ORIGINAL ARTICLE ASIAN JOURNAL OF MEDICAL SCIENCES

A comparative study of efficacy of ropivacaine (0.75%) with adjuvants – dexmedetomidine and fentanyl in supraclavicular brachial plexus block

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Submission: 18-04-2023 Revision: 27-06-2023 Publication: 01-08-2023

ABSTRACT

Background: Brachial plexus block is preferred to general anesthesia (GA) as it reduces many complications of GA, provides good intra and postoperative analgesia, adequate muscle relaxation. Addition of adjuvants along with LA is used to prolong block with improved quality of anesthesia and decrease dose of LA. This study was done to see the efficacy of Ropivacaine with dexmedetomidine and fentanyl in terms of duration of action and pain relief. **Aims and Objectives:** Dexmedetomidine and Fentanyl along with Ropivacaine in patients undergoing upper limb surgeries, the onset and duration of sensory and motor blockade as well as post op analgesia is compared. **Materials and Methods:** Prospective Randomized Comparative study with three groups randomly divided received total volume of 30 mL of drug in peripheral nerve stimulator guided supraclavicular blocks in patients undergoing upper limb surgeries. Group Dexmedetomidine received 28 cc of 0.75% Ropivacaine and Dexmedetomidine (1 mcg/kg), Group Fentanyl patients received 28 cc of 0.75% Ropivacaine and fentanyl (1 mcg/kg), whereas, group plain Ropivacaine patients received 28 cc of 0.75% Ropivacaine and 2 mL of normal saline. Haemodynamics, sensory and motor block (MB) were evaluated by VAS and modified Bromage scale. **Results:** The onset of sensory block and MB in the dexmedetomidine group, fentanyl group, and ropivacaine groups was 3.57 ± 0.50 min and 4.47 ± 0.51 min, 5.50 ± 0.51 min and 7.53 ± 0.51 min, and 8.07 ± 0.79 min and 10.07 ± 0.79 min respectively which were statistically significant. The duration of MB in the dexmedetomidine group, fentanyl group, and ropivacaine group were 6.57 ± 0.50 h, 4.47 ± 0.51 h, and 2.50 ± 0.51 h respectively which was statistically significant (P = 0.0000). The duration at which first postoperative analgesia was required in the dexmedetomidine group, fentanyl group, and ropivacaine group were 8.57 ± 0.50 h, 6.57 ± 0.50 h, and 5.30 ± 0.47 h respectively. **Conclusion:** Dexmedetomidine is better as an adjuvant to Ropivacaine for brachial plexus block in terms of onset and duration.

Key words: Brachial plexus block; Local anaesthesia; Dexmedetomidine; Fentanyl

Access this article online

Website: http://nepjol.info/index.php/AJMS

DOI: 10.3126/ajms.v14i8.54204

E-ISSN: 2091-0576

P-ISSN: 2467-9100

INTRODUCTION

Brachial plexus block provides adequate muscle relaxation and a minimal alteration in haemostasis, intra operative analgesia and post-operative pain relief. It also reduces the complications and reduces the post anesthesia care unit stay and the stress of laryngoscopy and tracheal intubation is also avoided, thus brachial plexus block is preferable to general anesthesia.[1] Adjuvants have been administered to achieve prolonged block with improved quality of anesthesia and to decrease the total dose of local anaesthetics used.[2] Adjuvants with local anaesthetics

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in brachial plexus block are used to achieve a quick, dense and prolonged block.[3] The supraclavicular approach is the oldest way to accomplish anesthesia of the brachial plexus. Use of ropivacaine (0.75%) with adjuvants Dexmedetomidine and Fentanyl is studied in order see the efficacy of both in terms of duration of action and pain relief. Hence this study was done to see the efficacy of ropivacaine with dexmedetomidine and fentanyl in peripheral nerve stimulator guided supraclavicular blocks in patients undergoing upper limb surgeries.

Aims and objectives

Major objective was to compare the onset and duration of sensory and motor blockade and duration of post-operative analgesia. We have also compared the intraoperative sedation levels and any side effects with dexmedetomidine and fentanyl.

MATERIALS AND METHODS

The present prospective randomized comparative study with done with simple randomization and a double blinding. It was conducted in our institute over a period of 2 years. This study was performed after the approval from Institutional Ethics Committee.

The sample size was calculated using Slovin's formula: $n=N/1+Ne^2$ where, n=Population Size, e=error margin and n=sample size. A total of n=90 samples who fulfill inclusion and exclusion criteria were included in the study. We included all patients undergoing elective surgeries of the upper limb with age group between 18 and 60 years falling into ASA grade 1 and 2. Duration of surgery extending more than 2 h were excluded. Patients with ASA grade 3 and 4, with known allergy to local anaesthetic agents, obese patients with BMI >35 kgm^2 (Body weight >100 kg), patients with bleeding disorders, peripheral neuropathy, local infection at the site of injection and any patients refusing block were also excluded in this study.

Written informed consent was obtained from each study participant after a clear explanation of the merits and demerits of the study. A total of 90 patients were included in the study and were randomly divided into 3 groups according to computer-generated random number codes that were placed in a sealed envelope. Each group consisted of n=30 patients and were named according to drugs used such as Group Dexmedetomidine, Group Fentanyl, and Group Ropivacaine. Pre-anaesthetic evaluations were performed 1 day before the surgery. Routine clinical and laboratory investigations were performed on all the patients. On the day of surgery pre-anaesthetic medications Inj. Ondansetron 4 mg IV and Inj. Ranitidine 50 mg IV were given to the subjects and a standardized protocol was followed. Patients in Group Dexmedetomidine received 28 cc of 0.75% Ropivacaine and dexmedetomidine (1 mcg/kg) a total volume of 30 mL, Group Fentanyl patients received 28 cc of 0.75% Ropivacaine and fentanyl (1 mcg/kg) a total volume of 30 mL, whereas, group plain Ropivacaine patients received 28 cc of 0.75% Ropivacaine and 2 mL of normal saline, a total volume of 30 mL The study solutions were prepared with identical syringes by an anesthesiologist who was not involved in the subsequent patient care or assessment Table 1.

Under aseptic conditions, brachial plexus block was performed by the nerve stimulator technique. Here, the patient was kept in the supine position, head at a 45° angle from the site to be blocked, arm adducted, and hand extended towards the ipsilateral knee. The point of entry was the lateral border of the anterior scalene muscle, the target was confirmed by palpating the subclavian artery pulsation, about 1 cm above the mid-clavicular point just lateral to the subclavian artery pulsation, the needle was introduced and directed towards the caudal downward and medial direction towards the first rib until the desired response was obtained (muscle twitching, and current strength reduced to 0.6 mA). In case of no adequate response, the needle was moved anteriorly or posteriorly along the first rib to elicit a response. The block was considered to be successful when at least 3 out of 4 nerve territories (ulnar, radial, median, and musculocutaneous) were effectively blocked for both sensory and motor. Post-negative aspiration, the study drug was administered.

The data regarding haemodynamics such as blood pressure and Heart rate were obtained. In case of bradycardia (HR<50 bpm), patients were administered with inj. Atropine (0.6 mg). In case of hypotension (<20% from baseline), Inj. Mephentermine 6 mg IV was given. The sensory block (SB) was assessed using a pin prick test. A modified Bromage scale was used to assess the motor block (MB). Whereas, Ramsay sedation scale was used to assess intraoperative sedation in our subjects.

The onset of the SB was defined as the time elapsed between the end of local anaesthetic administration and the

Table 1: Group of patients

Group dexmedetomidine (n=30)	Group fentanyl (n=30)	Group ropivacaine (n=30)
28 cc of 0.75% ropivacaine with 1 μg/kg of dexmedetomidine. Total volume of 30 mL	28cc of 0.75% ropivacaine with 1 μg/kg of fentanyl. Total volume of 30 mL	28cc of 0.75% ropivacaine with 2 mL NS. Total volume of 30 mL

complete SB. The absence of anesthesia in >2 peripheral nerves was considered a failure of anesthesia and the patient was discontinued from the study. The onset of MB was defined as the time elapsed between the end of the local anaesthetic administration to complete MB. Bromage scale score <2 was considered the MB failure. The duration of SB was defined as the time between onset of action to the return of the pinprick response. The duration of analgesia was defined as the time between the onset of action and the onset of pain when the patient was administered the first dose of analgesic, and the analgesic used was injection tramadol 100 mg in 100 mL NS. For patients with VAS score more than 4 during the intraoperative period, intramuscular injection tramadol 100 mg was given as a rescue analgesic, and still, if the pain persisted, general anesthesia was given, and the procedure was completed, and such patients were excluded from the study. Hemodynamic adverse events such as hypotension and bradycardia were managed using injection mephentermine in 6 mg incremental doses and 0.6 mg atropine, respectively.

Sensory and MB were evaluated for every minute during the first 5 min then every 3 min until 30 min, followed by post-operative evaluation every hour for 12 h or until the block was present. The vital signs and level of sedation were recorded every 5 min–30 min and 15 min–2 h and continued every 30 min thereafter.

Ethics

The study was approved by the institutional ethical/research committee.

Statistical analysis

Data were collected and entered into a Microsoft excel sheet. Using the SPSS IBM 20 version categorical variables were evaluated in terms of frequency and percentages, and the distribution was illustrated using pie charts and column charts. Continuous variables were analyzed using measures of central tendency (mean) and dispersion (Standard deviation), line chart was used to represent data in diagrammatic form. Independent sample t-test and Mann Whitney U-test were used to find the significant difference between the groups. P<0.05 was considered statistically significant.

RESULTS

In this study, a total of n=96 subjects were enrolled; among them n=6 patients experienced intraoperative pain (VAS-4) even after intramuscular administration of injection tramadol 100 mg. Thus, general anesthesia was given and the procedure was completed and such patients were excluded from the study.

The mean age of the dexmedetomidine group, fentanyl group, and ropivacaine group subjects was 39.00±11.39 years, 40.20±12.31 years, and 40.47±13.005 years, respectively.

Most of the participants in the study were female (n=47, 52.22%) followed by male (n=43, 47.78%). In the dexmedetomidine group, out of 30 patients, n=17 (56.67%) were female and n=13 (43.33%) were male. In the fentanyl group, n=14 (46.67%) and n=16 (53.33%), participants were female and male, respectively. Whereas in ropivacaine groups, this was n=16 (53.33%) and n=14 (46.67%), Table 2.

The mean heart rate in dexmedetomidine, fentanyl, and ropivacaine was 76.73±15.10 bpm, 88.86±5.62 bpm, and 96.36±7.74 bpm, respectively. A significant difference was found between the mean heart rate when compared between the groups (P=0.000216). Bradycardia and hypotension were observed only in 10% (n=3) patients of dexmedetomidine group. Whereas, there was no incidence of bradycardia in fentanyl and ropivacaine group subjects, as shown in Table 3.

A significant difference was found between mean Ramsay sedation score when compared between the groups (3.4±0.49 vs. 3.83±0.37 vs. 2.33±0.47, P=0.0000) Table 4.

The onset of SB in the dexmedetomidine group, fentanyl group, and ropivacaine groups was 3.57±0.50 min, 5.50±0.51 min, and 8.07±0.79 min respectively. A significant difference in the onset of SB was found when compared between the groups (P=0.0000). The onset of MB in the dexmedetomidine group, fentanyl group, and ropivacaine groups was 4.47±0.51 min, 7.53±0.51 min, and 10.07±0.79 min respectively. The

Table 2: Distribution of subjects according to gender

Gender	Frequency, n (%)			P
	Dexmedetomidine group	Fentanyl group	Ropivacaine group	
Female	17 (56.67)	14 (46.67)	16 (53.33)	0.86
Male	13 (43.33)	16 (53.33)	14 (46.67)	0.85
Total	30 (100)	30 (100)	30 (100)	

Table 3: Distribution of subjects according to the incidence of bradycardia and hypotension

Groups	Frequency, n (%)		P
	Bradycardia and hypotension	No bradycardia and hypotension	
Dexmedetomidine	3 (10)	27 (90)	0.000
Fentanyl	0	30 (100)	0.000
Ropivacaine	0	30 (100)	0.000

Table 4: Difference between mean and standard deviation among groups within different variables

Variables	Mean±SD			P
	Dexmedetomidine	Fentanyl	Ropivacaine	
Heart rate (bpm)	76.73±15.10	88.86±5.62	96.36±7.74	0.000216
Ramsay Sedation Scale	3.4±0.49	3.83±0.37	2.33±0.47	0.0000
Onset SB (min)	3.57±0.50	5.50±0.51	8.07±0.79	0.0000
Onset MB (min)	4.47±0.51	7.53±0.51	10.07±0.79	0.0000
Duration of MB (h)	6.57±0.50	4.47±0.51	2.50±0.51	0.0000
Duration of postoperative analgesia (h)	8.57±0.50	6.57±0.50	5.30±0.47	0.0000

SD: Standard deviation, MB: Motor block, SB: Sensory block

difference between the onset of SB in groups was statistically significant (P=0.0000). The duration of SB in the dexmedetomidine group was 7.57±0.50 h which were 5.47±0.51 h and 3.43±0.50 h in fentanyl and ropivacaine groups, respectively. There was a significant difference in the duration of the SB when compared between groups (P=0.0000) Table 4.

The duration of MB in the dexmedetomidine group, fentanyl group, and ropivacaine group were 6.57±0.50 h, 4.47±0.51 h, and 2.50±0.51 h respectively. The difference was statistically significant (P=0.0000). The duration at which first postoperative analgesia was required in the dexmedetomidine group, fentanyl group, and ropivacaine group were 8.57±0.50 h, 6.57±0.50 h, and 5.30±0.47 h, respectively Table 4.

DISCUSSION

The study aimed to compare dexmedetomidine and fentanyl along with ropivacaine in peripheral nerve stimulator-guided supraclavicular blocks in patients undergoing upper limb surgeries and by studying the effects of the addition of dexmedetomidine, fentanyl we can have a possibility of newer options to ropivacaine. The significant findings of the study were the onset of sensory and MB was significantly less in the dexmedetomidine group compared to the fentanyl group, and ropivacaine group patients (P=0.0000). Duration of sensory and MB was significantly high in the dexmedetomidine group than fentanyl group and ropivacaine group patients (P=0.0000). Furthermore, the duration at which first postoperative analgesia required was significantly more in the dexmedetomidine group than in the fentanyl group, and ropivacaine group patients (P=0.0000). These findings suggested that dexmedetomidine combined with ropivacaine has better efficacy in peripheral nerve stimulator guided supraclavicular blocks.

There was no significant difference in age among the groups (P>0.05). Various other studies like Sahi et al.,[4] and Dharmarao et al.,[5] have reported similar findings. Bradycardia and hypotension was noted in n=3 patients of dexmedetomidine group. Whereas, in fentanyl and ropivacaine group subjects no incidence of intraoperative bradycardia and hypotension was observed. In a study conducted by Hamed et al., the incidence of bradycardia and hypotension was reported in n=2 patients.[6] Whereas, Dai et al. suggested no incidence of bradycardia and hypotension.[7] The difference in the results may be due to type and duration of the study. The mean sedation score in fentanyl group patients (3.83±0.37) significantly more compared to ropivacaine (2.33±0.47) and dexmedetomidine (3.4±0.49) (P=0.0000). Moreover, dexmedetomidine group patients predominantly had grade 3 sedation score. These findings are comparable with the study by Swaro et al.[8]

The patients administered with dexmedetomidine adjunctive to the ropivacaine showed significantly rapid onset of sensory and MB compared to the fentanyl adjunctive and ropivacaine alone (P<0.0000). These findings are comparable with Sahi et al.,[9] Moreover, Sudani et al., and Khemka et al., also showed significant rapid onset of sensory and MB in the ropivacaine with dexmedetomidine group compared to ropivacaine alone group subjects.[10-12] However, Dharmarao et al., suggested an insignificant difference in the onset of sensory and MB in the dexmedetomidine and fentanyl group. The rapid onset of sensory and MB in the ropivacaine along with dexmedetomidine group may be due to its selective effect on sensory and motor nerves. These findings suggested that dexmedetomidine addition to ropivacaine improves the onset of sensory and MB.

We found that the duration of sensory and MB was significantly more in patients administered with Ropivacaine adjunctive with dexmedetomidine (7.57±0.50 h and 6.57±0.50 h) compared with fentanyl adjuvant (5.47±0.51 h and 4.47±0.51 h) and ropivacaine alone (3.43±0.50 h and 2.50±0.51 h) (P=0.0000). Similarly, These findings are comparable with Sahi et al.,[7] Rancourt et al., performed a prospective, randomized, controlled, double-blind, crossover trial in 14 healthy volunteers to study the effect of ropivacaine alone and in combination with dexmedetomidine. They reported a prolonged duration

of SB in patients treated with combination drugs.[8] Similarly, Chinnappa et al., showed increased duration of sensory and MB in patients who received ropivacaine and dexmedetomidine compared to those treated with ropivacaine alone.[12] Furthermore, Dharmarao et al., depicted a better duration of sensory and MB in dexmedetomidine with the ropivacaine group than fentanyl with the ropivacaine group.[13] These findings suggest that dexmedetomidine adjunctive to ropivacaine has a prolonged duration of sensory and MB.

In this study, we found that the duration of sensory and MB was significantly more in patients administered with Ropivacaine adjunctive with dexmedetomidine (7.57±0.50 h and 6.57±0.50 h) compared with fentanyl adjuvant (5.47±0.51 h and 4.47±0.51 h) and ropivacaine alone (3.43±0.50 h and 2.50±0.51 h) (P=0.0000). Similarly, These findings are comparable with Sahi et al.,[7] Rancourt et al., performed a prospective, randomized, controlled, double-blind, crossover trial in 14 healthy volunteers to study the effect of ropivacaine alone and in combination with dexmedetomidine. They reported a prolonged duration of SB in patients treated with combination drugs.[8] Similarly, Chinnappa et al., showed increased duration of sensory and MB in patients who received ropivacaine and dexmedetomidine compared to those treated with ropivacaine alone.[12] Furthermore, Rao et al., depicted a better duration of sensory and MB in dexmedetomidine with the ropivacaine group than fentanyl with the ropivacaine group.[13] These findings suggest that dexmedetomidine adjunctive to ropivacaine has a prolonged duration of sensory and MB.

In this study, the duration of postoperative analgesia was significantly more in patients administered with ropivacaine combined with dexmedetomidine compared to fentanyl adjuvant to ropivacaine and ropivacaine alone groups. These findings suggest that dexmedetomidine adjunctive to ropivacaine has prolonged duration of postoperative analgesia.

The strength of the study was the adequate sample size and uniform application of the protocol. Moreover, we claim less bias in the study due to the study type.

Limitations of the study

An important limitation of the study was the volume of local anaesthetic used. The volume used in our study was quite high though there were no side effects of such doses noted. The block could have been done with low volume. The use of ultrasound could have helped identify the plexus with a higher degree of accuracy and could have resulted in the use of a lower volume of drugs which was unlike what happened in our study. In this study, hemodynamic parameters were evaluated. Further, a multicentre study with a sufficient sample size assessing different dosages of drugs, including all variables, is the recommendation of the study.

CONCLUSION

The study aimed to compare dexmedetomidine and fentanyl along with ropivacaine in peripheral nerve stimulator guided supraclavicular blocks in patients undergoing upper limb surgeries. The onset of sensory and MB was significantly rapid in ropivacaine with dexmedetomidine group subjects. Ropivacaine with dexmedetomidine group subjects had longer duration of sensory and MB was significantly higher. Duration of postoperative analgesia was significantly more in Ropivacaine with dexmedetomidine group subjects. Dexmedetomidine and fentanyl increase readiness for surgery. However, dexmedetomidine is better as an adjuvant to ropivacaine for brachial plexus block.

ACKNOWLEDGMENT

We acknowledge department of orthopedics and all staff members of operation room for helping us conduct this study.

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ZSA- Prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, statistical analysis and interpretation; **SSK**- Concept, design of study, editing and manuscript revision; **PMK**- Concept, design, implementation of study protocol, definition of intellectual content, literature survey, manuscript preparation and submission of article; **HVK** - Review of manuscript and proof reading; **PKB** - Data collection and data analysis; **URS** - Manuscript preparation.

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Source of Funding: None, **Conflicts of Interest:** None.