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Original Research Article

Enhancing Supraclavicular Brachial Plexus Block: A Prospective Randomized Study Comparing Levobupivacaine with Dexamethasone versus Levobupivacaine Alone for Upper Limb Surgeries

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Abstract:

Background: Supraclavicular brachial plexus block is commonly used for upper limb surgeries. Levobupivacaine provides effective regional anaesthesia, but its duration may be limited. Dexamethasone has been used as an adjuvant to prolong postoperative analgesia.

Aim: To compare the efficacy of 0.5% levobupivacaine with 8 mg dexamethasone and 0.5% levobupivacaine with normal saline in terms of onset of sensory and motor blockade and duration of postoperative analgesia.

Methods: This prospective randomized study was conducted in the Department of Anaesthesiology, Rangaraya Medical College, Government General Hospital, Kakinada, over 18 months. Fifty ASA I and II patients aged 18–60 years undergoing upper limb surgery were randomized into two groups. Group S received 25 mL of 0.5% levobupivacaine with 8 mg dexamethasone, while Group M received 25 mL of 0.5% levobupivacaine with 2 mL normal saline. Sensory and motor block onset, block duration, VAS scores, and rescue analgesia requirement were assessed.

Results: Group S showed significantly faster sensory and motor block onset, longer sensory and motor block duration, delayed first rescue analgesia, and lower postoperative VAS scores compared with Group M. No major complications were observed.

Conclusion: Dexamethasone significantly enhanced the efficacy of levobupivacaine in supraclavicular brachial plexus block.

Keywords: Levobupivacaine; Dexamethasone; Supraclavicular Block; Brachial Plexus Block; Postoperative Analgesia.

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Introduction

Peripheral nerve blocks are widely used for intraoperative anaesthesia and postoperative analgesia because they provide site-specific pain relief, reduce opioid requirement, and improve early recovery. Levobupivacaine, the S-enantiomer of bupivacaine, is a long-acting amide local anaesthetic with favourable sensory blockade and relatively lower cardiotoxic potential, making it suitable for regional anaesthesia [1, 2]. However, when used alone, the duration of postoperative analgesia may be insufficient, and patients may require early rescue analgesics. Dexamethasone has therefore been studied as an adjuvant to local anaesthetics because of its anti-inflammatory action, possible local effect on nociceptive C-fibres, and ability to prolong analgesic duration. Recent meta-analyses have shown that dexamethasone is among the most effective adjuvants for prolonging analgesia in single-shot peripheral nerve blocks, although the magnitude of benefit and the preferred route remain debated [1, 3]. Earlier clinical evidence also showed that dexamethasone added to levobupivacaine increased the duration of postoperative analgesia compared with levobupivacaine alone [4]. Hence, the present study was designed to compare the efficacy of 0.5% levobupivacaine with 8 mg dexamethasone versus 0.5% levobupivacaine with 2 ml normal saline (NS) in terms of onset of sensory blockade, onset of motor blockade, and duration of postoperative analgesia.

Methods

This prospective randomized study was conducted in the Department of Anaesthesiology, Rangaraya Medical College, Kakinada, over a period of 18 months from 01 November 2022 to 30 April 2024. The study protocol was approved by the Institutional Ethics Committee before initiation. A total of 50 patients scheduled for upper limb surgery under ultrasound-guided supraclavicular brachial plexus block (SBPB) were included after obtaining written informed consent. Patients aged 18–60 years, of either gender, weighing >50 kg, belonging to ASA physical status I and II were enrolled. Patients who were unwilling, had coagulopathy, local infection at the block site, pregnancy, pre-existing neurological deficit or neuropathy involving the brachial plexus, allergy to local anaesthetics, abnormal renal or liver function tests, abnormal ECG, diabetes mellitus, COPD, cervical spondylosis, or poor cooperation were excluded. Patients were randomly allocated into two groups. Group M received 25 mL of 0.5% levobupivacaine with 2 mL NS, whereas Group S received 25 mL of 0.5% levobupivacaine with 2 mL dexamethasone containing 8 mg.

All patients underwent detailed pre-anaesthetic evaluation on the day before surgery. The procedure, expected effects, and possible complications were explained. Routine investigations were carried out according to institutional protocol. On the day of surgery, the anaesthesia machine, oxygen supply, suction apparatus, circuits, emergency drugs, intravenous fluids, airway equipment, and resuscitation equipment were checked and kept ready. Arrangements for conversion to general anaesthesia, if required, were ensured. In the operating room, an 18G intravenous cannula was secured in the non-operative upper limb, and NS infusion was started. Standard monitors including ECG, pulse oximeter, heart rate, systolic blood pressure, and diastolic blood pressure were attached, and baseline vital parameters were recorded. The ultrasound-guided SBPB was performed using a LOGIQ E ultrasound machine with a 5 cm, 8–13 MHz linear probe.

Under strict aseptic precautions, the patient was placed in the supine position with the affected arm adducted and the head turned to the opposite side. The supraclavicular area was prepared with povidone-iodine, and the ultrasound probe was covered with a sterile sheath. The brachial plexus was identified in the supraclavicular fossa, lateral and superior to the subclavian artery, appearing as a cluster of hypoechoic structures. After local infiltration of the skin with 1–2 mL of local anaesthetic, a needle was advanced under ultrasound guidance using an in-plane lateral-to-medial approach. After negative aspiration and confirmation of correct needle placement with a small test dose, the allocated drug mixture was deposited around the brachial plexus. Following the block, patients were assessed for onset and quality of sensory and motor blockade, duration of sensory and motor block, duration of postoperative analgesia, haemodynamic parameters, and complications. Sensory and motor blockade were assessed every 2 minutes until block development. Sensory block was evaluated by pinprick in the radial, median, ulnar, and musculocutaneous nerve territories and graded from 0 to 2. Motor blockade was assessed using a modified Bromage scale from 0 to 2. Intraoperative heart rate, blood pressure, SpO_2, and ECG were monitored at 5-minute intervals. Postoperative pain was assessed using a 10 cm visual analogue scale. Patients were monitored every 30 minutes until completion of surgery, hourly for the first 6 hours, every 2 hours for the next 6 hours, and every 3 hours thereafter up to 24 hours.

Statistical analysis: The data was analysed using SPSS version 24. Continuous variables such as onset and duration of sensory and motor blockade, duration of analgesia, and pain scores were analyzed using student's t-test. Categorical variables like sensory and MB success rates were compared using chi-square test. A P value < 0.05 was considered statistically significant.

Results

Total of 50 patients were included, with 25 patients each in Group S and Group M. Baseline variables were comparable between the groups. Male predominance was observed in both groups, with 17 males in Group S and 19 males in Group M. ASA physical status was also comparable, with most patients belonging to ASA I. Age distribution did not show a statistically significant difference between the groups ($\chi^2 = 4.5$; $p = 0.34$), and duration of surgery was similar between Group S and Group M (126.8 ± 8.8 vs 123.21 ± 8.1 minutes; $p = 0.274$). Regarding block characteristics, Group S showed significantly faster onset of sensory blockade than Group M (4.25 ± 1.12 vs 7.32 ± 1.21 minutes; $p<0.001$). Motor block onset was also significantly earlier in Group S (6.11 ± 0.91 vs 9.10 ± 1.62 minutes; $p<0.001$). The duration of sensory block, motor block, and time to first rescue analgesia were significantly prolonged in Group S compared with Group M. VAS scores were lower in Group S at all observed postoperative intervals, indicating better postoperative analgesic profile. No major complications such as accidental intravascular injection, bradycardia, hypotension, Horner's syndrome, local anaesthetic systemic toxicity, or pneumothorax were observed.

Table 1: Baseline characteristics of study participants				
Variable	**Group S**	**Group M**	**Statistical test**	**p-value**
Male	17 (68%)	19 (76%)	Chi-square	>0.05
Female	8 (32%)	6 (24%)	Chi-square	>0.05
ASA I	19 (76%)	21 (84%)	Chi-square	0.66
ASA II	6 (24%)	4 (16%)	Chi-square	0.66
Duration of surgery, min	126.8 ± 8.8	123.21 ± 8.1	Unpaired t-test	0.274

Table 2: Age-wise distribution of the study participants			
Age	**Group S**	**Group M**	**Total**
18–27	7 (28%)	6 (24%)	13 (26%)
28–37	5 (20%)	5 (20%)	10 (20%)
38–47	8 (32%)	5 (20%)	13 (26%)
48–57	2 (8%)	8 (32%)	10 (20%)
>58	3 (12%)	1 (4%)	4 (8%)
Total	25 (100%)	25 (100%)	50 (100%)
Statistical analysis	$\chi^2 = 4.5$; P = 0.34; Not significant		

Table 3: Comparison of block characteristics between the groups				
Parameter	**Group S**	**Group M**	**t-value**	**p-value**
Onset of sensory block, min	4.25 ± 1.12	7.32 ± 1.21	9.31	<0.001
Onset of motor block, min	6.11 ± 0.91	9.10 ± 1.62	8.04	<0.001
Duration of sensory block, hrs	7.03 ± 1.28	3.02 ± 0.64	14.01	<0.001
Duration of motor block, hrs	5.12 ± 1.18	2.53 ± 0.51	10.07	<0.001
Time to first rescue analgesia, hrs	11.80 ± 1.98	6.59 ± 1.80	9.74	<0.001

Table 4: VAS score distribution at different postoperative intervals						
Time	**Group**	**VAS 0**	**VAS 1**	**VAS 2**	**VAS 3**	**VAS 7**
3 hrs	Group S	14	8	3	0	0
3 hrs	Group M	10	6	9	0	0
6 hrs	Group S	12	9	4	0	0
6 hrs	Group M	5	10	9	1	0
12 hrs	Group S	11	8	4	2	0
12 hrs	Group M	9	6	6	3	1
24 hrs	Group S	9	6	7	3	0
24 hrs	Group M	6	6	4	8	1

Discussion

SBPB is a commonly used regional anaesthetic technique for upper limb surgeries because it provides dense anaesthesia of the brachial plexus at the level of trunks and divisions. The use of ultrasound guidance has further improved the safety and precision of this block by allowing real-time visualization of the brachial plexus, surrounding vascular structures, needle advancement, and spread of local anaesthetic. Levobupivacaine is widely preferred for prolonged peripheral nerve blockade because it provides good sensory and motor block with a relatively safer cardiovascular and neurological profile compared with racemic bupivacaine. However, a single-shot block with levobupivacaine alone may not provide adequate postoperative analgesia for longer-duration surgical pain. Therefore, adjuvants such as dexamethasone have been studied to hasten block onset, improve block quality, prolong sensory and motor blockade, and delay the need for rescue analgesia. In the present study, addition of 8 mg dexamethasone to 0.5% levobupivacaine produced clinically superior block characteristics compared with 0.5% levobupivacaine with normal saline, supporting the role of dexamethasone as an effective adjuvant in ultrasound-guided SBPB [5, 6].

In the present study, both groups were comparable with respect to baseline demographic and clinical variables. The total sample consisted of 50 patients, with 25 patients in each group. Male predominance was observed in both groups, but gender distribution was not statistically significant. Age distribution, ASA physical status, and duration of surgery were also comparable between the two groups, indicating that the observed differences in block characteristics were unlikely to be due to baseline imbalance. This comparability is important because factors such as

age, physical status, surgical duration, and tissue handling can influence postoperative pain perception and analgesic requirements. The mean duration of surgery was 126.8 ± 8.8 minutes in Group S and 123.21 ± 8.1 minutes in Group M, with no significant difference between groups. Thus, the prolonged analgesia and better pain scores observed in the dexamethasone group can be reasonably attributed to the pharmacological effect of dexamethasone rather than differences in surgical exposure or operative duration. Similar baseline comparability has been reported in previous randomized studies evaluating dexamethasone as an adjuvant to long-acting local anaesthetics in brachial plexus blocks [7 – 9].

The onset of sensory blockade was significantly faster in the dexamethasone group. Group S showed a mean sensory block onset of 4.25 ± 1.12 minutes, compared with 7.32 ± 1.21 minutes in Group M. This finding suggests that dexamethasone not only prolongs analgesia but may also improve the speed of block establishment. A faster onset is clinically relevant because it reduces waiting time before surgical incision and improves operating room efficiency. The possible mechanisms include local anti-inflammatory action, reduction of ectopic neuronal discharge, alteration in potassium channel activity, and modulation of nociceptive C-fibre transmission. Although dexamethasone is traditionally recognized for prolonging analgesia, several clinical studies have also reported earlier sensory onset when dexamethasone is added to levobupivacaine, ropivacaine, or bupivacaine in brachial plexus blocks. Baloda et al. observed that dexamethasone added to levobupivacaine in supraclavicular brachial plexus block reduced the onset time of sensory and motor blockade and prolonged analgesia [10]. Persec et al. also reported improved analgesic profile when low-dose dexamethasone was added to levobupivacaine for supraclavicular blockade [8]. These observations are consistent with the present findings.

Motor block onset was also significantly earlier in Group S. The mean onset of motor blockade was 6.11 ± 0.91 minutes in the dexamethasone group compared with 9.10 ± 1.62 minutes in the normal saline group. Rapid motor block is useful for upper limb surgeries because it improves surgical conditions and patient comfort. Earlier establishment of motor block may reflect enhanced penetration of local anaesthetic around nerve fibres or improved local anaesthetic action in the perineural environment. However, this must be balanced against the duration of postoperative motor weakness, as prolonged motor blockade may delay early limb movement. In the present study, motor block duration was longer in Group S, but no adverse neurological event was reported. This supports the clinical acceptability of dexamethasone when used in carefully selected patients. Studies comparing dexamethasone with other adjuvants have shown that dexamethasone produces reliable prolongation of both sensory and motor blockade, although agents such as dexmedetomidine may produce even longer block duration at the cost of haemodynamic effects such as bradycardia or hypotension [11, 12]. The absence of significant complications in the present study strengthens the practical utility of dexamethasone.

The most important finding of the present study was the significant prolongation of sensory block, motor block, and postoperative analgesia in the dexamethasone group. The duration of sensory blockade was 7.03 ± 1.28 hours in Group S compared with 3.02 ± 0.64 hours in Group M. Similarly, motor block lasted 5.12 ± 1.18 hours in Group S compared with 2.53 ± 0.51 hours in Group M. Time to first rescue analgesia was markedly prolonged in Group S, with a mean of 11.80 ± 1.98 hours compared with 6.59 ± 1.80 hours in Group M. This indicates that dexamethasone nearly doubled the analgesic duration of levobupivacaine in the present cohort. These findings are in agreement with recent systematic reviews and meta-analyses, which have consistently shown that dexamethasone, either perineural or intravenous, prolongs analgesic duration after peripheral nerve blocks [13, 14]. Tan et al. concluded that perineural dexamethasone provides longer analgesic duration than intravenous dexamethasone, although the clinical magnitude of difference may be modest [3]. Postoperative pain assessment using VAS also favoured the dexamethasone group. At 3, 6, 12, and 24 hours, a greater proportion of patients in Group S had lower VAS scores compared with Group M. At 24 hours, 9 patients in Group S had VAS 0 and only 3 had VAS 3, whereas in Group M, only 6 patients had VAS 0 and 8 patients had VAS 3, with one patient reporting VAS 7. These findings suggest that the analgesic benefit of dexamethasone extended beyond the immediate intraoperative period into the postoperative phase. Lower VAS scores are clinically meaningful because they reduce the need for systemic analgesics, particularly opioids, thereby minimizing nausea, vomiting, sedation, respiratory depression, and delayed mobilization. Dexamethasone also has systemic antiemetic and anti-inflammatory properties, which may contribute to improved postoperative recovery. Recent work on rebound pain after peripheral nerve block has suggested that dexamethasone may reduce the severity of pain experienced after block resolution, especially when used intravenously, although optimal dose and route remain areas of ongoing research [15]. In the present study, delayed rescue analgesia and lower VAS distribution in Group S support the analgesic-sparing effect of dexamethasone.

Haemodynamic variables remained clinically acceptable, and no major complications were observed in this study. Accidental intravascular injection, bradycardia, hypotension, Horner's syndrome, local anaesthetic systemic toxicity, and pneumothorax were not reported. This is an important finding because safety remains a major concern in supraclavicular brachial plexus block due to the proximity of the subclavian artery, pleura, and neural structures. Ultrasound guidance likely contributed to procedural safety by improving needle visualization and drug deposition. Dexamethasone itself has been used widely as an adjuvant in regional anaesthesia; however, perineural use is still considered off-label in many settings, and preservative-free preparation is generally preferred to minimize theoretical neurotoxicity risk. Available clinical literature has not demonstrated a consistent increase in neurological complications with single-dose perineural dexamethasone, but long-term safety data remain limited. Therefore, patient selection, aseptic technique, avoidance of intraneural injection, use of ultrasound guidance, and postoperative neurological monitoring remain essential. The exclusion of patients with diabetes mellitus, neuropathy, abnormal renal or liver function, and coagulopathy in the present study may also have contributed to the favourable safety profile [16 – 18].

Overall, the present study demonstrated that 8 mg dexamethasone added to 25 mL of 0.5% levobupivacaine significantly improved the quality of ultrasound-guided supraclavicular brachial plexus block compared with levobupivacaine and normal saline. The dexamethasone group had faster onset of sensory and motor block, longer duration of sensory and motor blockade, prolonged postoperative analgesia, lower VAS score trend, and no observed major complications. These findings are consistent with both older landmark studies and recent evidence supporting dexamethasone as an effective adjuvant for peripheral nerve blocks. The clinical implication is that dexamethasone may be considered when prolonged postoperative analgesia is desired after upper limb surgeries, particularly where catheter techniques are not feasible. However, the study had limitations, including small sample size, single-centre design, exclusion of diabetic and high-risk patients, and limited follow-up period. Larger multicentre randomized studies comparing different doses and routes of dexamethasone are needed to determine the minimum effective dose, route-specific efficacy, and long-term safety profile.

Conclusion

The present study concluded that addition of 8 mg dexamethasone to 0.5% levobupivacaine in ultrasound-guided supraclavicular brachial plexus block significantly improved block characteristics compared with 0.5% levobupivacaine with normal saline. Patients receiving dexamethasone had faster onset of sensory and motor blockade, prolonged duration of sensory and motor block, delayed requirement of first rescue analgesia, and better postoperative VAS scores. No major complications such as accidental intravascular injection, bradycardia, hypotension, Horner's syndrome, local anaesthetic systemic toxicity, or pneumothorax were observed, indicating that dexamethasone was effective and clinically safe in the selected study population. However, the study had certain limitations. It was a single-centre study with a small sample size of 50 patients. Only ASA I and II patients were included, and high-risk patients, diabetics, and patients with neuropathy were excluded. Long-term neurological follow-up was not performed, and different doses or routes of dexamethasone were not compared.

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