Section: Anesthesiology

Original Research Article

COMPARATIVE STUDY BETWEEN DEXAMETHASONE VERSUS DEXAMETHASONE AND TRAMADOL AS AN ADJUVANT TO ROPIVACAINE IN ULTRASOUND GUIDED SUPRACLAVICULAR BLOCK IN UPPER LIMB SURGERIES

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ABSTRACT

Background: Ultrasound-guided supraclavicular brachial plexus block provides effective anaesthesia for upper limb surgeries while avoiding the adverse effects of general anaesthesia. The use of adjuvants, such as dexamethasone and tramadol, enhances the efficacy and duration of the block. The aim is to compare the efficacy of dexamethasone versus dexamethasone combined with tramadol as adjuvants to ropivacaine in ultrasound-guided supraclavicular brachial plexus block. **Materials and Methods:** This prospective randomised double-blind study was conducted on 60 patients at the Government Thiruvarur Medical College over a period of one year. Patients were randomly assigned to two ultrasound-guided groups: Group A (n=30) received ropivacaine with dexamethasone, and Group B (n=30) received ropivacaine with dexamethasone and tramadol. The primary outcome was the duration of the postoperative analgesia. Secondary outcomes included the onset and duration of sensory and motor blockade, duration of surgery, and haemodynamic parameters. Demographic data and block characteristics were also assessed. **Result:** Baseline characteristics, BMI, ASA physical status, and duration of surgery were comparable between groups A and B ($p>0.05$). The onset of sensory block was significantly faster in Group B (2.48±0.38 min) than in Group A (5.42±0.91 min) ($p<0.0001$), with a similar trend observed for motor block onset (3.67±0.59 vs. 7.07±1.04 min; $p<0.0001$). Group B showed a longer duration of motor block (10.58±0.95 vs 6.95±0.70 h), sensory block (11.45±0.96 vs 7.70±0.68 h), and analgesia (12.20±0.96 vs 8.42±0.70 h) ($p<0.0001$). The heart rate, mean arterial pressure, and SpO_2 remained comparable between the groups throughout the study period. **Conclusion:** The addition of dexamethasone and tramadol to ropivacaine in ultrasound-guided supraclavicular brachial plexus block resulted in faster onset and prolonged duration of sensory and motor blockade and postoperative analgesia compared with dexamethasone alone.

INTRODUCTION

The supraclavicular brachial plexus block is an established regional anaesthetic procedure commonly used for upper limb surgeries. Often called the spinal of the upper limb, this method is a useful stand-in for general anaesthesia.[1] It has more benefits, chief among them being the avoidance of side effects related to upper airway instrumentation and general anaesthetic medications. The block offers complete surgical anaesthesia for treatments involving the elbow, forearm, and hand by selectively targeting the brachial plexus (C5-T1).[2]

The accuracy and effectiveness of the brachial plexus block have improved with the advent of ultrasound guidance. Accurate localisation of the nerve, real-time visualisation of the brachial plexus and accompanying blood arteries, needle placement, and the distribution of the local anaesthetic are all made possible by this technology.[3] The use of ultrasound

minimises the number of needle attempts, reducing patient discomfort and potential complications.[4]

The field of regional anaesthesia is developing, with research efforts aimed at maximising the effectiveness and duration of nerve blocks. The combination of adjuvants with local anaesthetics is an interesting research topic.[5] Adjuvants are compounds that can improve postoperative analgesia and extend the duration of sensory and motor blockage when combined with local anaesthetics.[6] This enhances the performance of regional blocks. Tramadol and dexamethasone are two adjuvants that have attracted considerable interest.

Dexamethasone, a strong corticosteroid with well-known anti-inflammatory and analgesic characteristics, is being widely explored as an adjuvant in regional anaesthesia. Being able to extend the duration of both motor and sensory blockage makes it an important supplement to local anaesthetics.[7,8] It is believed that dexamethasone accomplishes this effect by suppressing inflammation and inhibiting the transmission of nociceptive signals, which lengthens the time that local anaesthetics provide analgesia.[9]

Tramadol is a common opioid with multimodal mechanisms of action. It works as an analgesic by blocking the reuptake of norepinephrine and serotonin and by activating the μ-opioid receptor.[10] Due to its special qualities, tramadol is a good choice for use in conjunction with local anaesthetics for localised anaesthesia, which may improve analgesic results. Tramadol's multimodal analgesic properties are being investigated as an adjuvant to extend and enhance the effectiveness of nerve blocks.[11]

The accuracy and safety of the brachial plexus block operation have been enhanced by the use of ultrasound guidance.[12] Ultrasound guidance makes it possible to see the brachial plexus, blood vessels, and surrounding tissues in real time, which helps to ensure that the local anaesthetic is disseminated as evenly as possible.[13] This technological development has helped to minimise patient discomfort and the risk of problems such as vascular puncture or nerve injury by reducing the number of needle tries required.[14] However, limited literature exists comparing dexamethasone alone with a combination of dexamethasone and tramadol as adjuvants to ropivacaine in ultrasound-guided supraclavicular brachial plexus block.

Aim: This study aimed to evaluate the efficacy of Injection Dexamethasone (8 mg) vs Inj. Dexamethasone (8 mg) and Inj. Tramadol (100 mg) was used as an adjuvant to 0.5% 30 mL Inj. ropivacaine in ultrasound-guided supraclavicular brachial plexus block.

MATERIALS AND METHODS

This prospective randomised double-blind controlled trial was conducted at the Department of Anesthesiology, Government Thiruvarur Medical College and Hospital, a tertiary care teaching hospital in Thiruvarur, India. The study was conducted over a period of one year from January 2023 to December 2023, after obtaining approval from the Institutional Ethics Committee (IEC No: 033/IEC/GTMC/2023). Written informed consent was obtained from all participants prior to enrolment.

Inclusion criteria

Patients aged between 20 and 50 years, belonging to American Society of Anesthesiologists (ASA) physical status I or II, of both sexes, with a body weight >50 kg, and scheduled to undergo elective elbow, forearm, or hand surgery were included.

Exclusion criteria

Patients who refused to participate with bleeding disorders or those receiving anticoagulant therapy, pre-existing neurological or musculoskeletal conditions, or local infection at the injection site with significant systemic illness or psychiatric disorders, classified as ASA physical status III or IV, with known allergy to local anaesthetics, a history of steroid or opioid use, or opioid dependence/addiction were excluded.

Methods

Patients were randomly allocated to two groups, and the study was conducted under ultrasound guidance. Group A (n=30) comprised patients who received 30 mL of 0.5% ropivacaine, 2 mL (8 mg) of dexamethasone, and 2 mL of distilled water. Group B (n=30) comprised patients who received 30 mL of 0.5% ropivacaine, 2 mL (8 mg) of dexamethasone, and 2 mL (100 mg) of tramadol.

Randomisation was performed using a computer-generated random number table. Group allocation was concealed using sequentially numbered sealed opaque envelopes that were opened immediately before block administration. The study was conducted in a double-blind manner by two independent researchers. The study drugs were prepared by an anaesthesiologist who was not involved in block administration or data collection. Both the patient and the observer assessing the block characteristics and outcomes were blinded to the group allocation.

All supraclavicular brachial plexus blocks were performed under strict aseptic precautions using a high-frequency linear ultrasound probe (6–13 MHz). The patients were positioned supine, with their heads turned contralaterally. A 22-G, 50-mm insulated nerve block needle was introduced using an in-plane lateral-to-medial approach to the brachial plexus. All blocks were performed by the same experienced anaesthesiologist to ensure procedural uniformity.

Patient data, including age and sex, were collected. All patients underwent ultrasonography, and relevant procedural details were documented. The variables assessed included the onset of sensory block (time in minutes from drug administration to onset), onset of motor block, duration of sensory block (total duration in hours for which the sensory block remained effective), duration of motor block, duration of surgery (measured in hours), and duration of

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analgesia (total duration in hours of effective post-block analgesia).

Intraoperative and postoperative complications were monitored and recorded in both groups of patients. These included nausea and vomiting, hypotension, bradycardia, pneumothorax, respiratory depression, local hematoma, and nerve injury. All variables were recorded to evaluate and compare the efficacy and safety of the anaesthetic techniques used in Groups A and B. Sensory and motor block assessments were performed every 2 min after drug injection until complete blockade was achieved, and thereafter at 30-minute intervals postoperatively until block resolution.

Statistical analysis

Statistical analyses were performed using SPSS software version 25.0. Continuous variables are expressed as mean ± standard deviation and were compared using Student's independent t-test. Categorical variables were analysed using the Chi-square or Fisher's exact test, as appropriate. Statistical significance was set at $p < 0.05$. No missing data were observed during the study.

RESULTS

All enrolled patients completed the study and were included in the final analysis. The age distribution was comparable between groups A and B, with no significant difference (p=0.193). The sex distribution was similar, with males constituting 66.7% and 73.3% of Groups A and B, respectively (p=0.573). The BMI categories did not differ significantly between the groups (p=0.237). The ASA physical status was comparable, with most participants classified as ASA II in both groups, with no significant difference (p=0.787) [Table 1].

Table 1: Baseline demographic and clinical characteristics

Variable	Category	Group A	Group B	P value
Age (years)	< 30	11 (36.7%)	7 (23.3%)	0.193
	31–40	5 (16.7%)	11 (36.7%)	
	> 41	14 (46.7%)	12 (40.0%)	
Gender	Male	20 (66.7%)	22 (73.3%)	0.573
	Female	10 (33.3%)	8 (26.7%)	
BMI	Underweight	3 (10.0%)	2 (6.7%)	0.237
	Normal	21 (70.0%)	16 (53.3%)	
	Overweight	6 (20.0%)	12 (40.0%)	
ASA classification	I	10 (33.3%)	11 (36.7%)	0.787
	II	20 (66.7%)	19 (63.3%)	

The duration of surgery was comparable between Groups A (1.59±0.46 h) and B (1.68±0.66 h), with no significant difference (p=0.549). The onset of sensory blockade was significantly faster in Group B (2.48±0.38 min) than in Group A (5.42±0.91 min) (p<0.0001). Similarly, the onset of motor blockade occurred earlier in Group B (3.67±0.59 min) than in Group A (7.07±1.04 min) (p<0.0001).

The duration of motor blockade was significantly longer in Group B (10.58±0.95 h) than in Group A (6.95±0.70 h) (p<0.0001). Group B also demonstrated a longer duration of sensory blockade (11.45±0.96 vs. 7.70±0.68 h) and prolonged duration of analgesia (12.20±0.96 vs. 8.42±0.70 h) than Group A [Table 2].

Table 2: Comparison of intraoperative and block characteristics between the groups

Parameter	Group A	Group B	P value
Duration of surgery (hours)	1.59 ± 0.46	1.68 ± 0.66	0.549
Onset of sensory blockade (minutes)	5.42 ± 0.91	2.48 ± 0.38	<0.0001
Onset of motor blockade (minutes)	7.07 ± 1.04	3.67 ± 0.59	<0.0001
Duration of motor blockade (hours)	6.95 ± 0.70	10.58 ± 0.95	<0.0001
Duration of sensory blockade (hours)	7.70 ± 0.68	11.45 ± 0.96	<0.0001
Duration of analgesia (hours)	8.42 ± 0.70	12.20 ± 0.96	<0.0001

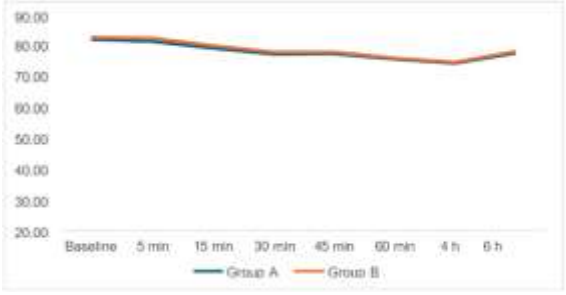

Figure 1: Heart rate changes over time between groups

There were no statistically significant differences in heart rate, mean arterial pressure (MAP), or oxygen saturation (SpO_2) between the two groups at any time point [Figure 1–3]. No intraoperative or postoperative complications were observed in either group of patients.

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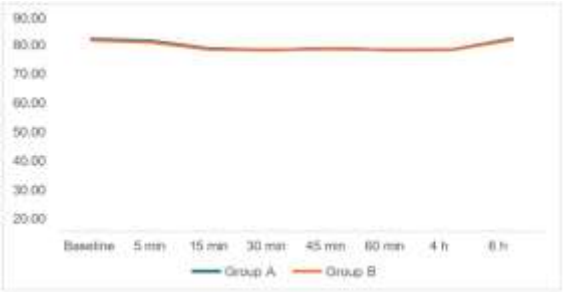

Figure 2: MAP changes over time between groups

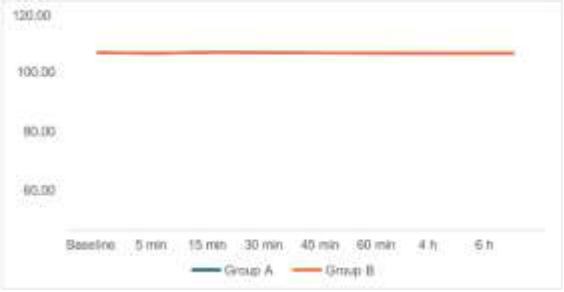

Figure 3: SpO_2 changes over time between groups

DISCUSSION

The present study evaluated the efficacy of dexamethasone alone versus dexamethasone combined with tramadol as adjuvants to ropivacaine in an ultrasound-guided supraclavicular brachial plexus block. The findings demonstrate that the addition of tramadol to dexamethasone significantly prolonged sensory and motor block durations and postoperative analgesia, with an earlier onset of blockade than that with dexamethasone alone. Yadav et al. found a significantly longer mean postoperative analgesic period in the dexamethasone group (1023.87 ± 161.01 min) than in the tramadol group (454.47 ± 44.29 min). Despite the relatively short postoperative analgesic period in the current study, the combined dexamethasone and tramadol group showed a significantly longer analgesic period (732.2 ± 57.6 min), consistent with the findings of Yadav et al.[15] These differences in analgesic periods could be attributed to differences in study design and population variability. Unlike Yadav et al., who compared dexamethasone and tramadol as individual adjuvants, in the present study, the combination of dexamethasone and tramadol as adjuvants may have affected the cumulative effects.

Mehta et al. found that the addition of dexamethasone to ropivacaine resulted in longer durations of both sensory (8.18 ± 0.49 h) and motor (7.49 ± 0.54 h) blocks compared to ropivacaine alone.16 In our study, the duration of sensory block (11.45 ± 0.96 h) and motor block (10.58 ± 0.95 h) was longer, which supports the use of dexamethasone in prolonging block times. The differences in block times may be attributed to the varying concentrations of local anaesthetics, methods of block, or surgical procedures. The addition of tramadol in our study may have affected the pharmacodynamic results, leading to longer block duration.

Venkatraman et al. reported that the duration of analgesia in the dexamethasone group was 867.2 ± 217.6 min, which was significantly longer than that in the morphine (739.2 ± 162.5 min) and dexmedetomidine (654.2 ± 179.9 min) groups.[17] Our study yielded similar observations, where Group B represented the duration of analgesia for 732.20 ± 57.6 min, highlighting the effectiveness of dexamethasone combined with tramadol. Singh et al. reported a significant extension of sensory block duration with dexamethasone (1128.0 ± 207.5 min).[18] Our study confirmed these findings, with a sensory block duration of 11.45 ± 0.96 h in the tramadol and dexamethasone group, indicating comparable efficacy. This consistency supports the use of dexamethasone, either alone or in combination with other adjuvants, to prolong sensory blockade. Supplementary analgesic benefits resulting from the addition of tramadol may further enhance patient comfort and satisfaction.

Raj et al. showed that dexamethasone provided a longer duration of motor blockade (1150.27 min) and analgesia (1300.83 min) than tramadol administered alone (764.63 min and 820.47 min, respectively).[19] Although the durations observed in our study were shorter, the combination of dexamethasone and tramadol still produced prolonged motor blockade and analgesia. These differences could be related to drug concentration, volume used, or patient factors.

Nasir et al. demonstrated that clonidine significantly prolonged the duration of sensory (17.4 ± 6 min) and motor blocks (16.8 ± 5.2 min) compared to ropivacaine alone.[20] Although clonidine was not studied in our study, the extended duration of the block with dexamethasone and tramadol would indicate equivalent effectiveness in enhancing regional block characteristics. Kumari et al. observed that dexmedetomidine and ropivacaine prolonged analgesia significantly by 1262.33 ± 90.07 min compared to 865.35 ± 41.62 min with clonidine and ropivacaine.[21] Although our combination of dexamethasone and tramadol caused a shorter period of analgesia, a significant prolongation was also achieved.

Iqbal et al. found that dexamethasone resulted in an earlier onset of sensory block (10.02 ± 1.26 min) and prolonged analgesia (19.11 ± 1.32 h) compared to midazolam.[22] Although our study demonstrated slightly shorter durations, the early onset and prolonged effect observed with dexamethasone and tramadol are consistent. The synergistic action of tramadol may contribute to the faster diffusion and absorption of the local anaesthetic, contributing to an earlier block onset. Sawale et al. reported that dexamethasone prolonged analgesia for a significantly longer period (1012 ± 99.24 min) than clonidine (649.8 ± 158 min).[23] These results are consistent with our findings and suggest that dexamethasone and tramadol are equally effective in prolonging analgesia and may decrease postoperative opioid demand.

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Yousef et al. established that dexamethasone caused a significant prolongation of the sensory nerve (17.33 ± 1.3 h) and motor blocks (14.58 ± 1.56 h) compared to magnesium sulphate.[24] These findings are consistent with our results, reinforcing dexamethasone's efficacy in enhancing block duration. Hamada et al. observed that dexmedetomidine showed a longer duration of sensory (19.00 ± 1.80 h) and motor blockade (18.93 ± 1.76 h) than dexamethasone.[25] Although dexmedetomidine showed a longer duration of action, our study supports the effectiveness of dexamethasone combined with tramadol as an alternative.

Vieira et al. found analgesia to be prolonged in dexamethasone combined with bupivacaine (1457 min) compared to bupivacaine alone (833 min).[26] Kumar et al. found the sensory block to be prolonged for dexamethasone combined with ropivacaine (1179.4 ± 108.60 min) compared to ropivacaine alone (557.25 ± 58.99 min).[27] Another study conducted by Islam et al. found that the prolonged sensory block duration (11.87 ± 0.53 h) was achieved with dexamethasone.[28]

In our study, the combination of 8 mg dexamethasone and 100 mg tramadol offered prolonged sensory and motor blockade, with analgesia lasting 732.20 ± 57.6 min. Albrecht et al. reported that dexamethasone dose-dependently prolonged analgesia, with a maximum duration of 1023 min at 4 mg.[29] Although our duration was shorter, the combination strategy resulted in longer analgesia than higher doses of dexamethasone alone, suggesting that there might be an advantage of combination therapy in regional anaesthesia.

Limitations: The sample size was small, and the study was conducted at a single centre, which may limit generalisability. Long-term outcomes and patient-reported satisfaction were not evaluated. Further multicentre studies with larger sample sizes are required to validate these findings.

CONCLUSION

In ultrasound-guided supraclavicular brachial plexus block for upper limb surgeries, the addition of tramadol to dexamethasone as an adjuvant to ropivacaine resulted in an earlier onset of sensory and motor blockade and a longer duration of sensory block, motor block, and postoperative analgesia than dexamethasone alone. Ultrasound guidance facilitated accurate block administration and was not associated with any observed complications. These findings support the role of combination adjuvants in enhancing the efficacy of regional anaesthesia. Further multicentre studies with larger sample sizes are required to confirm these results and establish optimal dosing regimens.

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