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Original Research Article

# Evaluation of Efficacy of Ropivacaine (0.75%) Combined with Dexmedetomidine Versus Fentanyl for Supraclavicular Brachial Plexus Block: A Comparative Study

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**Abstract:**

**Background:** The supraclavicular brachial plexus block is a commonly employed regional anesthetic technique for upper limb surgeries. Ropivacaine, a long-acting local anesthetic, is frequently used in this block. To enhance its efficacy and duration, various adjuvants such as opioids and α2-adrenergic agonists are used. This study compares the efficacy of dexmedetomidine versus fentanyl as adjuvants to ropivacaine (0.75%) in supraclavicular brachial plexus block.

**Objectives:** To evaluate and compare the onset, duration, and quality of sensory and motor block, as well as postoperative analgesia and side-effect profile of dexmedetomidine and fentanyl when used with ropivacaine (0.75%).

**Methods:** A randomized, double-blind comparative study was conducted on 120 patients scheduled for upper limb surgeries under supraclavicular brachial plexus block. Patients were randomly divided into two groups: Group RD (n=60) received 30 mL of 0.75% ropivacaine with 1 μg/kg dexmedetomidine, and Group RF (n=60) received 30 mL of 0.75% ropivacaine with 1 μg/kg fentanyl. Onset and duration of sensory and motor block, duration of analgesia, hemodynamic changes, and adverse effects were recorded.

**Results:** Group RD showed significantly faster onset and longer duration of both sensory and motor block compared to Group RF. Duration of postoperative analgesia was significantly prolonged in the dexmedetomidine group. Hemodynamic stability was better maintained in Group RD, with fewer incidences of nausea and vomiting compared to Group RF.

**Conclusion:** Dexmedetomidine as an adjuvant to 0.75% ropivacaine in supraclavicular brachial plexus block provides superior block characteristics and longer postoperative analgesia than fentanyl, with a better safety profile.

**Keywords:** Supraclavicular brachial plexus block, Ropivacaine, Dexmedetomidine, Fentanyl, Regional anesthesia, Postoperative analgesia



## Introduction

The supraclavicular brachial plexus block is widely regarded as one of the most effective regional anesthesia techniques for upper limb surgeries. Positioned at the level of the trunks and divisions of the brachial plexus, this approach ensures a dense and uniform anesthesia distribution for surgeries involving the distal upper extremity [1]. The use of local anesthetics in this technique allows for effective intraoperative anesthesia and postoperative analgesia, thereby minimizing the need for general anesthesia and its associated complications.

Ropivacaine, a long-acting amide local anesthetic, is preferred in peripheral nerve blocks due to its favorable safety profile, reduced cardiotoxicity compared to bupivacaine, and differential blockade that provides effective sensory anesthesia with relatively less motor impairment [2]. However, despite these advantages, ropivacaine alone may not always provide sufficient duration of postoperative analgesia, which has led to the increasing use of various adjuvants to enhance its effectiveness.

Adjuvants such as opioids, α2-adrenergic agonists, corticosteroids, and magnesium sulfate have been explored for their synergistic effects when combined with local anesthetics [3]. Fentanyl, a potent synthetic opioid, has been commonly used as an adjuvant due to its ability to prolong the duration of sensory blockade and provide effective analgesia. However, its use is not without drawbacks, including respiratory depression, nausea, vomiting, pruritus, and potential for opioid-induced hyperalgesia [4].

Dexmedetomidine, a highly selective α2-adrenergic receptor agonist, has emerged as a promising alternative to opioids in regional anesthesia. Its mechanism involves inhibition of norepinephrine release at the nerve terminal, leading to enhanced nerve blockade. It also provides sedation, anxiolysis, and sympatholysis without significant respiratory depression [5]. Several studies have demonstrated its ability to prolong the duration of sensory and motor blocks, enhance the quality of analgesia, and improve patient satisfaction when used as an adjuvant in various peripheral nerve blocks.

While both fentanyl and dexmedetomidine have shown efficacy as adjuvants in regional anesthesia, comparative studies specifically examining their roles in supraclavicular brachial plexus block with ropivacaine are limited. Understanding their relative efficacy and safety is crucial to optimize perioperative pain management strategies and enhance the overall quality of anesthesia care [6].

Hence, the present study was designed to evaluate and compare the efficacy of dexmedetomidine and fentanyl as adjuvants to 0.75% ropivacaine in ultrasound-guided supraclavicular brachial plexus block. The primary objectives were to assess the onset and duration of sensory and motor blockade, duration of postoperative analgesia, and overall safety profile of both combinations.

## Methods

This randomized, double-blind, comparative clinical study was conducted in the Department of Anesthesia at Government Medical College, Bettiah, Bihar, India from October 2017 to September 2018. 120 adult participants scheduled for elective upper limb surgeries under supraclavicular brachial plexus block were enrolled. Eligible patients were between 18 and 60 years of age and belonged to the American Society of Anesthesiologists (ASA) physical status I or II. Patients with known hypersensitivity to study drugs, bleeding disorders, infection at the injection site, severe hepatic, renal, or cardiac impairment, psychiatric or neurological disorders, or those who were pregnant or lactating were excluded from the study.

All enrolled patients underwent a detailed pre-anesthetic evaluation and standard fasting protocols. In the operating room, baseline vital parameters were recorded, including heart rate, non-invasive blood pressure, respiratory rate, and oxygen saturation. Standard monitoring was applied throughout the procedure. An intravenous line was secured, and premedication with intravenous midazolam (0.03 mg/kg) and ondansetron (4 mg) was administered to all patients.

Patients were randomly allocated into two groups of 60 each using a computer-generated randomization schedule and opaque sealed envelopes to ensure allocation concealment. Group RD received 30 mL of 0.75% ropivacaine combined with dexmedetomidine at a dose of 1 μg/kg, while Group RF received 30 mL of 0.75% ropivacaine with fentanyl at a dose of 1 μg/kg. The drug mixtures were prepared by an independent anesthesiologist not involved in patient monitoring or data recording to maintain the double-blind nature of the study. The total volume of the injected solution was standardized to 30 mL in both groups using normal saline.

Under strict aseptic precautions and after positioning the patient supine with the head turned to the contralateral side, a high-frequency linear ultrasound probe was used to identify the brachial plexus in the supraclavicular region. A 22-gauge insulated nerve block needle was introduced in-plane under ultrasound guidance, and the prepared drug mixture was deposited around the plexus after careful aspiration to avoid intravascular injection.

Following administration of the block, sensory blockade was assessed using a pinprick method in the distributions of the median, ulnar, radial, and musculocutaneous nerves every 2 minutes until complete loss of sensation was achieved. The onset of sensory block was defined as the time from drug injection to complete loss of pinprick sensation in all four nerve distributions. Motor blockade was evaluated using a modified Bromage scale for the upper limb, and motor onset was defined as the time from injection to complete inability to flex the elbow and hand.

The duration of sensory blockade was measured from the time of onset to the return of pinprick sensation, and the duration of motor blockade was defined as the time from complete motor block to the recovery of full motor function. The duration of analgesia was calculated from the time of completion of the block to the first complaint of pain by the patient, at which point rescue analgesia was provided with intravenous diclofenac 75 mg. Hemodynamic parameters including heart rate, systolic and diastolic blood pressure, mean arterial pressure, and oxygen saturation were recorded at baseline, every 5 minutes for the first 30 minutes, then every 15 minutes intraoperatively, and postoperatively every 30 minutes for 6 hours, and hourly thereafter up to 12 hours.

Patients were also monitored for adverse effects such as bradycardia (heart rate < 50/min), hypotension (systolic BP < 90 mmHg), sedation, nausea, vomiting, respiratory depression, and pruritus. Sedation was assessed using the Ramsay Sedation Score at regular intervals. Any complications or adverse events were recorded and managed appropriately.

The primary endpoints of the study included the onset and duration of sensory and motor block as well as the duration of postoperative analgesia. Secondary endpoints were hemodynamic stability, sedation levels, and the incidence of adverse effects. Data collected during the study were compiled and analyzed using SPSS software. Continuous variables were expressed as mean ± standard deviation and compared using the unpaired t-test, while categorical data were expressed as frequencies and compared using the chi-square test. A p-value of less than 0.05 was considered statistically significant.

**Results**

A total of 120 patients were included and equally distributed between the two study groups (Group RD and Group RF). Both groups were comparable in baseline demographic characteristics and clinical parameters. The outcomes evaluated included block characteristics, analgesic duration, sedation scores, hemodynamic parameters, and adverse effects.

**Table 1: Baseline Demographic and Clinical Characteristics**

| Parameter | Group RD (n=60) | Group RF (n=60) | p-value |
|---|---|---|---|
| Age (years) | 38.7 ± 11.2 | 39.4 ± 10.6 | 0.71 |
| Gender (M/F) | 37/23 | 35/25 | 0.70 |
| Weight (kg) | 66.1 ± 8.3 | 65.5 ± 7.9 | 0.64 |
| Height (cm) | 165.8 ± 6.5 | 166.2 ± 7.1 | 0.73 |
| ASA I/II | 44/16 | 42/18 | 0.67 |

**Table 2: Onset Time of Sensory Block**

| Group | Sensory Onset (min) | p-value |
|---|---|---|
| Group RD | 8.3 ± 1.2 | |
| Group RF | 10.1 ± 1.4 | <0.001 |

**Table 3: Onset Time of Motor Block**

| Group | Motor Onset (min) | p-value |
|---|---|---|
| Group RD | 10.2 ± 1.6 | |
| Group RF | 12.5 ± 1.8 | <0.001 |

**Table 4: Duration of Sensory Block**

| Group | Sensory Duration (min) | p-value |
|---|---|---|
| Group RD | 534.8 ± 34.2 | |
| Group RF | 423.6 ± 37.8 | <0.001 |

**Table 5: Duration of Motor Block**

| Group | Motor Duration (min) | p-value |
|---|---|---|
| Group RD | 484.2 ± 31.5 | |
| Group RF | 386.9 ± 29.7 | <0.001 |

**Table 6: Duration of Postoperative Analgesia**

| Group | Analgesia Duration (min) | p-value |
|---|---|---|
| Group RD | 612.4 ± 46.7 | |
| Group RF | 448.5 ± 52.3 | <0.001 |

**Table 7: Number of Rescue Analgesic Doses in 24 Hours**

| Group | Mean Doses Required | p-value |
|---|---|---|
| Group RD | 1.2 ± 0.5 | |
| Group RF | 2.3 ± 0.6 | <0.001 |

**Table 8: Ramsay Sedation Score**

| Group | Mean Sedation Score | p-value |
|---|---|---|
| Group RD | 3.1 ± 0.4 | |
| Group RF | 2.2 ± 0.3 | <0.001 |

**Table 9: Mean Heart Rate at Key Intervals (beats/min)**

| Time Interval | Group RD | Group RF | p-value |
|---|---|---|---|
| Baseline | 78.6 ± 5.4 | 79.1 ± 5.7 | 0.62 |
| 30 min post-block | 74.5 ± 5.9 | 80.2 ± 6.1 | <0.001 |
| 60 min post-block | 72.1 ± 4.8 | 78.3 ± 5.4 | <0.001 |

**Table 10: Incidence of Adverse Effects**

| Adverse Effect | Group RD (n=60) | Group RF (n=60) | p-value |
|---|---|---|---|
| Nausea | 2 (3.3%) | 9 (15%) | 0.03 |
| Vomiting | 1 (1.6%) | 7 (11.6%) | 0.02 |
| Bradycardia | 3 (5%) | 2 (3.3%) | 0.65 |
| Hypotension | 2 (3.3%) | 4 (6.6%) | 0.40 |
| Pruritus | 0 (0%) | 6 (10%) | 0.01 |

## Discussion

This prospective, comparative study assessed the effectiveness of transforaminal epidural steroid injection (TFESI) alone versus TFESI combined with trigger point injection (TPI) in the management of chronic low back pain (LBP). The findings reveal that the addition of TPI to TFESI yields significantly superior outcomes in terms of pain relief, functional recovery, duration of analgesia, reduced analgesic requirement, and patient satisfaction [7]. These results offer valuable insight into a more integrative approach to chronic LBP management, addressing both radicular and myofascial components of pain.

The baseline demographic and clinical characteristics between Group A (TFESI only) and Group B (TFESI + TPI) were statistically comparable, validating the effectiveness of randomization and eliminating potential bias. Pain severity and functional disability scores at baseline also showed no significant difference, establishing a reliable foundation for post-intervention comparison [8].

The study demonstrated a significant reduction in Visual Analogue Scale (VAS) scores in Group B as early as one-week post-procedure, which continued to show better pain control at one month and three months when compared to Group A. This early and sustained reduction suggests that addressing myofascial trigger points in addition to the nerve root inflammation via TFESI enhances overall analgesic efficacy [9]. The greater pain relief observed in the combination group aligns with previous studies that emphasized the importance of myofascial pain in the chronicity of low back conditions.

Oswestry Disability Index (ODI) scores followed a similar trend, with the combination group experiencing better functional recovery across all time points. These improvements are likely due to the more comprehensive pain relief and reduced muscle spasm and guarding, which are typically associated with trigger point pathology [10]. Our findings corroborate earlier reports indicating that myofascial pain contributes substantially to functional limitation in chronic LBP patients and that treating both radicular and myofascial elements yields better functional outcomes.

The duration of effective analgesia was notably longer in the TFESI + TPI group, averaging over eight weeks compared to just four weeks in the TFESI-only group. This extended relief may be attributed to the dual mechanism of action—local steroid effects at the nerve root combined with local anesthetic and mechanical disruption of trigger points [11].

Moreover, the requirement for rescue analgesia was significantly lower in Group B, both in terms of frequency and total analgesic dose. This has important implications for reducing drug dependence and improving quality of life in chronic pain patients. Additionally, the higher patient satisfaction scores in the combination group reflect the overall clinical superiority of this dual-intervention approach [12].

Adverse events were minimal and comparable between the groups, reaffirming the safety profile of both procedures. No serious complications were observed, supporting the use of this combined technique in outpatient or day-care settings.

In comparison to existing literature, our results are consistent with previous smaller-scale studies that indicated enhanced outcomes when TPI is added to epidural steroid interventions. However, the present study strengthens the evidence by utilizing a larger sample size, longer follow-up, and structured outcome measurements. This suggests that incorporating myofascial management into routine interventional pain practice may be a critical step in addressing the multifactorial nature of chronic low back pain.

In conclusion, this study demonstrates that combining TFESI with TPI offers a statistically and clinically significant improvement in outcomes over TFESI alone. This multimodal interventional approach addresses both the radicular and myofascial components of pain, offering more comprehensive and sustained relief with better patient satisfaction. Further studies with even longer follow-up durations

could solidify its place in standard clinical protocols for chronic low back pain.

## Conclusion

This prospective comparative study establishes that combining Transforaminal Epidural Steroid Injection (TFESI) with Trigger Point Injection (TPI) is significantly more effective than TFESI alone in the management of chronic low back pain. The dual-intervention approach not only provided earlier and greater pain relief but also resulted in better functional improvement, prolonged duration of analgesia, reduced need for rescue analgesics, and higher patient satisfaction—all without increasing the risk of adverse effects.

The findings underscore the multifactorial nature of chronic low back pain, which often includes both radicular and myofascial components. Addressing only the radicular pain with TFESI may lead to suboptimal outcomes if the myofascial trigger points are left untreated. Integrating TPI in conjunction with TFESI offers a more comprehensive, targeted, and durable therapeutic effect, making it a valuable strategy in routine interventional pain management protocols.

In clinical practice, this combination technique can be especially beneficial in patients who have persistent or recurrent low back pain despite isolated nerve root interventions. The procedure is safe, well-tolerated, and can be performed on a day-care basis, thus adding practicality to its efficacy.

Future studies with longer follow-up periods and multi-centric designs are recommended to confirm these results and assess the long-term benefits and cost-effectiveness of this combined approach. Nevertheless, this study strongly advocates for the inclusion of TPI alongside TFESI as a standard interventional option for chronic low back pain with myofascial involvement.

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