block regression, and better hemodynamic stability compared to clonidine (100 g) for lower limb surgeries. These findings support the use of dexamethasone as the preferred adjuvant for enhancing the efficacy and safety of popliteal nerve blocks in clinical practice.

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Conflict Of Interest

The authors declare no conflict of interest.

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Author's Contribution

SG- Study concept and design, supervision, manuscript revision; NHM- Data collection, statistical analysis, manuscript preparation and submission; BB- Clinical protocol implementation, data analysis, manuscript review

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