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Original Research Article

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

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Abstract:

Background: Supraclavicular brachial plexus block is a commonly used regional anesthetic technique for upper limb surgeries. The addition of adjuvants to local anesthetics has been shown to improve block quality, onset time, and postoperative analgesia. This study compares the efficacy of dexmedetomidine and fentanyl as adjuvants to 0.75% ropivacaine in supraclavicular brachial plexus block.

Aim and Objectives: To evaluate and compare the onset time, duration of sensory and motor block, and duration of postoperative analgesia between dexmedetomidine and fentanyl when used with 0.75% ropivacaine in supraclavicular brachial plexus block.

Materials and Methods: This was a retrospective observational study conducted in the Department of Anesthesia at Sri Krishna Medical College and Hospital (SKMCH), Muzaffarpur, Bihar, India from January 2023 to December 2023.120 adult patients who underwent upper limb surgeries under supraclavicular brachial plexus block. Group D (n=60) received 0.75% ropivacaine with dexmedetomidine (1 µg/kg), while Group F (n=60) received 0.75% ropivacaine with fentanyl (1 µg/kg). Parameters assessed included onset and duration of sensory and motor block, duration of analgesia, and adverse events.

Results: Group D demonstrated a significantly faster onset of both sensory and motor block, and a longer duration of analgesia compared to Group F ($p<0.05$). The incidence of sedation was higher in Group D, whereas nausea and vomiting were more frequent in Group F.

Conclusion: Dexmedetomidine is a more effective adjuvant than fentanyl when combined with 0.75% ropivacaine for supraclavicular brachial plexus block, offering prolonged analgesia and faster block onset with minimal complications.

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

Introduction

The supraclavicular brachial plexus block is one of the most frequently used regional anesthesia techniques for upper limb surgeries, owing to its predictable and dense anesthesia of the upper extremity from the mid-humerus to the fingertips [1]. Its anatomical location at the level of the trunks and divisions of the brachial plexus offers the advantage of compact nerve grouping, which facilitates reliable blockade using a relatively low volume of local anesthetic. Compared to general anesthesia, this technique provides superior postoperative analgesia, reduces the need for systemic opioids, minimizes respiratory complications, and allows for early ambulation and same-day discharge in many cases [2].

While local anesthetics alone can produce effective nerve blocks, their duration of action is limited and often insufficient for prolonged surgical procedures or sustained postoperative pain relief. As a result, the addition of adjuvants to local anesthetics has become a widely accepted strategy to improve the onset, intensity, and duration of nerve blocks [3]. Among available local anesthetics, ropivacaine, a pure S-enantiomer of bupivacaine, has emerged as a preferred agent for peripheral nerve blocks due to its favorable pharmacokinetics, lower neuro- and cardiotoxicity, and a greater degree of sensory-motor differentiation. At a concentration of 0.75%, ropivacaine provides profound and long-lasting

analgesia suitable for complex upper limb procedures [4].

Dexmedetomidine, a highly selective α2-adrenergic receptor agonist, acts both centrally and peripherally to enhance local anesthetic effects. It hyperpolarizes nerve membranes by inhibiting voltage-gated sodium and potassium channels, prolongs the duration of both sensory and motor blocks, and offers sedative and anxiolytic effects without significant respiratory depression [5]. It also reduces sympathetic outflow, thus stabilizing hemodynamics during surgery. Numerous studies have demonstrated its efficacy in prolonging block duration and reducing postoperative opioid requirement, making it a promising adjuvant for peripheral nerve blocks [6].

On the other hand, fentanyl, a potent synthetic μ-opioid receptor agonist, has been widely used as an adjuvant to both neuraxial and peripheral nerve blocks. Its mechanism of action involves inhibition of nociceptive transmission at the level of the dorsal horn, leading to rapid onset and intraoperative analgesia [7]. Although it is known to improve block quality, fentanyl is often associated with adverse effects such as nausea, vomiting, pruritus, and respiratory depression, particularly when absorbed systemically. Its perineural efficacy has shown mixed results in clinical trials, with some studies reporting modest benefits and others showing limited impact on block characteristics [8].

Comparative studies evaluating dexmedetomidine and fentanyl as adjuvants to ropivacaine are limited, especially in the context of supraclavicular brachial plexus block. Most existing literature is either based on bupivacaine or studies involving different nerve blocks [9]. Moreover, prospective trials often exclude high-risk or complex cases, whereas retrospective analyses reflect real-world patient populations and perioperative practices, providing clinically relevant insights into the efficacy and safety profiles of these adjuvants [10].

Therefore, this retrospective observational study was designed to assess and compare the effects of adding dexmedetomidine versus fentanyl to 0.75% ropivacaine in supraclavicular brachial plexus block. The focus is on evaluating the differences in block onset, duration of sensory and motor block, postoperative analgesia, and incidence of complications, with the goal of guiding evidence-based decisions in anesthetic practice.

Aim and Objectives

Aim: To evaluate and compare the clinical efficacy of 0.75% ropivacaine when combined with dexmedetomidine versus fentanyl as adjuvants in supraclavicular brachial plexus block for upper limb surgeries.

Objectives:

1. To assess and compare the onset time of sensory and motor block in both study groups.
2. To determine the duration of sensory and motor blockade achieved with each adjuvant.
3. To compare the total duration of postoperative analgesia in both groups.
4. To evaluate the incidence of intraoperative and postoperative complications such as hypotension, bradycardia, sedation, nausea, vomiting, or respiratory depression.
5. To assess the need for rescue analgesia within the first 24 hours postoperatively.
6. To analyze any significant differences in patient recovery profile and overall satisfaction between the two adjuvant groups.

Methodology

Study Design and Setting: This was a retrospective observational study conducted in the Department of Anesthesia at Sri Krishna Medical College and Hospital (SKMCH), Muzaffarpur, Bihar, India from January 2023 to December 2023. The study included patient records from elective upper limb surgeries performed under supraclavicular brachial plexus block over a period of 18 months.

Study Population: A total of 120 adult patients, aged between 18 and 60 years, of either gender, who underwent upper limb orthopedic or soft tissue surgeries under supraclavicular brachial plexus block were included. Patients were divided into two equal groups of 60 each based on the adjuvant used along with 0.75% ropivacaine.

Group D (n=60): Received 20 ml of 0.75% ropivacaine with dexmedetomidine (1 μg/kg)

Group F (n=60): Received 20 ml of 0.75% ropivacaine with fentanyl (1 μg/kg)

Inclusion Criteria:

- Adult patients aged 18–60 years
- ASA physical status I and II
- Patients who underwent elective upper limb surgeries under supraclavicular brachial plexus block
- Complete and legible anesthesia records available

Exclusion Criteria:

- Patients with incomplete medical records
- ASA grade III and IV patients
- Patients with coagulopathy or local infection at the block site
- Known allergy to study drugs
- History of chronic opioid use or pre-existing neuropathy

Data Collection Procedure: Patient medical records were reviewed for demographic details,

ASA grading, type and duration of surgery, drugs administered for the block, and intraoperative and postoperative monitoring parameters. The following clinical parameters were extracted and compared between the two groups:

- Onset time of sensory block (time from drug injection to complete sensory loss in dermatomes)
- Onset time of motor block (time from drug injection to complete motor paralysis of upper limb)
- Duration of sensory and motor block (time from onset to return of sensation/movement)
- Duration of postoperative analgesia (time to first request for analgesia)
- Total analgesic requirement in first 24 hours
- Incidence of adverse effects: sedation, hypotension, bradycardia, nausea, vomiting, respiratory depression

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 25. Continuous variables were expressed as mean ± standard deviation and compared using unpaired Student's t-test. Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate. A p-value of <0.05 was considered statistically significant.

Results

The present retrospective comparative study included 120 adult patients undergoing upper limb surgeries under supraclavicular brachial plexus block. Patients were equally divided into two groups: Group D (ropivacaine 0.75% with dexmedetomidine, n=60) and Group F (ropivacaine 0.75% with fentanyl, n=60). Both groups were comparable in demographic characteristics including age, sex, and ASA physical status. The primary outcomes assessed included the onset and duration of sensory and motor block, duration of postoperative analgesia, and the requirement for rescue analgesia. Secondary outcomes included the incidence of adverse effects. Group D demonstrated significantly faster onset and prolonged duration of both sensory and motor block, as well as superior postoperative analgesia. Adverse effects were minimal in both groups but varied in type.

Table 1: Distribution of Patients by Age Group

Age Group (years)	Group D (n=60)	Group F (n=60)
18–30	12	11
31–40	18	19
41–50	22	20
51–60	8	10

Table 2: Gender Distribution of Study Participants

Gender	Group D (n=60)	Group F (n=60)
Male	39	42
Female	21	18

Table 3: ASA Physical Status Classification

ASA Grade	Group D (n=60)	Group F (n=60)
I	36	34
II	24	26

Table 4: Mean Onset Time of Sensory Block

Parameter	Group D (n=60)	Group F (n=60)
Mean onset time ± SD (min)	8.2 ± 1.1	10.4 ± 1.3

Table 5: Mean Onset Time of Motor Block

Parameter	Group D (n=60)	Group F (n=60)
Mean onset time ± SD (min)	10.1 ± 1.2	12.7 ± 1.4

Table 6: Duration of Sensory Block

Parameter	Group D (n=60)	Group F (n=60)
Mean duration ± SD (min)	435.6 ± 25.4	368.3 ± 30.2

Table 7: Duration of Motor Block

Parameter	Group D (n=60)	Group F (n=60)
Mean duration ± SD (min)	403.5 ± 27.8	350.4 ± 29.1

Table 8: Duration of Postoperative Analgesia

Parameter	Group D (n=60)	Group F (n=60)
Mean duration ± SD (min)	590.2 ± 35.1	438.7 ± 32.6

Table 9: Requirement of Rescue Analgesia within 24 Hours

Rescue Analgesia Required	Group D (n=60)	Group F (n=60)
Yes	15	38
No	45	22

Table 10: Incidence of Adverse Effects in Both Groups

Adverse Effect	Group D (n=60)	Group F (n=60)
Sedation	10	4
Nausea/Vomiting	2	11
Bradycardia	3	1
Hypotension	2	1
Respiratory depression	0	1

Table 1 showed the age-wise distribution with most patients in the 31–50-year group and comparable distributions in both arms. Table 2 demonstrated a male predominance across both groups. Table 3 confirmed the majority were ASA Grade I in both groups, indicating similar operative risk. Table 4 and Table 5 revealed a significantly faster onset of both sensory and motor block in Group D. Table 6 and Table 7 showed a longer duration of both blocks in Group D, suggesting prolonged anesthetic effect. Table 8 confirmed that postoperative analgesia lasted substantially longer in Group D. Table 9 documented fewer patients in Group D requiring rescue analgesia, showing superior pain control. Table 10 highlighted that sedation was more common with dexmedetomidine, while nausea/vomiting and rare respiratory depression were noted more in the fentanyl group.

Discussion

This retrospective comparative study was undertaken to evaluate and compare the efficacy and safety of ropivacaine 0.75% combined with either dexmedetomidine (Group D) or fentanyl (Group F) in supraclavicular brachial plexus block for upper limb surgeries. The primary objective was to assess the onset and duration of sensory and motor blocks, postoperative analgesia, and the need for rescue analgesia, while also monitoring for any adverse effects associated with each combination [11].

The demographic profiles of both groups were statistically comparable in terms of age, gender distribution, and ASA physical status. This helped eliminate confounding factors and ensured a uniform baseline for comparison between the two intervention arms [12].

In terms of block characteristics, patients in Group D (ropivacaine with dexmedetomidine) experienced a significantly faster onset of both sensory and motor blocks compared to those in Group F (ropivacaine with fentanyl). This observation suggests that dexmedetomidine enhances the speed of nerve block onset, likely due to its synergistic action as an α2-adrenoceptor agonist, which facilitates neuronal hyperpolarization and augments local anesthetic efficacy [13,14].

Furthermore, the duration of both sensory and motor blocks was markedly prolonged in Group D. This is in alignment with clinical expectations and literature which has demonstrated that dexmedetomidine, by decreasing the release of norepinephrine and delaying nerve fiber repolarization, significantly prolongs the duration of regional anesthesia. Prolonged block duration has clinical utility in providing sustained intraoperative anesthesia and extended postoperative analgesia, reducing the reliance on systemic analgesics [15,16].

Postoperative analgesia was also significantly superior in Group D. Patients in this group had longer pain-free intervals post-surgery and required less rescue analgesia within the first 24 hours, confirming the extended analgesic benefits of dexmedetomidine. These findings not only support its utility in enhancing patient comfort but also indicate potential for reducing opioid consumption and associated adverse effects [17].

Adverse effect profiles in the two groups differed. Sedation was more frequently noted in Group D, although it was mild and clinically manageable in all cases. On the other hand, Group F had a higher incidence of nausea and vomiting, which could be attributed to the opioid nature of fentanyl [18]. Additionally, a few patients in Group F developed respiratory depression, reinforcing the need for caution with opioid adjuncts. Notably, neither group showed life-threatening complications, affirming the overall safety of both combinations when used with appropriate monitoring [19].

The findings from this study support the growing preference for dexmedetomidine as an adjuvant to local anesthetics in peripheral nerve blocks. Its benefits in prolonging analgesia, enhancing block characteristics, and reducing postoperative analgesic

requirements make it a favorable alternative to fentanyl. However, the associated sedation, though generally manageable, requires careful observation, especially in day-care settings or when rapid recovery is needed [20].

While the results are promising, the retrospective design is a limitation. Prospective randomized controlled trials with larger sample sizes and longer follow-up periods are recommended to confirm these outcomes and assess long-term safety. Furthermore, patient satisfaction scores and quality of recovery measures could enhance the understanding of clinical benefits in future studies.

The addition of dexmedetomidine to ropivacaine in supraclavicular brachial plexus block offers superior clinical outcomes compared to fentanyl, with better onset and duration of block, improved postoperative analgesia, and a tolerable adverse effect profile.

Conclusion

This retrospective comparative study highlights the superior clinical efficacy of dexmedetomidine over fentanyl as an adjuvant to ropivacaine in supraclavicular brachial plexus block. Dexmedetomidine significantly shortened the onset time of both sensory and motor block while also prolonging their duration. It provided extended postoperative analgesia and reduced the need for rescue analgesics within the first 24 hours after surgery. Though mild sedation was observed more frequently with dexmedetomidine, it was clinically manageable and did not compromise patient safety. In contrast, fentanyl was associated with a higher incidence of nausea, vomiting, and rare episodes of respiratory depression. These findings reinforce the safety and effectiveness of dexmedetomidine in enhancing the quality of regional anesthesia. Its use may contribute to improved perioperative pain control, reduced analgesic requirement, and better overall patient outcomes. However, prospective trials are warranted to validate these results further and determine optimal dosing regimens. Until then, dexmedetomidine appears to be a promising and effective adjuvant in peripheral nerve block protocols.

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