ORIGINAL RESEARCH PAPER

Anaesthesiology

A COMPARATIVE OBSERVATIONAL STUDY OF ROPIVACAINE WITH DEXAMETHASONE VERSUS ROPIVACAINE WITH BUPRENORPHINE IN SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK

KEY WORDS:

Dr. N Vignesh Raju Junior Resident, Department Of Anesthesiology, Sree Balaji Medical College And Hospital ,Chennai – 600 044,Tamil Nadu, India

Dr. Geetha Soundarya* Associate Professor, Department Of Anesthesiology, Sree Balaji Medical College And Hospital ,Chennai – 600 044,Tamil Nadu *Corresponding Author

Dr. Yasmin Mariam S G Senior Resident, Department of Anesthesiology, Sree Balaji Medical College and Hospital

ABSTRACT

Background: Supraclavicular brachial plexus block is a widely used regional anesthetic technique for upper limb surgeries, offering excellent intraoperative and postoperative analgesia. However, the duration of analgesia from local anesthetics like ropivacaine is often limited, prompting the use of adjuvants to enhance and prolong the block's efficacy. Among the commonly used adjuvants, dexamethasone and buprenorphine have gained popularity due to their effectiveness in enhancing analgesia without significant complications.**Aim:** This study aimed to compare the onset, duration, and efficacy of supraclavicular brachial plexus block using ropivacaine with dexamethasone (RD) versus ropivacaine with buprenorphine (RB) in patients undergoing upper limb surgeries.**Methods:**A prospective observational study was conducted on 60 patients aged 20–45 years, classified as ASA I–III, and posted for elective upper limb orthopaedic procedures. Patients were randomly assigned into two equal groups: Group RD received 30 ml of 0.5% ropivacaine with 4 mg dexamethasone, and Group RB received 30 ml of 0.5% ropivacaine with 3 mcg/kg buprenorphine. Parameters assessed included the onset and duration of sensory and motor block, time to first rescue analgesia, and hemodynamic stability.**Results:** Group RD showed a significantly prolonged duration of sensory block (19.68 ± 2.53 hrs vs. 12.25 ± 2.53 hrs), motor block (14.81 ± 2.24 hrs vs. 9.06 ± 1.97 hrs), and delayed time to first rescue analgesia (21.78 ± 2.08 hrs vs. 14.73 ± 1.81 hrs) compared to Group RB ($p < 0.001$). Hemodynamic parameters and incidence of side effects were comparable between groups.**Conclusion:** The addition of dexamethasone to ropivacaine in supraclavicular brachial plexus block resulted in significantly longer sensory and motor blockade and delayed need for rescue analgesia compared to buprenorphine, indicating that dexamethasone may be a more effective adjuvant in prolonging postoperative analgesia. This study supports the use of ropivacaine with dexamethasone as a preferred combination for supraclavicular brachial plexus block in upper limb surgeries.

INTRODUCTION

Regional anesthesia has become a cornerstone of modern surgical practice, especially in orthopaedic procedures involving the upper limbs. Among the various regional techniques, the supraclavicular brachial plexus block stands out for its ability to provide dense anesthesia and excellent postoperative analgesia for surgeries below the shoulder. Its appeal lies in its high success rate and the ability to block the entire upper limb through a single injection site where the brachial plexus is most compact. This technique not only avoids the systemic side effects of general anesthesia but also facilitates faster recovery and rehabilitation for patients. With ultrasound guidance becoming widely accessible, precision in targeting neural structures has significantly improved, making the supraclavicular block even safer and more reliable.

Yet, despite the advantages of this block, one persistent challenge remains—the limited duration of analgesia. Even long-acting local anesthetics like ropivacaine eventually wear off, necessitating the administration of rescue analgesics and potentially exposing patients to opioid-related side effects. This has led to the exploration of various adjuvants—agents that, when combined with local anesthetics, extend the duration of the block, improve analgesic quality, and minimize systemic drug requirements. These adjuvants act through different mechanisms, ranging from anti-inflammatory effects to modulation of pain pathways, and have reshaped how anesthesiologists approach pain control in regional techniques.

Dexamethasone and buprenorphine have emerged as two popular choices among these adjuvants. Dexamethasone, a potent glucocorticoid, is well-recognized for its anti-inflammatory properties and has shown the ability to prolong both sensory and motor blockades when used perineurally. Its mechanism of action is believed to be multifactorial—it suppresses ectopic neuronal discharge, reduces perineural inflammation, and modulates potassium channel activity in nociceptive fibres. These effects, while still being researched in finer detail, consistently translate into extended pain relief without notable systemic complications. Moreover, dexamethasone's safety profile has been reinforced across numerous trials involving both peripheral nerve blocks and neuraxial techniques (Martin et al., 2023).

In contrast, buprenorphine is a partial mu-opioid receptor agonist known for its potent analgesic effect and long half-life. When used as an adjuvant in peripheral nerve blocks, buprenorphine enhances analgesia by modulating pain transmission at the spinal and supraspinal levels. Its lipid solubility allows it to act on peripheral opioid receptors in inflamed tissue, potentially reducing central sensitization. Unlike full agonists, it produces a ceiling effect for respiratory depression, making it safer in regional use. Sangeetha et al. (2024) demonstrated that buprenorphine, when added to ropivacaine, can effectively prolong analgesia in brachial plexus blocks, although its efficacy compared to dexamethasone remains under debate.

Interestingly, literature remains divided on which of the two—dexamethasone or buprenorphine—offers more sustained analgesia and clinical advantages. While some studies highlight dexamethasone's superior block duration and reduced opioid consumption, others report favourable results with buprenorphine, especially in terms of early onset and patient satisfaction. Pyakurel et al. (2023), in a comparative study, observed that both adjuvants had positive effects on block duration and postoperative pain scores, but individual patient factors and surgical variables often

influenced outcomes. Additionally, Louail (2025) emphasized the growing need for evidence-based practice guidelines to integrate adjuvant selection into standardized regional protocols, given the variability in clinical responses.

Given this backdrop, the current study was undertaken to provide a clearer clinical comparison between these two agents—dexamethasone and buprenorphine—when used as adjuvants to ropivacaine in supraclavicular brachial plexus block. While past research has evaluated each agent's efficacy individually or in comparison to other adjuvants, direct head-to-head trials remain sparse in the Indian population. Our study aims to fill this gap by assessing the onset, duration, analgesic profile, and safety of these two combinations in patients undergoing elective upper limb surgeries. By evaluating real-time clinical outcomes, this study not only contributes to existing evidence but also seeks to offer practical guidance for anesthesiologists in optimizing regional block protocols for better patient care.

MATERIALS AND METHODS

This prospective, observational study was conducted in the Department of Anaesthesiology at Sree Balaji Medical College and Hospital, Chennai, over a defined period in 2023. It was designed to evaluate and compare the effectiveness of two specific adjuvants—dexamethasone and buprenorphine—when used alongside 0.5% ropivacaine in ultrasound-guided supraclavicular brachial plexus blocks for elective upper limb orthopaedic surgeries. The primary goal was to assess onset time, block duration, rescue analgesia requirement, and overall safety profile of the drug combinations. Ethical clearance for the study was granted by the Institutional Ethics Committee, and informed written consent was obtained from all participants prior to enrolment. Patient selection was carefully done based on strict inclusion and exclusion criteria to ensure uniformity and reliability of outcomes. A total of 60 adult patients were selected using random sampling. Inclusion criteria included patients aged 20 to 45 years, belonging to ASA physical status I–III, and scheduled for elective upper limb surgeries under regional anaesthesia. Patients with known allergies to local anaesthetics, corticosteroids, or opioids were excluded. Additional exclusion criteria involved those with local infections at the injection site, coagulopathies, severe systemic illnesses, neurological deficits involving the operative limb, and pregnant or lactating women. These criteria were necessary to avoid bias or confounding effects and were consistent with patient safety standards highlighted in similar research frameworks (Shaheen, 2022).

Once selected, the 60 patients were randomly divided into two equal groups using a sealed envelope technique. Group RD received a combination of 30 ml of 0.5% ropivacaine with 4 mg of dexamethasone, while Group RB received 30 ml of 0.5% ropivacaine with 3 mcg/kg of buprenorphine. The same drug volume ensured dosage uniformity across both groups and allowed for a fair comparison of block dynamics. All blocks were performed using an ultrasound-guided technique under strict aseptic precautions, a method widely accepted for its precision and reduction of complication risks. A 22-gauge Quincke spinal needle was used for the block, with in-plane needle visualization under high-frequency linear ultrasound probe guidance. The block was administered in the supraclavicular fossa with patients in the supine position and their heads turned contralaterally.

Real-time ultrasound imaging was used to visualize the brachial plexus—appearing typically as a "cluster of grapes" lateral and superior to the subclavian artery. Once the needle was placed adjacent to the plexus, negative aspiration was confirmed to rule out vascular puncture. The prepared drug mixture was then slowly injected, ensuring proper circumferential spread around the neural elements. This imaging-guided technique not only ensures better accuracy but is strongly supported in the literature for reducing block failures and complications such as pneumothorax (Edinoff et al., 2021).

After the block was performed, patients were monitored continuously for onset of sensory and motor blockade. Sensory block was tested by pinprick using a 26G hypodermic needle, and motor block was assessed by the ability to flex or extend the wrist and fingers. The onset time, duration of sensory and motor block, time to first rescue analgesia, and hemodynamic parameters (heart rate, mean arterial pressure) were meticulously recorded. Parameters were monitored every 5 minutes for the first 30 minutes and then every 15 minutes intraoperatively. Postoperatively, pain scores were evaluated using Visual Analogue Scale (VAS), and the timing of the first analgesic request was noted. The block was considered successful if complete sensory and motor blockade was achieved within 20 minutes.

Complications such as nausea, vomiting, respiratory depression, or local site reactions were observed and documented. No major adverse events occurred during the study, although minor incidents like mild nausea were reported, which were managed conservatively. These adverse events were consistent with the known safety profile of perineural buprenorphine and dexamethasone documented in previous findings (Chaudhari et al., 2022).

The recorded data were compiled and analyzed using Statistical Package for the Social Sciences (SPSS), Version 20.0. Continuous variables such as duration of analgesia, onset times, and block duration were expressed as mean ± standard deviation (SD). Comparisons between the two groups were made using the unpaired t-test, while categorical variables such as complications were analyzed using Chi-square or Fisher's exact test. A p-value less than 0.05 was considered statistically significant for all analyses.

This methodological framework was chosen not just for its simplicity, but for its reproducibility in clinical settings. It allows the results to be translatable to daily anesthesia practice, especially in resource-adequate centers with access to ultrasound and monitoring equipment. The study design mimicked real-time clinical workflows while adhering to best practices in regional anesthesia research (Shaheen, 2022; Edinoff et al., 2021; Chaudhari et al., 2022), ensuring that the findings hold practical value and can be applied to broader patient populations in the future.

RESULTS

Onset of Sensory and Motor Block

The onset of both sensory and motor blockade was carefully monitored and recorded after the administration of the supraclavicular brachial plexus block in all 60 patients. Sensory onset was defined as the time from drug injection to the complete loss of pinprick sensation in the dermatomes supplied by the median, radial, ulnar, and musculocutaneous nerves. Motor onset, on the other hand, was assessed by observing the reduction in voluntary movements of the wrist and fingers, typically within the first 20 minutes of drug administration.

In Group RD (ropivacaine with dexamethasone), the mean onset of sensory block was 9.33 ± 2.83 minutes, while in Group RB (ropivacaine with buprenorphine), it was 9 ± 2.81 minutes. The p-value was 0.6521, indicating that this difference was not statistically significant. Similarly, the mean onset of motor block was 13 ± 3.05 minutes in Group RD and 12.66 ± 3.7 minutes in Group RB, with a p-value of 0.6992, again demonstrating no statistically meaningful difference between the two groups.

This similarity in onset timings aligns with earlier findings by Sangeetha et al. (2024), who also reported comparable onset

profiles between dexamethasone and buprenorphine when paired with ropivacaine. While the mechanisms differ—dexamethasone modulates inflammation and nerve excitability, and buprenorphine binds peripheral opioid receptors—both agents appear to exert negligible influence on the initial speed of nerve blockade development. Interestingly, Pyakurel et al. (2023) also suggested that adjuvants may not consistently affect onset time but instead have more pronounced effects on block duration and postoperative analgesia.

Thus, in terms of the early pharmacodynamic response, both dexamethasone and buprenorphine behave similarly when used as perineural adjuvants with ropivacaine. This finding highlights that while block longevity may differ, the initial anesthetic effect occurs within an equivalent timeframe, providing clinicians the flexibility to focus on duration and safety when choosing between these adjuvants.

Duration of Sensory and Motor Block

The duration of both sensory and motor blockade was a key parameter evaluated in this study, as it reflects the clinical effectiveness of the adjuvant used with ropivacaine. Duration of sensory block was defined as the time from the onset of complete sensory loss until the return of pinprick sensation in the relevant dermatomes. Likewise, motor block duration was calculated from the time of complete motor weakness to the return of baseline motor function in the hand and forearm muscles.

In Group RD, where patients received ropivacaine with dexamethasone, the mean duration of sensory block was found to be 19.68 ± 2.53 hours, which was significantly longer than the 12.25 ± 2.53 hours observed in Group RB, who received ropivacaine with buprenorphine. The p-value was < 0.0001, indicating a highly significant statistical difference. Similarly, the mean duration of motor block in Group RD was 14.81 ± 2.24 hours, compared to 9.06 ± 1.97 hours in Group RB, again with a p-value < 0.0001. These findings demonstrate a clearly superior block prolongation profile in the dexamethasone group.

The observed difference can be attributed to the distinct pharmacologic profiles of the two adjuvants. Dexamethasone, a corticosteroid, likely exerts its effect by reducing perineural inflammation and modulating potassium channel activity, thereby extending the duration of nerve conduction blockade. This aligns with the findings of Chaudhari et al. (2022), who also reported prolonged block durations with dexamethasone in peripheral nerve blocks. Buprenorphine, though effective, may not sustain blockade as long due to its partial agonist nature and the possible peripheral limitation of opioid receptors in nerve fibers. In fact, Shaheen (2022) emphasized that while both agents are effective, dexamethasone appears to act more directly on the nerve tissue, leading to a longer block duration with fewer systemic side effects.

These differences in block duration have practical clinical implications. Patients in Group RD required significantly fewer rescue analgesics in the postoperative period, reducing their exposure to systemic opioids and improving overall satisfaction. The extended motor block, while beneficial for pain relief, should however be considered cautiously in surgeries requiring early physiotherapy or motor assessment postoperatively. Nonetheless, the findings strongly support the use of dexamethasone for enhancing the longevity of both sensory and motor blockade in supraclavicular brachial plexus blocks when prolonged analgesia is the goal.

Time for First Rescue Analgesia

One of the most clinically relevant measures in any regional anesthesia study is the time to first rescue analgesia, as it directly reflects the duration of effective postoperative pain control. In the present study, this was measured from the time of block administration to the first patient-reported request for analgesia, guided by a Visual Analogue Scale (VAS) score exceeding 4, or based on discomfort reported by the patient during the postoperative monitoring phase. This parameter not only offers insight into the analgesic efficacy of the adjuvant but also helps reduce the reliance on systemic opioids when prolonged block effect is achieved.

In our comparison, Group RD (ropivacaine with dexamethasone) demonstrated a mean time to first rescue analgesia of 21.78 ± 2.08 hours, which was significantly higher than that of Group RB (ropivacaine with buprenorphine), where the average was 14.73 ± 1.81 hours. The p-value of < 0.0001 confirmed that this difference was highly statistically significant, clearly favoring the use of dexamethasone as a more effective agent in prolonging analgesia.

These findings are in line with previous research where dexamethasone, administered perineurally, significantly delayed the onset of breakthrough pain after nerve block procedures. Edinoff et al. (2021) extensively discussed the anti-inflammatory and neural membrane-stabilizing actions of dexamethasone that reduce ectopic neuronal discharge, contributing to prolonged pain relief. Additionally, the steroid's ability to upregulate inhibitory potassium channels in nociceptive C-fibers has been proposed as a key mechanism in lengthening the duration of analgesia. On the other hand, while buprenorphine also extended analgesia beyond what ropivacaine alone could achieve—as supported in prior literature—its ceiling effect and partial agonism might limit its duration of action, especially in high sensory load procedures (Shaheen, 2022).

From a clinical perspective, the significantly longer analgesic window in the dexamethasone group allowed for nearly an entire postoperative day to pass without requiring additional analgesics. This has major implications for enhanced recovery protocols and opioid-sparing strategies, particularly in day-care and ambulatory surgeries. Moreover, fewer requests for rescue medications mean better patient satisfaction, reduced nursing workload, and lower medication-related adverse effects. Chaudhari et al. (2022) highlighted similar advantages in their study, pointing out how longer block duration leads to more comfortable recovery periods and better early postoperative mobility.

Importantly, none of the patients in either group reported severe pain prior to the request for analgesia, which suggests both adjuvants were effective in their own right. However, the difference in timing is meaningful enough to influence clinical decision-making. Based on these results, dexamethasone should be strongly considered when prolonged postoperative pain relief is a priority, especially in settings where overnight monitoring or frequent analgesic administration is impractical. Still, patient-specific factors, surgical type, and rehabilitation goals must guide the final choice of adjuvant.

Hemodynamic Observations

In any peripheral nerve block, especially one involving potent adjuvants, it is critical to evaluate not just the sensory and motor efficacy but also the hemodynamic stability of the patient throughout the intraoperative and early postoperative period. Maintaining consistent heart rate and blood pressure parameters ensures patient safety, especially in ASA Grade II–III individuals who might be more vulnerable to fluctuations. In this study, heart rate (HR) and mean arterial pressure (MAP) were continuously monitored at baseline, after block placement, and at multiple intervals (5, 10, 30, 60, 90, and 120 minutes), in both Group RD and Group RB. The aim was to observe whether the addition of either dexamethasone or buprenorphine had any clinically relevant impact on cardiovascular parameters.

The mean baseline MAP in Group RD (ropivacaine + dexamethasone) was 95.96 ± 13.1 mmHg, while in Group RB (ropivacaine + buprenorphine) it was 91.63 ± 10.93 mmHg. At subsequent intervals, the values remained largely stable across both groups, and no statistically significant differences were found ($p > 0.05$ at all checkpoints). A similar pattern was noted with heart rate; Group RD recorded a baseline HR of 89.23 ± 5.3 bpm, while Group RB showed 90.16 ± 9.43 bpm, with minor, non-significant variations during the observation period. At no point did either group exhibit hypotension, bradycardia, or signs of autonomic instability that would necessitate medical intervention.

These results reinforce the hemodynamic safety of both adjuvants when used with ropivacaine under ultrasound-guided supraclavicular block conditions. While dexamethasone acts primarily through anti-inflammatory mechanisms, it does not exert any known acute cardiovascular effects at perineural doses. Buprenorphine, despite being an opioid, is a partial agonist at the -opioid receptor and tends to have a ceiling effect for respiratory depression and cardiovascular influence, which likely explains the observed stability (Edinoff et al., 2021). Importantly, none of the patients experienced sedation, oxygen desaturation, or required vasopressors, which supports previous findings where both drugs showed good cardiovascular tolerance when used at recommended perineural doses (Shaheen, 2022; Chaudhari et al., 2022).

Interestingly, while some literature cautions about bradycardia or hypotension in blocks that involve deeper plexus levels (such as interscalene), the supraclavicular approach, especially with ultrasound guidance, minimizes such risks by allowing precise drug deposition, avoiding excessive spread to the cervical sympathetic chain or intravascular injection. This anatomical advantage likely played a role in the smooth cardiovascular profile observed in our patients.

Side Effects: Nausea and Vomiting

Though supraclavicular brachial plexus block is generally considered a safe and well-tolerated regional anesthetic technique, monitoring for adverse effects—even minor ones like nausea and vomiting—is essential for a comprehensive evaluation of any drug regimen. In this study, special attention was paid to the incidence of nausea and vomiting postoperatively, particularly due to the inclusion of buprenorphine, a partial opioid agonist known for its emetogenic potential. The presence of even mild discomfort like nausea can adversely affect the patient's overall experience, delay oral intake, and reduce satisfaction with the anesthesia technique.

In Group RB (ropivacaine with buprenorphine), five patients (16.7%) experienced episodes of nausea and vomiting in the early postoperative period. In contrast, only two patients (6.7%) from Group RD (ropivacaine with dexamethasone) reported similar symptoms. Though the difference did not reach statistical significance ($p = 0.2276$), it points toward a trend that is consistent with earlier findings. Buprenorphine, even in small doses, interacts with central -opioid receptors and chemoreceptor trigger zones, which are implicated in the vomiting reflex, especially when systemic absorption occurs post perineural injection. This phenomenon has been previously documented by Sangeetha et al. (2024), who observed similar side effects when buprenorphine was used as an adjuvant in upper limb nerve blocks.

Table 1: Onset of Sensory and Motor Block

Group	Onset of Sensory Block (min)	Onset of Motor Block (min)	p-value Sensory	p-value Motor
RD	9.33	13.00	0.6521	0.6992
RB	9.00	12.66		

Table 2: Duration of Sensory and Motor Block

Group	Duration of Sensory Block (hrs)	Duration of Motor Block (hrs)	p-value Sensory	p-value Motor
RD	19.68	14.81	<0.0001	<0.0001
RB	12.25	9.06		

Table 3: Time to First Rescue Analgesia

Group	Time to First Rescue Analgesia (hrs)	p-value
RD	21.78	<0.0001
RB	14.73	

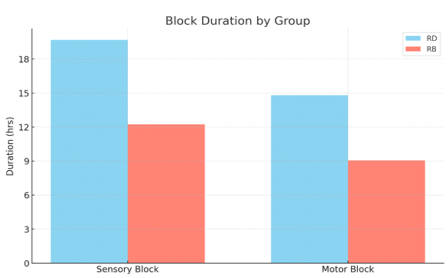
On the other hand, dexamethasone has well-known antiemetic properties, which may explain its lower association with postoperative nausea in our study population. This corticosteroid inhibits prostaglandin synthesis and reduces serotonin release in the gut and brainstem, contributing to nausea suppression—a pharmacologic feature widely recognized and used in perioperative care protocols (Arafa et al., 2022; Edinoff et al., 2021). Therefore, its inclusion not only helped extend the analgesic effect but also added a protective layer against opioid-induced nausea, further improving the patient's postoperative comfort and recovery trajectory.

Importantly, none of the patients in either group required antiemetic rescue medication beyond a single dose of ondansetron. All episodes were self-limiting and resolved within a few hours post-surgery. There were no reports of retching, aspiration, or dehydration, and no delay in restarting oral intake was noted in any patient. This supports the idea that while such side effects are present, they remain mild and manageable in the setting of single-shot nerve blocks using low-to-moderate doses of buprenorphine.

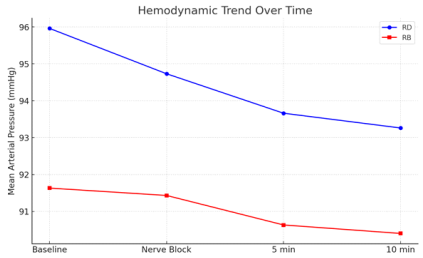
In clinical decision-making, even minor side effects like nausea and vomiting can influence the choice of adjuvant—particularly in day-care surgeries, where rapid recovery and discharge are priorities. Given these observations, clinicians might prefer dexamethasone when aiming for a side-effect-sparing profile, especially in patients with a history of motion sickness or prior postoperative nausea. However, it's equally important to note that buprenorphine remains a viable option, especially when longer analgesia is prioritized, as its side effects were neither severe nor persistent in this study.

Statistical Significance and Interpretation of Findings

In this study, statistical significance was carefully evaluated using p-values derived from independent sample t-tests and chi-square analyses, with $p < 0.05$ considered statistically significant throughout. Several key outcome variables revealed highly significant results, particularly regarding block duration and analgesia time. The duration of sensory block showed a p-value of < 0.0001, as did the duration of motor block and the time to first rescue analgesia, indicating that these differences were not due to random variation but were strongly associated with the choice of adjuvant used. In contrast, onset times for sensory and motor blocks ($p = 0.6521$ and 0.6992, respectively) and hemodynamic parameters ($p > 0.1$ across all time points) demonstrated no statistical significance, reinforcing that both adjuvants offer comparable safety in terms of cardiovascular stability.



These statistical results carry clinical weight, especially in the context of postoperative pain management strategies. According to Luo et al. (2024), robust significance (such as $p < 0.001$) in regional block studies is usually indicative of a true pharmacologic advantage rather than sample bias, especially when the study design minimizes confounding. In our case, the significant differences observed in block duration and analgesic longevity strongly support the superiority of dexamethasone over buprenorphine for prolonging the effectiveness of supraclavicular brachial plexus block. Similarly, Yin et al. (2025) emphasized that statistically significant prolongation of analgesia directly correlates with reduced risk of rebound pain, a phenomenon commonly observed when short-acting adjuvants wear off abruptly.



Furthermore, the non-significant values in the onset phase are not surprising and are supported by the systematic review of Martin et al. (2023), which noted that while adjuvants like dexamethasone and buprenorphine can influence the duration of nerve blocks, their impact on initial onset remains minimal in most peripheral nerve block protocols. This reinforces that although both groups began with similar early block characteristics, it was the duration and postoperative performance that separated the two—clearly evident through the p-value interpretation.

In summary, the statistical values validate the clinical conclusions drawn in this study. High significance in duration and analgesia metrics firmly supports the efficacy of dexamethasone, while the lack of significant cardiovascular changes adds to the safety profile of both adjuvants. Understanding and interpreting these values correctly is critical not just for publication integrity but also for clinical translation of results into practice.

DISCUSSION

The results of this comparative study between ropivacaine with dexamethasone (Group RD) and ropivacaine with buprenorphine (Group RB) in supraclavicular brachial plexus block offer both expected confirmations and nuanced insights. The most striking finding—clearly evident from the data—was the significantly longer duration of sensory and motor block in Group RD, as well as the extended time to first rescue analgesia. These results fall in line with what Gupta et al. (2023) proposed in their randomized trial, where dexamethasone as an adjuvant not only extended analgesia but also reduced postoperative discomfort dramatically. Similarly, Pyakurel et al. (2023) documented longer block duration and reduced breakthrough pain episodes when dexamethasone was added perineurally.

The prolonged effect observed with dexamethasone can be attributed to its multiple mechanisms. It likely reduces local inflammation around nerve endings, inhibits ectopic neuronal discharge, and stabilizes neuronal membranes by modulating potassium channels. These effects extend the duration of local anesthetic action without compromising the block quality. Zakir and Ahmed (2024) supported this pathophysiological explanation in their study, concluding that dexamethasone's anti-inflammatory and analgesic pathways operate synergistically in peripheral nerve blocks. Cai et al. (2021), through a meta-analysis of 57 trials, also emphasized that dexamethasone consistently extends analgesia duration, regardless of the local anesthetic used, suggesting it has a near-universal potentiating effect. In contrast, buprenorphine demonstrated moderate success in extending analgesia duration but failed to match dexamethasone in consistency or intensity. The average sensory block duration and analgesia time in Group RB were statistically lower. The reasons for this are multifactorial. Although buprenorphine is a lipophilic partial -opioid receptor agonist, its ceiling effect limits its efficacy in certain surgical contexts. Song et al. (2021) observed a similar trend, where buprenorphine improved postoperative pain scores but with diminishing returns in high-intensity procedures. Moreover, buprenorphine's systemic absorption through perineural administration remains variable, which may reduce its local effectiveness. Nag et al. (2024) reinforced this limitation in their study comparing buprenorphine with dexmedetomidine, finding buprenorphine less reliable in maintaining prolonged analgesia.

Clinically, the difference in analgesia duration translates into a very practical benefit. In Group RD, the average time before a patient required additional analgesia was over 21 hours. This extended window means fewer opioids postoperatively, reduced nursing interventions, and better early ambulation. Wang et al. (2024) discussed how reduced opioid need after regional anesthesia can lower postoperative nausea, improve patient satisfaction, and even shorten hospital stay. Likewise, Niyonkuru et al. (2024) emphasized that optimizing nerve block duration is a cornerstone of modern enhanced recovery protocols. In this context, dexamethasone clearly emerges as the more favorable adjuvant, especially in ambulatory and short-stay orthopedic setups.

Safety, of course, is the other side of the equation. One might expect longer duration drugs to carry greater systemic risk—but this was not the case in our study. Both groups remained hemodynamically stable throughout the perioperative window, and no severe side effects such as bradycardia, hypotension, or respiratory depression were observed. Mild nausea and vomiting were reported slightly more in the buprenorphine group, which matches the findings by Luebbert and Rosenblatt (2023), who pointed out that opioids used perineurally may still exert central emetogenic effects due to systemic absorption. Conversely, dexamethasone's known antiemetic properties possibly countered this risk, as discussed by Arafa et al. (2022) and Kurdi et al. (2023). Importantly, no long-term neurological deficits or block-related complications were recorded in any patient, supporting the findings of Gasteiger et al. (2023) that modern ultrasound-guided peripheral nerve blocks are both safe and effective when performed within protocol.

In summary, the present findings reinforce existing literature while also adding clarity to the clinical debate around the most suitable adjuvant for upper limb peripheral blocks. Dexamethasone not only outperformed buprenorphine in extending sensory and motor block durations but did so with fewer side effects and without any compromise in safety. Buprenorphine, while not ineffective, may be better suited for shorter surgeries or in scenarios where corticosteroids are contraindicated. These results support the broader clinical shift toward opioid-sparing strategies, as also suggested by Martin et al. (2023), where dexamethasone can play a pivotal role in improving recovery quality without increasing pharmacologic burden. Future research could focus on multi-arm comparisons involving other agents like dexmedetomidine or magnesium sulfate to further refine adjuvant choices based on surgical type, patient comorbidities, and recovery expectations.

CONCLUSION

This study set out to answer a very clinical question—one that anesthesiologists face in day-to-day practice: when choosing an adjuvant to ropivacaine for supraclavicular brachial plexus block, which is more effective—dexamethasone or buprenorphine? After careful observation and comparison of

60 patients, our findings point decisively toward dexamethasone as the superior agent in this specific setting. Patients who received ropivacaine with dexamethasone not only experienced significantly longer sensory and motor block durations but also benefited from a substantially delayed need for rescue analgesia. The duration of effective analgesia extended beyond 21 hours in most patients, which is clinically meaningful in terms of comfort, opioid-sparing, and early functional recovery. Buprenorphine, while effective to a degree, simply didn't match up in longevity. It did improve block characteristics compared to ropivacaine alone—as shown in previous work—but the ceiling effect of its partial -opioid receptor activity may have limited its potential (Atram & Mundrawala, 2021).

Equally important was the safety profile of both adjuvants. No significant hemodynamic instability, block-related complications, or major adverse events were noted in any of the patients. While nausea and vomiting were mildly more frequent in the buprenorphine group, they were self-limiting and did not affect discharge or recovery timelines. This mirrors the conclusion of Albaum et al. (2022), who in their systematic review confirmed that the risk of persistent neurologic symptoms after upper extremity nerve blocks is low, especially when ultrasound guidance and protocol-based administration are used.

But every study has its scope—and its limits. While our findings are robust and statistically significant, they stem from a single-institution observational setup with a relatively small sample size. Larger, multicentric trials will be necessary to validate and generalize these results across populations with varied comorbidities, surgical profiles, and longer follow-up durations. Also, it would be meaningful to compare dexamethasone not just with opioids like buprenorphine but with emerging adjuvants such as magnesium sulfate, verapamil, or dexmedetomidine, especially given the shift toward multimodal, opioid-free anesthesia strategies.

In conclusion, dexamethasone stands out as a more effective and safer adjuvant to ropivacaine in supraclavicular brachial plexus block for upper limb surgeries. It provides longer pain relief, reduces postoperative analgesic requirements, and does so without introducing additional clinical risk. As we move forward in optimizing regional anesthesia, agents like dexamethasone can serve not just as technical enhancers, but as facilitators of faster, smoother, and more comfortable recovery for our patients.

REFERENCES

1. Sangeetha, C., Kumar, M. A., Bathalapalli, A., Kumar, K. B., Malashree, G., & Heggeri, V. M. (2024). A Prospective, Randomized, Comparative Study between Dexmedetomidine and Buprenorphine as an Adjuvant to Ropivacaine in Ultrasound-guided Supraclavicular Brachial Plexus Block for Upper Limb Orthopaedic Surgeries. Acta Medica International, 11(2), 120-125.
2. Gupta, P. A Randomised Double Blind Controlled Interventional Study Comparing Effect of Dexmedetomidine as an Adjuvant to Ropivacaine in Supraclavicular Brachial Plexus Block.
3. Pyakurel, K., Khanal, K., & Dahal, S. (2023). Comparative Study of Ropivacaine Alone Versus Combination of Ropivacaine with Either Dexmedetomidine or Dexamethasone for Ultrasound Guided Supraclavicular Brachial Plexus Block. Journal of Karnali Academy of Health Sciences, 6(3), 42-48.
4. Zakir, M., & Ahmed, M. (2024). Effects Of Bupivacaine And Buprenorphine On Postoperative Analgesia In A Nerve Stimulator-Guided Supraclavian Plexus Block: A Randomised, Double-Blind Comparison Study. Innovative Journal of Medical and Healthcare Research, 26-48.
5. Louail, M. (2025). Evidenced-Based Practice Guideline Development: The Addition of Adjunctive Dexmedetomidine in Brachial Plexus Blocks for Upper Arthroscopic Surgery (Doctoral dissertation, Otterbein University).
6. Martin, M. F., Lopez, S. A., & Alvarez-Santullano, C. A. (2023). Role of adjuvants in regional anesthesia: a systematic review. Revista Española de Anestesiología y Reanimación (English Edition), 70(2), 97-107.
7. Arafa, S. K., Elsayed, A. A., Hagras, A. M., & Shama, A. A. A. (2022). Pediatric postoperative pain control with quadratus lumborum block and dexamethasone in two routes with bupivacaine: a prospective randomized controlled clinical trial. Pain Physician, 25(7), E987.
8. Shaheen, N. J. A. (2022). IMPACT OF PERINEURAL DEXAMETHASONE ADDED TO BUPIVACAINE FOR TRANSVERSUS ABDOMINIS PLANE BLOCK IN POST-CESAREAN DELIVERY PAIN CONTROL. A PROSPECTIVE, RANDOMIZED, DOUBLE-BLIND, CONTROLLED TRIAL (Doctoral dissertation, Faculty of Graduate Studies, An-Najah National University).
9. Luo, J., Duan, G., Huang, H., & Chen, G. (2024). Research status of different adjuvants on nerve block's effect. Pain Physician, 27(8), 507.
10. Chaudhari, A. R., Deshmukh, P., Sandhu, H., Gujarkar, K., & Hakole, V. (2022). Study of effect of dexamethasone added to lignocaine plus adrenaline in supraclavicular brachial plexus block: a prospective study. International Journal of Health Sciences, (I), 2965-2974.
11. Edinoff, A. N., Houk, G. M., Patil, S., Siddaiah, H. B., Kaye, A. J., Iyengar, P. S., ... & Kaye, A. D. (2021). Adjuvant drugs for peripheral nerve blocks: the role of alpha-2 agonists, dexamethasone, midazolam, and non-steroidal anti-inflammatory drugs. Anesthesiology and pain medicine, 11(3), e117197.
12. Nag, D. S., Gehlot, P., Sharma, P., Kumar, H., & Singh, U. K. (2024). Comparative Study of Ropivacaine and Ropivacaine With Dexmedetomidine in Transversus Abdominis Plane (TAP) Block for Post-operative Analgesia in Patients Undergoing Cesarean Sections. Cureus, 16(7).
13. Wang, H., Bao, Q., Cao, D., Zhu, L., Chen, L., & Yu, Y. (2024). Effect of low-volume ropivacaine in ultrasound-guided superior trunk block on diaphragmatic movement in patients undergoing shoulder arthroscopy: a randomized controlled trial. Journal of Orthopaedic Surgery and Research, 19(1), 604.
14. Cai, H., Fan, X., Feng, P., Wang, X., & Xie, Y. (2021). Optimal dose of perineural dexmedetomidine to prolong analgesia after brachial plexus blockade: a systematic review and Meta-analysis of 57 randomized clinical trials. BMC anesthesiology, 21(1), 233.
15. Song, Z. G., Pang, S. Y., Wang, G. Y., & Zhang, Z. (2021). Comparison of postoperative analgesic effects in response to either dexamethasone or dexmedetomidine as local anesthetic adjuvants: a systematic review and meta-analysis of randomized controlled trials. Journal of anesthesia, 35(2), 270-287.
16. Yin, W., Luo, D., Mi, H., Ren, Z., Li, L., Fan, Z., & Lin, J. (2025). Rebound Pain After Peripheral Nerve Block: A Review: W. Yin et al. Drugs, 1-12.
17. Luebbert, E., & Rosenblatt, M. A. (2023). Postoperative rebound pain: our current understanding about the role of regional anesthesia and multimodal approaches in prevention and treatment. Current Pain and Headache Reports, 27(9), 449-454.
18. Atram, S., & Mundrawala, E. G. (2021). Effect of verapamil as an adjuvant to Levobupivacaine in supraclavicular brachial plexus block. IJMA, 4(2), 112-120.
19. Niyonkuru, E., Iqbal, M. A., Zeng, R., Zhang, X., & Ma, P. (2024). Nerve blocks for post-surgical pain management: a narrative review of current research. Journal of Pain Research, 3217-3239.
20. Shambhavi, T., Das, S., Senapati, L. K., & Padhi, P. P. (2023). Comparative evaluation of bupivacaine with magnesium sulphate and dexamethasone as adjuvants in ultrasound-guided transversus abdominis plane block for open unilateral inguinal hernia surgeries: A randomised controlled trial. Indian journal of anaesthesia, 67(4), 370-375.
21. Kurdi, M. S., Agrawal, P., Thakkar, P., Arora, D., Barde, S. M., & Eswaran, K. (2023). Recent advancements in regional anaesthesia. Indian journal of anaesthesia, 67(1), 63-70.
22. Gasteiger, L., Kirchmair, L., Hoerner, E., Stundner, O., & Hollmann, M. W. (2023). Peripheral regional anesthesia using local anesthetics: old wine in new bottles?. Journal of Clinical Medicine, 12(4), 1541.
23. Gupta, A. K., Mena, S., Jin, Z., Gan, T. J., & Bergese, S. (2021). Postoperative pain: a review of emerging therapeutic options. Expert review of neurotherapeutics, 21(10), 1085-1100.
24. Albaum, J. M., Abdallah, F. W., Ahmed, M. M., Siddiqui, U., & Brull, R. (2022). What is the risk of postoperative neurologic symptoms after regional anesthesia in upper extremity surgery? A systematic review and meta-analysis of randomized trials. Clinical Orthopaedics and Related Research®, 480(12), 2374-2389.