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Original Research Article

Comparative Evaluation of 0.5% Ropivacaine with Dexamethasone and 0.5% Bupivacaine with Dexamethasone in Ultrasound Guided Infraclavicular Brachial Plexus Block

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Conflict of interest: Nil

Abstract

Background: Ultrasound-guided infraclavicular brachial plexus block provides effective anaesthesia and postoperative analgesia for upper-limb surgery. Objective: To compare 0.5% ropivacaine with dexamethasone and 0.5% bupivacaine with dexamethasone in ultrasound-guided infraclavicular brachial plexus block.

Methodology: This prospective randomized double-blind comparative study was conducted at Department of Anesthesiology, Khaja Bandenawaz University Faculty of Medical Sciences kalaburagi,India from December 2024 to April 2025and included 50 patients undergoing elective upper-limb surgery.

Results: The mean sensory block onset was significantly faster in Group R than Group B, 11.2 ± 2.6 versus 13.1 ± 2.8 minutes (p=0.016). Sensory block duration was significantly longer in Group B, 812.7 ± 104.8 versus 738.4 ± 96.5 minutes (p=0.012), while motor block duration was 701.8 ± 95.7 versus 612.6 ± 88.3 minutes (p=0.001). Postoperative analgesia lasted longer with bupivacaine, 934.8 ± 126.4 versus 842.5 ± 118.6 minutes (p=0.010), and the first rescue analgesic was required later, 15.6 ± 2.1 versus 14.0 ± 2.0 hours (p=0.008). Total 24-hour rescue analgesic consumption was lower in Group B, 61.5 ± 28.4 versus 82.0 ± 32.6 mg (p=0.022). Successful surgical block was achieved in 24 (96.0%) patients in each group. Adverse events occurred in 4 (16.0%) patients in Group R and 6 (24.0%) in Group B, with no significant difference (p=0.725).

Conclusion: Both combinations provided effective and safe infraclavicular brachial plexus block. Ropivacaine produced a faster sensory onset and earlier motor recovery, whereas bupivacaine provided longer sensory and motor blockade, prolonged postoperative analgesia, and lower rescue analgesic consumption.

Keywords: Ropivacaine; bupivacaine; dexamethasone; infraclavicular block; brachial plexus block; postoperative analgesia.

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Introduction

Effective intraoperative anaesthesia and prolonged postoperative analgesia is common during upper-limb surgical procedures. While general anaesthetic is still in common use, regional anaesthetic using ultrasound is an option for obtaining an area of surgical anaesthesia, lowering the peri-operative use of opioids, better post-operative pain management, and quicker recovery from anaesthetic [1]. Brachial plexus blocks are especially useful for surgeries involving the elbow, forearm, wrist, and hand, as they provide good sensory and motor blockade with fewer systemic effects than general anaesthesia [2]. The infraclavicular approach makes a journey around the axillary artery along the cords of the brachial plexus just inferior to the clavicle. It is a reliable method for anaesthetizing the distal upper limb and may have some benefits, including stable catheter placement, decreased risk of phrenic nerve involvement, and good coverage of the musculocutaneous, median, radial and ulnar nerves [3]. The use of ultrasound guidance allows direct visualization of the axillary artery, nearby cords, needle advancement, and local anaesthetic spread, which are advantageous compared with landmark-based techniques [4]. This can enhance block precision, minimize the amount of local anaesthetic used, decrease the duration of performance, and minimize the risk of vascular puncture, pneumothorax and accidental intraneural injection [5]. Several factors such as the anatomical approach, injection technique, local-anaesthetic concentration, local-anaesthetic volume, operator experience, and adjuvant drugs play roles in the success of infraclavicular block [6]. The ideal local anaesthetic

would produce a dense sensory and motor block, quick onset, long-lasting postoperative analgesia and is safe to administer. Long-acting amid local anaesthetics such as bupivacaine and ropivacaine are often used for brachial plexus blocks [7]. Bupivacaine is known to cause a sensory and motor blockade that is deep and long. When administered intravenously, however, central nervous system toxicity and significant cardiovascular effects such as ventricular arrhythmias and myocardial depression may occur [8]. Ropivacaine shares many of the pharmacologic properties of bupivacaine, but it has a greater margin of safety with respect to the cardiovascular and neurological systems [9]. It also has a higher differential sensory block compared to comparatively less intense motor blockade at low concentrations, which may help to promote earlier postoperative limb movement [10].

In brachial plexus blocks, previous clinical studies have demonstrated the effectiveness of both long-acting local anaesthetic agents, ropivacaine and bupivacaine, for providing surgical anaesthesia. In certain circumstances, bupivacaine can cause a deeper and/or longer motor block than ropivacaine, and ropivacaine may facilitate recovery of motor function and have a more benign toxicity profile [11]. Evidence from infraclavicular and other approaches to the brachial plexus has indicated that differences in onset and duration vary with the concentration, volume, location, and evaluation technique [12]. For this reason, the relative clinical performance cannot be determined without making a comparison at the same concentration and by using an identical ultrasound-guided technique. Dexamethasone is a corticosteroid that has become the preferred adjuvant for local anaesthetics used for peripheral nerve blocks. It might have local anti-inflammatory properties and inhibit ectopic neuronal discharge and modulate the activity of potassium channels to prolong analgesia [13]. Developed by previous studies, dexamethasone has been shown to significantly prolong the duration of sensory blockades and postoperative analgesia when used in combination with long-acting local anaesthetics, and to delay the use of rescue analgesics [14]. There is evidence from meta-analysis that perineural dexamethasone may significantly extend long-acting local anaesthetic (LALA) analgesia, although the degree of effect seems to differ across block types and studies [15]. Preservative-free preparations and patient selection and informed consent, however, are important considerations, as is the fact that dexamethasone is still an off-label route.

Objective: To compare 0.5% ropivacaine with dexamethasone and 0.5% bupivacaine with dexamethasone in ultrasound-guided infraclavicular brachial plexus block.

Methodology

This prospective randomized double-blind comparative study was conducted at Department of Anesthesiology, Khaja Bandenawaz University Faculty of Medical Sciences kalaburagi,India from December 2024 to April 2025and included 50 patients undergoing elective upper-limb surgery under ultrasound-guided infraclavicular brachial plexus block. The participants were divided equally into two groups, with 25 patients in each group. Patients aged 18–65 years of either gender, belonging to American Society of Anesthesiologists physical status I or II, and scheduled for elective surgery involving the elbow, forearm, wrist, or hand were included. Patients who provided written informed consent and were suitable for ultrasound-guided infraclavicular brachial plexus block were considered eligible. Patients who refused regional anaesthesia, had allergy to amide local anaesthetics or dexamethasone, infection at the injection site, coagulopathy, ongoing anticoagulant therapy, pre-existing neurological deficit in the operative limb, severe cardiovascular, respiratory, hepatic, or renal disease, uncontrolled diabetes mellitus, pregnancy, body mass index greater than 35 kg/m², or inability to understand the pain-scoring system were excluded. Patients with incomplete or failed block requiring conversion to general anaesthesia were also excluded from the final analysis.

Data Collection: Following approval from the Institutional Ethical Review Committee, eligible patients were enrolled through non-probability consecutive sampling after obtaining written informed consent. Participants were randomly allocated into two equal groups using a computer-generated randomization sequence concealed in sealed opaque envelopes. The study solutions were prepared by an anaesthetist not involved in block administration or outcome assessment. Group R received 30 mL of 0.5% ropivacaine combined with 4 mg preservative-free dexamethasone, while Group B received 30 mL of 0.5% bupivacaine combined with 4 mg preservative-free dexamethasone. The final volume and appearance of both solutions were kept identical to maintain blinding. Baseline variables included age, gender, body mass index, ASA physical status, type and duration of surgery, operative limb, heart rate, blood pressure, respiratory rate, and oxygen saturation. Standard monitoring was applied after arrival in the operating room, and intravenous access was secured. Patients were positioned supine with the head turned to the opposite side. Under strict aseptic precautions, a high-frequency linear ultrasound probe was placed below the clavicle to identify the axillary artery, vein, pectoral muscles, and cords of the brachial plexus. A block needle was advanced using an in-plane technique, and after repeated negative aspiration, the allocated solution was injected incrementally around the medial, lateral, and posterior cords. Ultrasound visualization was used to confirm proper spread of the local anaesthetic

around the axillary artery. Sensory block was assessed every two minutes using a pinprick test in the distribution of the musculocutaneous, median, radial, and ulnar nerves. Sensory block was graded as normal sensation, reduced sensation, or complete loss of sensation. The onset of sensory block was defined as the time from completion of injection to complete loss of sensation in all required nerve distributions. The duration of sensory block was measured from complete sensory blockade until return of normal sensation. Motor block was assessed every two minutes using a modified Bromage scale for the upper limb. The onset of motor block was defined as the time from completion of injection to complete motor paralysis, while the duration of motor block was recorded until normal motor function returned. The block was considered successful when complete surgical anaesthesia was achieved within 30 minutes without the need for general anaesthesia. Intraoperative heart rate, blood pressure, oxygen saturation, and any complications were recorded throughout the procedure. Postoperative pain was assessed using the Visual Analogue Scale from 0 to 10. Rescue analgesia was administered when the pain score reached 4 or more. The duration of postoperative analgesia was defined as the time from completion of the block to the first request for rescue analgesia. Total rescue analgesic consumption during the first 24 hours, patient satisfaction, and adverse events including vascular puncture, haematoma, hypotension, bradycardia, nausea, vomiting, pneumothorax, neurological deficit, and local-anaesthetic systemic toxicity were recorded. The primary outcomes were duration of postoperative analgesia and duration of sensory block. Secondary outcomes included onset of sensory and motor block, duration of motor block, block success rate, postoperative pain scores, time to first rescue analgesia, total 24-hour analgesic requirement, patient satisfaction, haemodynamic changes, and adverse effects.

Statistical Analysis: Data were analyzed using SPSS version 26.0. Continuous variables such as age, body mass index, onset and duration of sensory and motor block, duration of analgesia, pain scores, and rescue analgesic consumption were expressed as mean ± standard deviation or median with interquartile range according to data distribution. Categorical variables such as gender, ASA status, block success, patient satisfaction, and adverse events were presented as frequencies and percentages. The Shapiro–Wilk test was used to assess normality. The independent-samples t-test was applied to compare normally distributed continuous variables, while the Mann–Whitney U test was used for non-normally distributed variables. A p-value ≤0.05 was considered statistically significant.

Results

Both groups were comparable at baseline. The mean age was 38.6 ± 12.1 years in the ropivacaine group and 40.2 ± 11.4 years in the bupivacaine group, while mean BMI was 25.8 ± 3.4 and 26.1 ± 3.7 kg/m², respectively. Most patients were male and belonged to ASA class I. The distribution of operative limb, surgical site, and mean surgical duration, 74.8 ± 18.6 versus 77.2 ± 20.1 minutes, was also similar, with no statistically significant differences.

Table 1: Baseline demographic and operative characteristics of participants

Characteristic	Group R: Ropivacaine + dexamethasone n=25	Group B: Bupivacaine + dexamethasone n=25	p-value
Age, years	38.6 ± 12.1	40.2 ± 11.4	0.632
Gender, n (%)			0.771
Male	16 (64.0%)	15 (60.0%)	
Female	9 (36.0%)	10 (40.0%)	
BMI, kg/m²	25.8 ± 3.4	26.1 ± 3.7	0.766
ASA physical status, n (%)			0.733
ASA I	17 (68.0%)	16 (64.0%)	
ASA II	8 (32.0%)	9 (36.0%)	
Operative limb, n (%)			0.777
Right	14 (56.0%)	13 (52.0%)	
Left	11 (44.0%)	12 (48.0%)	
Surgical site, n (%)			0.958
Elbow	5 (20.0%)	4 (16.0%)	
Forearm	8 (32.0%)	9 (36.0%)	
Wrist	7 (28.0%)	7 (28.0%)	
Hand	5 (20.0%)	5 (20.0%)	
Duration of surgery, minutes	74.8 ± 18.6	77.2 ± 20.1	0.664

Values are presented as mean ± SD or n (%). Independent-samples t-test and Chi-square test were applied as appropriate.

Ropivacaine produced a significantly faster sensory block onset than bupivacaine, at 11.2 ± 2.6 versus 13.1 ± 2.8 minutes (p=0.016). Motor onset was also faster with ropivacaine, 14.0 ± 3.1 versus 15.8 ± 3.4 minutes, although the difference was not significant (p=0.056). Bupivacaine provided significantly longer sensory blockade, 812.7 ± 104.8 versus 738.4 ± 96.5 minutes, and motor blockade, 701.8 ± 95.7 versus 612.6 ± 88.3 minutes. Successful surgical block was achieved in 24 (96.0%) patients in each group.

Table 2: Comparison of onset and duration of sensory and motor blockade

Block characteristic	Group R: Ropivacaine + dexamethasone	Group B: Bupivacaine + dexamethasone	p-value
Onset of sensory block, minutes	11.2 ± 2.6	13.1 ± 2.8	0.016
Onset of motor block, minutes	14.0 ± 3.1	15.8 ± 3.4	0.056
Duration of sensory block, minutes	738.4 ± 96.5	812.7 ± 104.8	0.012
Duration of motor block, minutes	612.6 ± 88.3	701.8 ± 95.7	0.001
Complete sensory block within 20 minutes, n (%)	23 (92.0%)	20 (80.0%)	0.417
Complete motor block within 20 minutes, n (%)	21 (84.0%)	18 (72.0%)	0.496
Successful surgical block, n (%)	24 (96.0%)	24 (96.0%)	1.000

Postoperative analgesia lasted significantly longer with bupivacaine, at 934.8 ± 126.4 minutes compared with 842.5 ± 118.6 minutes for ropivacaine (p=0.010). The first rescue analgesic was required later in the bupivacaine group, 15.6 ± 2.1 versus 14.0 ± 2.0 hours (p=0.008). Pain scores were generally lower with bupivacaine, with a significant difference at 12 hours, 2.9 ± 1.1 versus 3.6 ± 1.2 (p=0.036). Total 24-hour rescue analgesic consumption was also lower with bupivacaine, 61.5 ± 28.4 versus 82.0 ± 32.6 mg (p=0.022), while satisfaction scores were comparable.

Table 3: Postoperative analgesia and pain outcomes

Outcome	Group R: Ropivacaine + dexamethasone	Group B: Bupivacaine + dexamethasone	p-value
Duration of postoperative analgesia, minutes	842.5 ± 118.6	934.8 ± 126.4	0.010
Time to first rescue analgesia, hours	14.0 ± 2.0	15.6 ± 2.1	0.008
VAS score at 2 hours	1.1 ± 0.8	0.9 ± 0.7	0.349
VAS score at 6 hours	2.0 ± 1.0	1.6 ± 0.9	0.145
VAS score at 12 hours	3.6 ± 1.2	2.9 ± 1.1	0.036
VAS score at 24 hours	3.1 ± 1.0	2.8 ± 1.1	0.319
Patients requiring rescue analgesia within 12 hours, n (%)	9 (36.0%)	4 (16.0%)	0.196
Total rescue analgesic consumption in 24 hours, mg	82.0 ± 32.6	61.5 ± 28.4	0.022
Patient satisfaction score, out of 10	8.5 ± 1.0	8.7 ± 0.9	0.464

Any adverse event occurred in 4 (16.0%) patients in the ropivacaine group and 6 (24.0%) in the bupivacaine group, with no significant difference (p=0.725). Hypotension, bradycardia, nausea or vomiting, vascular puncture, and haematoma were uncommon, while no patient developed local-anaesthetic systemic toxicity, pneumothorax, or persistent neurological deficit. Stable intraoperative haemodynamics were maintained in 24 (96.0%) and 23 (92.0%) patients, respectively.

Table 4: Comparison of haemodynamic stability and adverse events

Outcome	Group R: Ropivacaine + dexamethasone n (%)	Group B: Bupivacaine + dexamethasone n (%)	p-value
Hypotension	1 (4.0%)	2 (8.0%)	1.000
Bradycardia	1 (4.0%)	1 (4.0%)	1.000
Nausea or vomiting	2 (8.0%)	3 (12.0%)	1.000
Vascular puncture	1 (4.0%)	2 (8.0%)	1.000
Haematoma	0 (0.0%)	1 (4.0%)	1.000
Local-anaesthetic systemic toxicity	0 (0.0%)	0 (0.0%)	—
Pneumothorax	0 (0.0%)	0 (0.0%)	—

Persistent neurological deficit	0 (0.0%)	0 (0.0%)	—
Any adverse event	4 (16.0%)	6 (24.0%)	0.725
Stable intraoperative haemodynamics	24 (96.0%)	23 (92.0%)	1.000

Discussion

In the present study, 0.5% ropivacain and dexamethasone were compared with 0.5% bupivacain and dexamethasone for infraclavicular brachial plexus block in 50 patients guided by ultrasound. There were no significant differences between the two groups with respect to age, gender, BMI, ASA score, operative limb, surgical site or length of surgery, indicating no baseline differences should have impacted the results. The onset of sensory block was faster with ropivacaine than bupivacaine (11.2 ± 2.6 minutes, respectively, 13.1 ± 2.8 minutes; p=0.016). Motor block was also induced earlier with ropivacaine (14.0 ± 3.1 minutes) compared with bupivacain (15.8 ± 3.4 minutes), but this difference was not statistically significant (p=0.056). A similar study conducted previously has also demonstrated that the onset of brachial plexus blockade with ropivacaine may be relatively quicker [17]. By comparison, however, bupivacaine resulted in markedly prolonged sensory and motor block. Sensory block lasted 812.7 ± 104.8 minutes with bupivacaine compared with 738.4 ± 96.5 minutes with ropivacaine (p=0.012), while motor block lasted 701.8 ± 95.7 versus 612.6 ± 88.3 minutes (p=0.001). The use of bupivacaine-related agents are also reported to have more prolonged blockade while ropivacaine is reported to allow earlier motor recovery. This has led to the use of ropivacaine when early movement of the limb is desired while bupivacaine is used when prolonged anaesthesia is required. Twenty-four (96.0%) patients in each group had successful surgical block. Twenty-three (92.0%) and 20 (80.0%) patients receiving ropivacaine and bupivacaine, respectively, had complete sensory block within 20 minutes, and complete motor block occurred in 21 (84.0%) and 18 (72.0%) patients, respectively. Previous studies have also demonstrated both drugs to be good anaesthetic agents for surgery, having high rates of block success. Bupivacaine resulted in significantly longer postoperative analgesia. Mean analgesic duration was 934.8 ± 126.4 minutes compared with 842.5 ± 118.6 minutes with ropivacaine (p=0.010). The first rescue analgesic was also required later, at 15.6 ± 2.1 versus 14.0 ± 2.0 hours (p=0.008). Long acting local anaesthetic have also been shown to provide prolonged analgesia with the addition of dexamethasone in previous studies [19].Generally, the pain scores were lower in the bupivacaine group with significant difference at 12 Hours (2.9 ± 1.1 vs 3.6 ± 1.2), p=0.036. The amount of rescue analgesics required within the first 24 hours was also less with bupivacaine (61.5 ± 28.4 mg) than with ropivacaine (82.0 ± 32.6 mg; p=0.022). In previous studies, similar benefits have been found for longer duration of regional blocks in terms of reduction in postoperative analgesic use. The patient satisfaction scores were similar and high across both groups (8.5 ± 1.0 for ropivacaine and 8.7 ± 0.9 for bupivacaine). This suggests that both treatment regimens created satisfactory surgical conditions and postoperative pain management. There were few complications and both combinations were haemodynamically stable. No significant difference was found between the ropivacaine and bupivacaine groups in terms of adverse events (4/40, 16.0% in the ropivacaine group vs 6/25, 24.0% in the bupivacaine group; p=0.725). None of the patients had local-anaesthetic systemic toxicity, pneumothorax or a persisting neurological deficit. Similar safety has been reported in previous studies with these drugs when administered in proper dose under ultrasound guidance [20].

Limitations

This study had several limitations. It was conducted at a single centre with a relatively small sample of 50 patients, which may limit the generalizability of the findings and the ability to detect uncommon adverse events. Only ASA I and II patients undergoing selected upper-limb procedures were included; therefore, the results may not apply to high-risk patients or emergency surgery. Postoperative pain and patient satisfaction were assessed subjectively, and long-term neurological outcomes were not evaluated. In addition, plasma local-anaesthetic concentrations and the independent effect of dexamethasone were not assessed because both groups received the same adjuvant.

Conclusion

Both 0.5% ropivacaine with dexamethasone and 0.5% bupivacaine with dexamethasone provided effective and safe ultrasound-guided infraclavicular brachial plexus block. Ropivacaine produced a faster sensory onset and earlier motor recovery, while bupivacaine resulted in longer sensory and motor blockade, more prolonged postoperative analgesia, and lower rescue analgesic consumption. Therefore, ropivacaine may be preferred when rapid onset and earlier return of motor function are desired, whereas bupivacaine may be more suitable when extended postoperative pain relief is the main priority.

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