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Original Article

Anaesthesia Section

Dexamethasone versus Clonidine as Adjuvants to Ropivacaine in Popliteal Sciatic Nerve Blocks for Postoperative Analgesia in Foot and Ankle Surgeries: A Randomised Clinical Study

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ABSTRACT

Introduction: Effective postoperative pain management is crucial in foot and ankle surgeries to enhance patient comfort and recovery. Popliteal Sciatic Nerve Blocks (PSNBs) are particularly useful in this context, as they provide site-specific, long-lasting analgesia with minimal systemic side effects, offer motor-sparing benefits, and facilitate early postoperative mobilisation. When combined with adjuvants like dexamethasone or clonidine, they may significantly improve the quality and duration of pain relief.

Aim: To compare the analgesic efficacy, sensory and motor blockade, haemodynamic variability, and patient satisfaction when dexamethasone and clonidine are used as adjuvants to ropivacaine in PSNBs for patients undergoing foot and ankle surgeries.

Materials and Methods: A prospective, randomised, double-blind trial was conducted in the department of Anaesthesiology, Dr. DY Patil Medical College and Research Centre, Pimpri, Maharashtra, India from March 2024 to March 2025 on 50 American Society of Anaesthesiologists (ASA) I and II patients aged 18-75 years undergoing elective foot and ankle surgery. Using a computer-generated randomisation sequence, patients were randomly assigned to two equal groups (n=25 each). Group RD received 28 mL of 0.5% ropivacaine with 2 mL (8 mg) dexamethasone, while Group RC received 28 mL of 0.5% ropivacaine with 2 mL (100 µg) clonidine. All blocks were administered under ultrasound guidance via the lateral approach. The primary outcome was the duration of analgesia, while secondary outcomes included Visual Analogue Scale (VAS) scores, durations of sensory and motor blocks, haemodynamic variability, and patient satisfaction. Statistical analysis was performed using independent t-tests and Chi-square tests, with $p<0.05$ considered significant.

Results: Group RD demonstrated significantly prolonged analgesia (24.24±2.18 hours) compared to Group RC (18.00±2.45 hours, $p<0.001$). VAS scores were significantly lower in Group RD after 12 hours postoperatively (2.08±0.49 vs 3.36±0.49, $p<0.001$). The duration of the sensory block was 21.80±2.94 hours in Group RD versus 14.16±2.94 hours in Group RC ($p<0.001$), and the motor block duration was 21.36±4.48 hours versus 18.96±4.48 hours, respectively ($p=0.03$). Haemodynamic variability was comparable across groups, with no adverse effects, and patient satisfaction was higher in the dexamethasone group, though this was not statistically significant.

Conclusion: Dexamethasone, when used as an adjuvant to ropivacaine in PSNBs, provides superior and longer-lasting analgesia, extended block duration, and better pain control compared to clonidine, with excellent safety and tolerability.

Keywords: Anaesthesia, Interventional, Pain management, Peripheral nerve block, Postoperative care, Ultrasonography

INTRODUCTION

Postoperative pain following foot and ankle surgeries can significantly impact recovery, mobility, and overall patient satisfaction. Effective analgesic strategies are essential not only to alleviate suffering but also to reduce complications such as delayed mobilisation, thromboembolism, and increased opioid consumption [1]. Due to their capacity to provide site-specific pain relief with minimal systemic adverse effects, regional anaesthetic techniques, especially Peripheral Nerve Blocks (PNBs), have become an important aspect of multimodal analgesia regimens [1,2].

Among the various PNBs, the PSNB has emerged as the preferred option for foot and ankle surgeries. It provides excellent analgesia for the lower leg and foot while preserving motor function at the knee. The block's efficacy is further enhanced by the use of ultrasound guidance, which allows for precise needle placement and real-time visualisation of drug spread, thereby improving block success and safety [2,3].

Ropivacaine, a long-acting amide local anaesthetic, is widely used in PNBs due to its favourable profile-providing adequate sensory blockade while minimising motor blockade, thus promoting early postoperative ambulation [4]. However, its duration of action may be insufficient to treat persistent postoperative pain, necessitating the use of adjuvants [4,5].

Dexamethasone and clonidine are two commonly studied adjuvants that have shown potential to extend the duration of analgesia. Dexamethasone, a corticosteroid, may exert its effects through anti-inflammatory mechanisms and vasoconstriction, thereby delaying the systemic absorption of the anaesthetic drug [5,6]. Clonidine, an alpha-2 adrenergic agonist, prolongs blockade by hyperpolarising nerve membranes and enhancing inhibitory pain pathways [7]. Previous studies have demonstrated that both dexamethasone and clonidine, when used as adjuvants to local anesthetics in PNBs, can prolong the duration of analgesia and enhance block quality [5-7]. However, limited data directly compare these two agents in the context of ultrasound-guided PSNBs specifically for foot and ankle surgeries [8]. Most existing literature focuses either on upper limb blocks or lacks consistency in outcome measures such as haemodynamic effects and patient satisfaction [5,9,10]. Thus, this

study was designed to compare the effectiveness of dexamethasone and clonidine as adjuvants to ropivacaine in ultrasound-guided PSNBs in patients undergoing foot and ankle surgeries, focusing on the duration of analgesia, quality of block, haemodynamic variability, and patient satisfaction.

MATERIALS AND METHODS

This prospective, randomised, double-blind clinical study was conducted at the Department of Anesthesiology, Dr. D. Y. Patil Medical College and Research Centre, Pimpri, Pune, from March 2024 to March 2025. Ethics clearance (IESC/342/2023) was obtained from the Institutional Ethics Committee prior to the start of the study, and the trial was registered with the Clinical Trials Registry of India (CTRI/2024/09/074399). Informed written consent was obtained from all participants after thorough pre-anesthetic evaluation and relevant investigations.

Sample size calculation: The sample size was calculated using WinPepi software version 11.65, based on sensory regression times reported by Vermeylen K et al., in their 2016 study [8]. With 80% power, a 5% significance level, and accounting for a 10% loss to follow-up, the minimum required sample size was determined to be 42. To enhance statistical power and account for potential dropouts, a total of 50 patients were enrolled based on the following criteria:

Inclusion criteria: Patients aged between 18 and 75 years, with a Body Mass Index (BMI) ranging from 20 to 35 kg/m^2 and classified as ASA physical status I or II, were included. All patients scheduled for foot and ankle surgeries provided written informed consent.

Exclusion criteria: Patients were excluded if they had a known allergy to any of the study drugs, bradycardia (heart rate ≤45 bpm), recent opioid use within the past three months, contraindications to nerve block, pregnancy, neurologic or psychiatric illnesses, or significant systemic comorbidities such as cardiac disease (e.g., heart failure, coronary heart disease, heart block), renal insufficiency, liver impairment, coagulopathy, or if they declined to participate in the study.

Randomisation and blinding: Patients were randomly allocated using a computer-generated randomisation table into:

- **Group RD (n=25):** Received 28 mL of 0.5% ropivacaine + 2 mL dexamethasone (8 mg) [5,11-13].
- **Group RC (n=25):** Received 28 mL of 0.5% ropivacaine + 2 mL clonidine (100 µg diluted in 2 mL NS) [7,8,11,12,14].

Allocation was concealed using serially numbered opaque envelopes. The anesthesiologist preparing the drug, the block performer, the assessor, the surgeon, and the patient were all blinded to group allocation. Data analysis was performed independently.

Study Procedure

All patients underwent surgery under spinal anaesthesia with 2.5 mL of 0.5% hyperbaric bupivacaine. After surgery, patients were shifted to a dedicated block room where ultrasound-guided PSNB was administered using a linear transducer (8-14 MHz) and a 23G, 90 mm short bevel needle via the lateral approach. The sciatic nerve was identified proximal to its bifurcation, and the study drug was injected in 5 mL aliquots under real-time ultrasound visualisation. Proper needle placement and adequate drug spread were confirmed by observing the "donut sign" [3,8].

Assessments were conducted at the following postoperative intervals: T0 (immediately after block), T1 (15 min), T2 (30 min), T3 (45 min), T4 (60 min), T5 (2 h), T6 (4 h), T7 (6 h), T8 (12 h), T9 (18 h), and T10 (24 h). Vital parameters (heart rate, blood pressure, SpO_2) were monitored continuously for the first hour and documented at each time interval from T0 to T10 [8].

Pain assessment was conducted at each interval from T0 to T10 using the Visual Analogue Scale (VAS) from 0 (no pain) to 10 (worst imaginable pain). Rescue analgesia (IV tramadol 50 mg) was administered if the VAS score was >3. The duration of analgesia, defined as the time from block completion to VAS score >3, was noted [8,13].

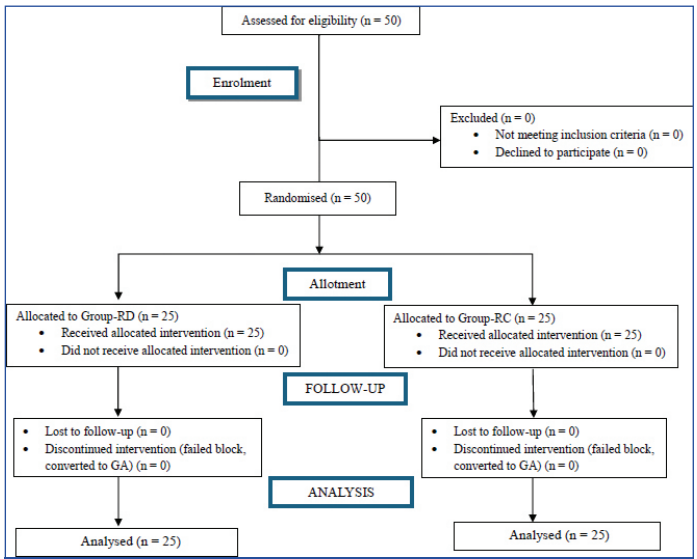
Sensory block was assessed by the pinprick method over the great toe from T0 until regression to score 0, where score 0=normal sensation, 1=absence of pinprick sensation, 2=absence of light touch over the great toe [8]. Motor block was assessed by toe movement from T0 until complete recovery (score 2), where score 0=absent movement of the ankle and toes, 1=partial weakness of ankle and toe movement, 2=normal movement of the ankle and toes [8]. For the purpose of this study, patient satisfaction at 24 hours was rated on a 3-point scale where 1=not satisfied, 2=satisfied, 3=better than expected. Complications, including nausea, vomiting, sedation, and itching, were noted if present.

STATISTICAL ANALYSIS

Data were recorded using a predesigned form and entered into Microsoft Excel. Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as means±Standard Deviation (SD). The independent sample t-test was used to compare means between groups, and the Chi-square test was used for categorical variables. A p-value <0.05 was considered statistically significant at a 95% confidence interval.

RESULTS

A total of 50 patients were included in the final analysis, with 25 patients in each group (RD and RC), as seen in [Table/Fig-1]. The demographic details of the study participants has been shown in [Table/fig-2]. Group RD exhibited a significantly longer duration of analgesia (24.24±2.18 hours) compared to Group RC (18.00±2.45 hours), with p<0.001. The duration of the sensory block was also significantly prolonged in Group RD (21.80±2.94 hours) versus Group RC (14.16±2.94 hours), with p<0.001. Group RD also demonstrated a slower regression of sensory block. The duration of motor blockade was longer in Group RD (21.36±4.48 hours) than in Group RC (18.96±4.48 hours), with a moderately significant difference of p=0.03 [Table/Fig-3].



[Table/Fig-1]: CONSORT diagram.

Pain scores (VAS) remained minimal in both groups until 12 hours. After that, Group RC showed significantly higher VAS scores at 12, 18, and 24 hours compared to Group RD, with p<0.001, which was statistically significant [Table/Fig-4]. No significant differences were found between the groups in pulse rate, systolic and diastolic blood pressure, mean arterial pressure, respiratory rate, or oxygen saturation at any time point (p>0.05), indicating haemodynamic stability throughout the study period.

Variables		Group RD n=25	Group RC n=25	p-value
Age (years)		34.1±10.3	34.1±10.6	0.40*
Sex	Male	16 (64 %)	15 (60 %)	1.00**
	Female	9 (36 %)	10 (40 %)	
Weight (kg)		53.04±7.12	52.12±6.74	0.32*
ASA	Grade I	11 (44 %)	12 (48 %)	1.00**
	Grade II	14 (56 %)	13 (52 %)	

[Table/Fig-2]: Demographic data.
Evaluated by *Independent t-test and **Chi-square test; p-values not significant (>0.05); No statistically significant difference in demographics of both groups

Parameters	Group RD		Group RC		p-value
	Mean	SD	Mean	SD	
Duration of analgesia (hrs)	24.24	2.18	18.00	2.45	<0.001*
Duration of sensory blockade (hrs)	21.80	2.94	14.16	2.94	<0.001*
Duration of motor blockade (hrs)	21.36	4.48	18.96	4.48	0.03*

[Table/Fig-3]: Duration of block action.
Independent t-test. *Statistically significant as p-value <0.05

Time interval		Group RD		Group RC		p-value
		Mean	SD	Mean	SD	
Immediate post block	T0	0.36	0.04	0.20	0.50	0.33
15 min	T1	0.04	0.20	0.04	0.20	1.00
30 min	T2	0.00	0.00	0.00	0.00	-
45 min	T3	0.00	0.00	0.00	0.00	-
1 h	T4	0.00	0.00	0.00	0.00	-
2 h	T5	0.00	0.00	0.00	0.00	-
4 h	T6	0.00	0.00	0.00	0.00	-
6 h	T7	0.00	0.00	0.08	0.28	0.16
12 h	T8	0.00	0.00	1.84	0.75	<0.001*
18 h	T9	0.44	1.04	3.56	0.58	<0.001*
24 h	T10	2.64	0.64	3.40	0.58	<0.001*

[Table/Fig-4]: Comparison of VAS scores.
Independent t-test; VAS scores from 12 to 24 hours are considered statistically significant as *p-value <0.05

Patient satisfaction was comparable between groups. In Group RD, 14 patients (56%) rated their experience as "better than expected" (score 3), and 11 (44%) rated it as "satisfactory" (score 2). In Group RC, 10 patients (40%) rated it as "better than expected," and 15 (60%) rated it as "satisfactory." The difference in scoring between the two groups was not statistically significant (p=0.39), as seen in [Table/Fig-5]. No adverse effects such as nausea, vomiting, hypotension, or bradycardia were observed in either group during the study period.

Satisfaction Score	Group		p-value
	RD	RC	
2 - satisfactory	11 (44 %)	15 (60 %)	0.39
3 - better than expected	14 (56 %)	10 (40 %)	

[Table/Fig-5]: Comparison of satisfaction scores.
Chi-square test, statistically significant as *p-value <0.05.

DISCUSSION

This randomised, double-blind study evaluated and compared the analgesic efficacy and safety of dexamethasone (8 mg) versus clonidine (100 µg) as adjuvants to 0.5% ropivacaine in ultrasound-guided PSNBs for foot and ankle surgeries. Dexamethasone demonstrated greater efficacy than clonidine in extending the duration of analgesia, sensory and motor block, and maintaining lower VAS scores beyond the 12-hour mark, while both groups exhibited similar safety profiles and haemodynamic stability.

Dexamethasone prolonged pain relief by approximately six hours more than clonidine and consistently demonstrated lower VAS scores beyond the initial 12 hours, indicating superior postoperative pain control and potentially facilitating early mobilisation. These results align with the findings of Vermeylen K et al., who demonstrated that dexamethasone in PSNBs provides a longer duration of analgesia and lower VAS scores compared to clonidine [8]. Comparable results have been reported in upper limb block studies by Nobre LV et al. and Balakrishnaiah MK et al. [9,10]; similarly, Abd Elrahman A et al., reported significantly prolonged duration of analgesia and reduced pain scores with dexamethasone in popliteal nerve blocks for below-knee surgeries [13]. Albrecht E et al., and Desmet M et al., further corroborated these findings, demonstrating the efficacy of perineural dexamethasone in prolonging sensory and motor block durations across various PNBs [5,6].

In the current study, the duration of sensory blockade was extended by approximately eight hours in the dexamethasone group compared to the clonidine group, while the motor block lasted an additional 2-3 hours. This sensory-motor differential is clinically advantageous, providing prolonged pain relief without significantly hindering early mobilisation, an essential aspect of enhanced recovery protocols. Nobre LV et al., reported similar sensory-motor block differentials with dexamethasone, further supporting its efficacy as an adjuvant [9].

Although patient satisfaction was higher in the dexamethasone group (56% vs. 40%), this difference did not reach statistical significance. Nevertheless, this trend mirrors the findings of Nobre LV et al., and Balakrishnaiah MK et al., where prolonged analgesic duration resulted in improved patient-reported experiences [9,10]. The superior performance of dexamethasone can be attributed to its multifaceted mechanisms of action, including anti-inflammatory properties, vasoconstriction (which delays systemic absorption of local anesthetic), and potential membrane-stabilising effects that reduce ectopic neural discharge [5,6]. Clonidine, in contrast, operates via a more targeted mechanism—primarily involving α2-adrenergic receptor activation, hyperpolarisation of nerve membranes, and mild vasoconstriction. However, its shorter half-life and limited pharmacologic profile likely account for its comparatively reduced duration of action [7,14].

Both adjuvants were safe and well-tolerated at the studied doses, with no significant haemodynamic instability or systemic side effects observed. Clonidine's systemic effects, such as bradycardia or hypotension, are dose-dependent, with higher doses (>150 µg) associated with an increased risk, as seen in Pöpping DM et al., [7]. These complications were absent in this study due to the lower dosage (100 µg). Similarly, dexamethasone demonstrated excellent tolerability, with no major adverse effects observed, corroborating prior evidence [5,9]. These results, supported by existing literature, reinforce that both adjuvants are safe and well-tolerated when administered within recommended dosing parameters [5,7-9].

Taken together, these findings highlight dexamethasone's superiority as an adjuvant to ropivacaine in PSNBs, providing extended analgesia and clinical benefits without compromising safety.

Limitation(s)

The study's single-center design and short-term follow-up may limit the generalisability of the findings. Additionally, pain tolerance differs among individuals, leading to subjectivity and variability in the reporting of VAS scores. Future research with larger, multi-center cohorts and objective pain assessment methods could help confirm these results and further clarify their clinical applicability.

CONCLUSION(S)

In conclusion, this randomised, double-blind study demonstrates that dexamethasone is a superior adjuvant to clonidine when combined with ropivacaine in ultrasound-guided PSNB for foot and ankle surgeries. Dexamethasone significantly prolonged the duration of analgesia and sensory block, maintained lower postoperative VAS scores beyond 12 hours, and achieved higher, though not statistically significant, patient satisfaction without compromising safety. These advantages support enhanced postoperative pain control and may facilitate early mobilisation and faster recovery. Given its superior efficacy, safety, and ease of use, dexamethasone may be considered the optimal adjuvant to ropivacaine for foot and ankle surgeries requiring extended postoperative pain control.

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