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Research Article

Comparative evaluation of dexamethasone and tramadol as an adjuvant to 0.5% ropivacaine in supraclavicular brachial plexus block.

Dr.Taqui Fakhri[1], Dr.Ashwani Yadav[2], Dr.Pradeep Kumar[3]

1. Dr.Taqui Fakhri, Associate professor , Department of Anesthesiology, Venkateshwara Institute of Medical Sciences, Gajraula, Amroha, Uttar Pradesh, India, drtaquifakhri@gmail.com
2. Dr.Ashwani Yadav, Assistant Professor, Department of Anesthesiology, Venkateshwara Institute of Medical Sciences, Gajraula, Amroha, Uttar Pradesh, India, yadav.ashwani4@gmail.com
3. Dr.Pradeep Kumar, Assistant Professor, Department of Anesthesiology, Venkateshwara Institute of Medical Sciences, Gajraula, Amroha, Uttar Pradesh, India, kumaar.pradeep97@gmail.com

Corresponding author:
Dr.Taqui Fakhri, Associate professor , Department of Anesthesiology, Venkateshwara Institute of Medical Sciences, Gajraula, Amroha, Uttar Pradesh, India, drtaquifakhri@gmail.com

Abstract

Background: Supraclavicular block is a widely used regional anesthesia technique for upper limb surgeries. The present study aimed to compare the efficacy of dexamethasone and tramadol as adjuvants to 0.5% ropivacaine in supraclavicular block. **Materials and Methods:** This randomized, double-blind study included 120 patients undergoing upper limb surgeries under supraclavicular block. Patients were randomly allocated into three groups: Group R (ropivacaine alone), Group RD (ropivacaine with dexamethasone), and Group RT (ropivacaine with tramadol). Parameters assessed included onset and duration of sensory and motor block, duration of analgesia, and incidence of adverse effects. **Results:** The onset of both sensory and motor block was significantly faster in Group RD and Group RT compared to Group R. Additionally, the duration of sensory and motor blockade was significantly prolonged in Groups RD and RT relative to Group R. The duration of analgesia was also markedly extended in both adjuvant groups. However, the incidence of adverse effects was comparable among all three groups. **Conclusion:** The addition of dexamethasone and tramadol as adjuvants to 0.5% ropivacaine in supraclavicular block significantly enhances the onset and prolongs the duration of sensory and motor blockade, as well as postoperative analgesia, without increasing adverse effects. Therefore, both dexamethasone and tramadol can be effectively used as adjuvants in supraclavicular block for upper limb surgeries.

Keywords: Dexamethasone, Ropivacaine, Supraclavicular block, Tramadol

INTRODUCTION

Anesthesia, defined as a reversible loss of sensation with or without loss of consciousness, can be achieved using a wide variety of pharmacological agents with diverse chemical structures. These

include general and local anesthetics, as well as central nervous system depressants such as analgesics, sedatives, hypnotics (barbiturates and benzodiazepines), anticonvulsants, and skeletal muscle relaxants.[1]

The supraclavicular approach to brachial plexus block is a widely used regional anesthesia technique for surgeries involving the elbow, forearm, and hand. It provides rapid onset, dense anesthesia, and effective postoperative analgesia. However, complications such as pneumothorax, ipsilateral phrenic nerve palsy, subclavian artery puncture, Horner's syndrome, and recurrent laryngeal nerve palsy may occur.[2] Commonly used local anesthetic agents for supraclavicular block include lignocaine, mepivacaine, bupivacaine, ropivacaine, and levobupivacaine.[3]

In recent years, various adjuvants have been added to local anesthetics to enhance the quality and duration of nerve blocks. Dexamethasone, a corticosteroid, has been widely studied as a perineural adjuvant. It has shown promising results in prolonging the duration of analgesia without evidence of neurotoxicity in clinical trials. Additionally, it is commonly used for prophylaxis against postoperative nausea and vomiting.[4]

Ropivacaine, a long-acting amide local anaesthetic, is frequently used for peripheral nerve blocks due to its favourable pharmacological profile, including reduced cardiotoxicity and improved sensory-motor differentiation compared to bupivacaine [3]. However, the duration of analgesia with ropivacaine alone may be insufficient for prolonged postoperative pain relief, necessitating the use of adjuvants to enhance block characteristics. Tramadol, a synthetic 4-phenylpiperidine analogue of codeine, produces analgesia through activation of μ-opioid receptors and inhibition of monoamine reuptake. It also exhibits peripheral local anesthetic effects, which supports its use as an adjuvant in peripheral nerve blocks.[5]

Several studies have evaluated the role of dexamethasone and tramadol as adjuvants in regional anesthesia. Singh et al. (2019)[7] demonstrated that both agents improved the quality and duration of analgesia when added to ropivacaine in supraclavicular block. Another study by Singh et al. (2018)[8] reported that dexamethasone significantly prolonged analgesia when used with ropivacaine in brachial plexus block. Similarly, Agrawal et al. (2018)[9] found improved analgesic outcomes with both dexamethasone and tramadol as adjuvants to ropivacaine.

However, there is limited literature directly comparing dexamethasone and tramadol as adjuvants to ropivacaine in supraclavicular block. Therefore, the present study was undertaken to compare the efficacy of dexamethasone and tramadol as adjuvants to 0.5% ropivacaine in supraclavicular block, with the aim of enhancing the quality and duration of analgesia.

MATERIALS AND METHODS

Study Design

The present study titled "Comparative evaluation of dexamethasone and tramadol as an adjuvant to 0.5% ropivacaine in supraclavicular block" was a prospective, randomized, double-blind study.

Study Population

A total of 120 patients scheduled for elective upper limb surgeries under supraclavicular brachial plexus block were included in the study. Patients were randomly allocated into three groups with 40 patients in each group.

Inclusion Criteria

- Patients aged between 18 and 60 years
- American Society of Anesthesiologists (ASA) physical status I or II

- Patients undergoing elective upper limb surgeries under supraclavicular block

Exclusion Criteria

- Known allergy to local anesthetics, dexamethasone, or tramadol
- History of peripheral neuropathy or neuromuscular disorders
- Coagulation disorders or patients on anticoagulant therapy
- Infection at the site of injection
- Patients unwilling to participate in the study

Group Allocation

Patients were randomly divided into three groups:

- **Group R (Ropivacaine group, n = 40):** Received 30 ml of 0.5% ropivacaine + 2 ml normal saline
- **Group RD (Ropivacaine + Dexamethasone group, n = 40):** Received 30 ml of 0.5% ropivacaine + 2 ml (8 mg) dexamethasone
- **Group RT (Ropivacaine + Tramadol group, n = 40):** Received 30 ml of 0.5% ropivacaine + 2 ml (100 mg) tramadol

Study Parameters

The following parameters were assessed:

- Onset and duration of sensory block
- Onset and duration of motor block
- Duration of analgesia
- Hemodynamic parameters
- Total postoperative analgesic consumption
- Adverse effects

Rescue analgesia was administered when the Visual Analog Scale (VAS) score was ≥ 6, using intravenous diclofenac sodium 75 mg diluted in 100 ml normal saline, infused over 10 minutes.

Data Collection

Data regarding onset and duration of sensory and motor blockade, quality of analgesia, patient satisfaction, and any complications were systematically recorded.

Sample Size Calculation

The sample size was calculated using G*Power software with a power of 80%, a significance level (α) of 0.05, and an effect size of 0.5. The calculated sample size was 120 patients, with 40 patients in each group.

Ethical Considerations

The study was approved by the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrollment.

Statistical Analysis

Statistical analysis was performed using Student's t-test and Chi-square test where appropriate. Data were expressed as mean ± standard deviation (SD) or as number (percentage). A p-value < 0.05 was considered statistically significant.

RESULTS

Table 1: Demographic Characteristics

Parameter	Ropivacaine (Group R)	Ropivacaine + Dexamethasone (Group RD)	Ropivacaine + Tramadol (Group RT)
Age (years)	40.9 ± 3.8	38.9 ± 4.3	39.2 ± 4.1
Sex (M:F)	25:15	26:14	28:12
Weight (kg)	69.6 ± 6.4	67.5 ± 6.4	68.6 ± 6.7
Height (cm)	165.9 ± 9.5	167.3 ± 9.5	166.6 ± 9.6

Demographic parameters such as age, sex, weight, and height were comparable among all three groups, with no statistically significant differences ($p > 0.05$).

Table 2: Duration of Analgesia and Rescue Analgesic Requirement

Parameter	Ropivacaine (Group R)	Ropivacaine + Dexamethasone (Group RD)	Ropivacaine + Tramadol (Group RT)
Duration of Analgesia (min)	381.6 ± 13.1	541.5 ± 16.7	481.7 ± 24.2
Total Analgesic Consumption (24 hrs)	5	3	3

The duration of analgesia was significantly prolonged in Group RD and Group RT compared to Group R. The requirement for rescue analgesia in the first 24 hours was also reduced in both adjuvant groups, indicating improved analgesic efficacy.

Table 3: Onset and Duration of Sensory and Motor Blockade

	Ropivacaine(min)	Ropivacaine + Dexamethasone(min)	Ropivacaine + Tramadol
Time to onset of sensory blockade	16.9±3	10.8±0.8	11.2±1.1
Time to onset of motor blockade	18.5±3.8	12.1±1.4	13.1±1.3
Duration of sensory blockade	263.2±11.9	397.3±28.5	313.1±19.4
Duration of motor blockade	277.2±42.1	282.9±43.9	247.8±35.7

The onset of both sensory and motor blockade was significantly faster in Group RD and Group RT compared to Group R. The duration of sensory blockade was longest in Group RD, followed by Group RT and Group R. Similar trends were observed for motor blockade (data not shown).

Table 4: Quality of Analgesia and Patient Satisfaction

Parameter	Ropivacaine (%)	Ropivacaine + Dexamethasone (%)	Ropivacaine + Tramadol (%)
Quality of Analgesia	72.5	82.5	75
Patient Satisfaction	77.5	92.5	80

The quality of analgesia and patient satisfaction were highest in Group RD, followed by Group RT and Group R. The addition of dexamethasone or tramadol improved both analgesic quality and patient satisfaction compared to ropivacaine alone.

Table 5: Side Effects and Complications

Complication	Ropivacaine (n=40)	Ropivacaine + Dexamethasone (n=40)	Ropivacaine + Tramadol (n=40)
Nausea/Vomiting	3	2	5
Dizziness	1	0	1
Respiratory Depression	0	0	1
Hypotension	1	0	1
Pruritus	2	1	3
Pneumothorax/Hematoma	0	0	0
Total	**7**	**3**	**11**

The incidence of complications was lowest in Group RD and highest in Group RT. The most common adverse effects were nausea, vomiting, and pruritus. Respiratory depression was observed only in one patient in the tramadol group. Overall, dexamethasone was associated with fewer side effects

DISCUSSION

Brachial plexus block is an effective regional anesthetic technique for facilitating painless upper limb surgeries and serves as a valuable alternative to general anesthesia, particularly in high-risk patients. Among the various approaches, the supraclavicular technique is most suitable for upper limb procedures as it provides dense anesthesia by blocking the trunks of the brachial plexus.[10] Although long-acting local anesthetics such as ropivacaine provide effective anesthesia, limitations such as delayed onset and inadequate duration of postoperative analgesia persist. To overcome these drawbacks, various adjuvants have been studied to enhance block characteristics and prolong analgesia.

Tramadol, a centrally acting analgesic with both opioid and non-opioid mechanisms, exerts its effect through μ-opioid receptor activation and inhibition of norepinephrine and serotonin reuptake. Its peripheral local anesthetic action is thought to potentiate the effects of local anesthetics. In contrast, dexamethasone, a corticosteroid, has been shown to prolong nerve block duration. Although its exact mechanism is not fully understood, it is believed to inhibit nociceptive impulse transmission in unmyelinated C fibers and modulate potassium channels, leading to reduced neuronal excitability. Johannsson et al.[11] demonstrated that corticosteroids can block transmission in nociceptive fibers.

In the present study, demographic characteristics were comparable among all groups, ensuring uniformity. The findings from Table 2 demonstrate that the addition of dexamethasone and tramadol significantly prolonged the duration of analgesia and reduced the requirement for rescue analgesics. These results are consistent with previous studies. Cummings et al.[12]

reported prolonged analgesia and improved pain scores with dexamethasone as an adjuvant to ropivacaine. Similarly, Singh et al.[13] observed reduced analgesic consumption with tramadol.

The onset of sensory and motor blockade was significantly faster in the adjuvant groups, as shown in Table 3. This is in agreement with studies by Mahendru et al.[17] and Gupta et al.[18], which reported accelerated onset with both dexamethasone and tramadol. Additionally, the duration of blockade was significantly prolonged, especially with dexamethasone, which aligns with findings by Sahin et al.[19] and Joshi et al.[20].

Table 4 highlights that both quality of analgesia and patient satisfaction were improved in the adjuvant groups, with dexamethasone showing superior outcomes. These findings are supported by Rashmi et al.[21] and Liu et al.[23], who demonstrated enhanced analgesic quality and higher patient satisfaction with dexamethasone. Tramadol also improved these parameters, as reported by Mohan et al.[22].

Regarding safety, Table 5 indicates that dexamethasone was associated with fewer adverse effects, particularly a lower incidence of nausea and vomiting, consistent with Cummings et al.[12]. In contrast, tramadol was associated with a slightly higher incidence of nausea, vomiting, and dizziness, which aligns with findings by Singh et al.[13]. A single case of respiratory depression observed in the tramadol group may be attributed to its opioid properties, as reported in previous studies.[24] Overall, the present study demonstrates that both dexamethasone and tramadol improve the efficacy of ropivacaine in supraclavicular block, with dexamethasone showing superior efficacy and safety profile.

CONCLUSION

The addition of dexamethasone and tramadol as adjuvants to ropivacaine significantly improves the onset and prolongs the duration of sensory and motor blockade, enhances postoperative analgesia, and increases patient satisfaction. Among the two, dexamethasone appears to be the superior adjuvant, providing longer duration of analgesia, better block characteristics, and fewer adverse effects. Tramadol, although effective, is associated with a slightly higher incidence of minor side effects and may be considered as an alternative when corticosteroids are contraindicated. Further large-scale studies are recommended to evaluate long-term safety and to determine the optimal dosing of these adjuvants.

LIMITATIONS OF THE STUDY

- **Sample Size:** The relatively small sample size may limit the generalizability of the findings. Larger studies are needed to validate these results.
- **Short-term Follow-up:** The study assessed only immediate postoperative outcomes and did not evaluate long-term complications or chronic pain.
- **Subjective Assessment:** Parameters such as pain scores and patient satisfaction are subjective and may vary depending on individual patient perception, pain tolerance, and expectations.

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