Original Research Article

Comparative study of Fentanyl versus Dexmedetomidine with 0.75 percent Ropivacaine in Supraclavicular Block for Upper Limb Surgery

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Abstract

Aim: Comparing the potency of fentanyl and dexmedetomidine as adjuvants in the supraclavicular block to 0.75 percent ropivacaine. **Materials and Methods**: 90 Patients listed for orthopaedic upper limb surgery under ultrasound guided Supraclavicular brachial plexus block were randomly divided into three categories. Group R received 23ml of 0.75% Ropivacaine and 2ml Normal Saline, Group RF was given 0.75% Ropivacaine(23 mL) with 1mcg/kg of Fentanyl and Group RD received 0. 75% Ropivacaine (23 mL) with 1mcg/kg of Dexmedetomidine. Block characteristics in all three groups were observed.**Results**: For all three groups demographic profile and hemodynamic parameters was equivalent. The mean time of onset and completion of the sensory and motor block was significantly less in the groups RD and RF relative to the group R and even in the RD group compared with the RF group. The overall sensory block and motor block duration was significantly greater in the groups RD and RF relative to the group R and even in the RD relative to the RF group. The mean time for first rescue analgesia in RD and RF was significantly higher than in R group and even higher in RD compared to RF group. Rescue analgesic requirement in the first 12 hours was more in control group compared to RD and RF group. There were no grievous side- effects seen in any group. **Conclusion:** Ropivacaine with dexmedetomidine produced a more prolonged duration of motor and sensory block and postoperative analgesia as compared to ropivacaine with fentanyl or ropivacaine alone.

Keywords: fentanyl, dexmedetomidine, ropivacaine, supraclavicular block.

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Introduction

Supraclavicular block has gained popularity because of the advancements in techniques of regional anesthesia in terms of local anesthetic drugs, newer adjuvant drugs and use of ultrasound for safe and successful conduct of block. It helps in reducing hospital stay, less financial burden and also leads to avoidance of undesirable side effects of general anesthesia [1]. Ropivacaine, a relatively newer local anesthetic agent, is less cardiotoxic and neurotoxic and has a wider margin of safety when compared with bupivacaine. It produces differential neural blockade with less motor block, hence better tolerated for postoperative analgesia [2] .Various studies have been done using additives such as opioids, dexamethasone, clonidine, midazolam, neostigmine, etc with local anesthetics in brachial plexus block in order to improve the quality of block, like early onset with dense and prolonged block[3,4,5,6] . Opioids such as fentanyl as an adjuvant have been shown to improve block quality and duration [7]. Dexmedetomidine, an α2-adrenoreceptor agonist having anxiolytic, sedative and analgesic characteristics. Various studies have shown that block duration and postoperative analgesia are prolonged when used with local anaesthetics in regional blocks [1].The search for the ideal additive, which causes early onset, prolonged duration of block but with lesser adverse effects has led to many studies. There is limited literature on studies comparing fentanyl and dexmedetomidine with 0. 75% ropivacaine in supraclavicular block performed under ultrasound guidance. We therefore conducted a study to compare fentanyl and dexmedetomidine as adjuvants with 0.75 percent ropivacaine, using less volume, i. e. 25ml.

Material and Methods

A double blind randomized, control, prospective study was performed on 90 ASA I and II patients aged 18-60 years, posted for upper limb orthopaedic surgery under supraclavicular block. Obtained approval from the Institutional Ethical Committee, 90 patients were divided randomly into three groups: R, RF and RD, each consisting of 30 patients. Group R was given 23ml of 0.75% Ropivacaine and 2ml Normal Saline, Group RF was given 23ml of 0.75% Ropivacaine with 1mcg/kg of Fentanyl and Group RD given 23ml of 0.75% Ropivacaine with 1mcg/kg of Dexmedetomidine . Total volume administered was made to 25 ml by adding normal saline in all the three groups . Patients are selected as per inclusion and exclusion criteria. Inclusion Criteria constitute age group- 18 to 60 years, Weight- 50-80 kg, Sex- Male or female, ASA grade I and II. Exclusion Criteria in study are Patient refusal, Patient with history of drug sensitivity to amidegroup of local anesthetics, Pregnant and breast-feeding females, Patients on adrenoreceptor agonist or antagonist therapy, Patients with bleeding disorders .

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Sample size was calculated using the formula: n=(Z α+Z β)2 (σ12 + σ2 2)/d2 , where σ1= 48, σ2= 59, d = 48, , α = Type I error (5%)β = Type II error (20%), Power of the study = 80%, Data loss = 10% . Sample size came out to be n = 28 each group, so we decided to take 30 patients in each group. Written informed consent was received from all patients for the supraclavicular brachial plexus block, after explaining the procedure .All the patients entering the study were subjected to a detailed preanesthetic evaluation to rule out presence of any significant comorbidity. Preoperative assessment included detailed history, general physical examination, systemic examination, airway assessment and routine investigations, such as hemoglobin, total and differential white blood cell count, platelet count, clotting time, bleeding time, prothrombin time, INR, blood glucose, serum creatinine, blood urea and viral markers. Chest X-ray and Electrocardiography were also performed. Patients were given tablet Alprazolam 0.5mg and tablet Ranitidine 150mg night prior to the surgery and on the morning of surgery and were advised minimum 8 hrs. of fasting. Patients were randomized into three groups via a computer-generated number system. Using the same procedure, one anesthesiologist performed supraclavicular block in all three classes under ultrasound guidance. The person who prepared the drug solutions was different from the person who administered the block and the person who monitored the duration and quality of block and also hemodynamics .The patients were put in supine posture, with head turned to the contralateral side. The arm to be anesthetized adducted and the hand extended along the side towards the ipsilateral knee as far as possible. After disinfecting the skin, neural localization was achieved by ultrasound guidance using Micromax Sonosite (USA) machine with Micromax ® L38e/10-5 MHz transducer which approximately its midpoint was positioned in a transverse plane immediately superior to the clavicle. The transducer was caudally rotated to provide a cross-sectional view of subclavianartery. The brachial plexus visualized as lateral and marginal series of hypoechoic circular structures close to the artery. Using a 25 gauge needle, 1 to 2ml of local aesthetic was injected into the skin, 1 cm lateral to the transducer to minimize pain during the insertion of a needle. Then the block needle was inserted in plane towards the brachial plexus, in a lateral to medial direction till it hit the plexus. After aspiration, the drug was injected into two or three aliquots at various positions within the plexus sheath to ensure the distribution of the local anesthetic solution in brachial plexus planes .Completion of injection was taken as time 0- (T0). Following injection, area was massaged to help the solution to track along the plexus. The patients were vigilantly monitored during block procedure and afterwards for any complications (like arterial puncture, Horner's syndrome, respiratory distress for pneumothorax, etc.) and for the toxicity of the injected drugs (like hypotension, bradycardia, nausea, vomiting, itching, etc.).The patients were monitored for HR (heart rate), NIBP(noninvasive measurements blood pressure) i e , DBP (diastolic blood pressure), SBP(systolic blood pressure), and MAP(mean arterial blood pressure) at an interval of 5 minutes for first half an hour and thereafter every 15 minutes for next 30 minutes and then every 30 minutes for the next 5 hours and hourly thereafter till 12 hours. Electrocardiogram (ECG) and hemoglobin oxygen saturation (SPO2) was constantly tracked, intraoperativelyand for 2 hours in the post-operative period .

The sensory and motor block assessment was carried out every 1 minute after giving block to full sensory and motor block or 30 minutes, whichever earlier. Pin-prick procedure was used to test sensory block **. Score 0**- sharp pain, **Score 1**-only sensation of touch, **Score 2**-no sensation.

The time of onset of the sensory block is taken as the time of completion of injection (T0) to sensory block recognition (Score 1) for the distribution of any of the main nerves (musculocutaneous, radial, ulnar, and median). The time it took from T0 to attain a Score 2 in the distribution of all the main nerves is taken as time to complete sensory block .The total duration of the sensory block was from the complete block to the score<= 1.

The motor block was tested with the Modified Bromage Scale. **Score 1:** Partial block: able to do flexion of forearm completely and arm flexion partially; **Score 2:** Almost complete block: not able to flex the arm and decreased ability to flex the forearm; **Score 3:** Total block; unable to flex both arm and forearm.

The motor block onset time was taken from the administering of the test drug to detect a score of ≥ 1. The time from completing injection toa score of 3 in motor block scale was defined as the time needed to complete the motor block. The overall duration of the motor block was the interval between full motor block and its regression to score 1.

The block was considered to have failed if anaesthesia was not observed in any of the main nerve distributions 30 minutes later to injection of the drug into the sheath, and these patients were then taken out of analysis .

Hypotension was defined as fall in mean arterial pressure (MAP) of >20% of baseline value and treated with intravenous fluid bolus of 100 ml and if still persists, injection mephentermine 6mg intravenous bolus was administered.Bradycardia was taken as pulse rate of ≤ 50/minute and managed with intravenous injection atropine 0.6mg stat.

After-surgery, in recovery room patients were assessed for pain, to rate their pain on 0-10 numeric pain rating scale. Pain was assessed regularly every 30 min for first 3 hours and then hourly for the next 12 hours.

When numeric pain rating score is ≥4, Injection Diclofenac Sodium aqueous 75mg intravenous was given. The time between the end of local anesthetic administration and first rescue analgesic administration was recorded as the duration of analgesia.

0-10 numeric pain rating Scale for pain

0-10 numeric pain rating scale (0, no pain and 10, worst pain imaginable)

Statistical Analysis

The quantitative statistics were represented as their mean ± SD. Categorical and nominal data in percentage .The ANOVA test was used to analyse quantitative data, or Kruskal Wallis test evaluated non-parametric data and analysed categorical data using chi-square test. The p-value significance limit was set at < 0.05. All the analyses were performed using version 21 of SPSS program.

Results

Table 1: Comparison of Demographic variables in study

	Group	N	Mean	SD	p- value
Age	R	30	34.03	12.12	0.186
	RF	30	39.30	12.91	
	RD	30	35.27	9.18	
Weight	R	30	64.60	7.25	0.319
	RF	30	66.50	6.44	
	RD	30	67.07	5.98	
Height	R	30	167.77	4.13	0.47
	RF	30	167.03	3.62	

	RD	30	166.57	3.61	

Table 2: Mean time of onset, time to complete sensory block and total duration of sensory block

Sensory Block	Group	N	Mean	SD	p- value
Time of Onset (mins)	R	30	6.17	0.79	<0.01 (all groups)
	RF	30	4.67	0.55	
	RD	30	3.63	0.56	
Time to complete sensory block (mins)	R	30	25.60	0.77	<0.01 (all groups)
	RF	30	22.70	0.79	
	RD	30	19.60	1.22	
Total Duration (mins)	R	30	308.87	20.17	<0.01 (all groups)
	RF	30	426.60	17.40	
	RD	30	520.43	16.31	

Table 3: Mean time of onset, time to complete motor block and total duration of motor block

Motor Block	Group	N	Mean	SD	p- value
Time of Onset (mins)	R	30	8.03	0.81	<0.01 (all groups)
	RF	30	6.43	0.73	
	RD	30	5.23	0.77	
Time to complete motor block (mins)	R	30	29.63	1.94	<0.01 (all groups)
	RF	30	25.77	1.01	
	RD	30	23.03	4.12	
Total Duration (mins)	R	30	295.53	16.56	<0.01 (all groups)
	RF	30	412.00	17.15	
	RD	30	503.37	16.87	

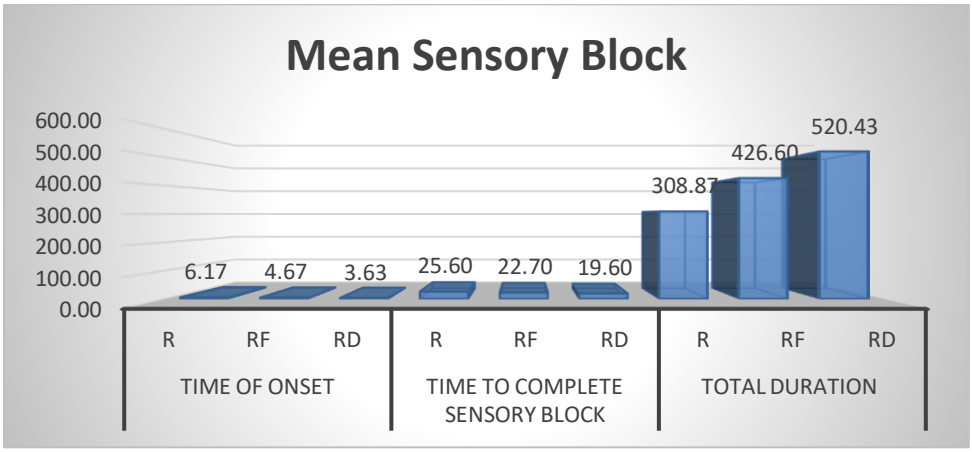

Fig. 1: Comparision of sensory block in 3 groups

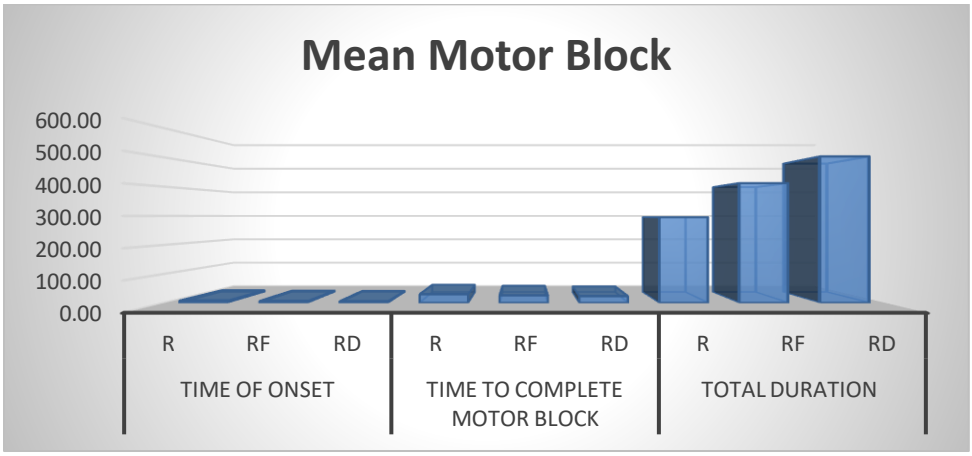

Fig. 2: Comparision of motor block in 3 groups

Table 4: Mean time for first rescue, duration and number of rescue analgesia in 12 hours

Analgesia	Group	N	Mean	SD	p- value

Time for first rescue Analgesia (mins)	R	30	335.50	23.70	<0.01 (all groups)
	RF	30	451.43	23.50	
	RD	30	552.93	28.69	
Number of Rescue Analgesia in 12 hours	R	30	1.33	0.48	<0.01 (R vs RF; R vs RD)
	RF	30	1.00	0.00	
	RD	30	1.00	0.00	

All three groups were comparable with mean age, gender, weight and height (p>0.05); mean heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure in all study groups were comparable at baseline, intraoperatively and up to 12 hours (p>0.05). For dexmedetomidine and fentanyl groups the mean time of onset and completion of the sensory and motor block was significantly lower compared to the control group; (p<0.01) . The mean time of onset and completion of the sensory and motor block was shown to be lower in the dexmedetomidine group relative to the fentanyl group by comparing the adjuvant groups; (p<0.01). The mean of total sensory and motor block duration was significantly greater for dexmedetomidine and fentanyl groups compared with control group; (p<0.01). The duration of the sensory and motor block in the dexmedetomidine group compared with the fentanyl group was significantly prolonged between the adjuvant groups; (p<0.01). As shown in Tables 2 and 3, figure 1 and 2.

Mean time for first rescue analgesia i.e., duration of analgesia was significantly greater in dexmedetomidine and fentanyl groups compared with control group; p<0.01. Analgesia duration prolongation was shown to be significantly greater in the dexmedetomidine group as compared to the fentanyl group; (p<0.01). Rescue Analgesia demand in 12 hours was higher in control group than dexmedetomidine and fentanyl group (p<0.01), as seen in table 4 .Pulse oximetry was constantly tracked intraoperatively and in all cases, oxygen saturation was maintained between 95-100 percent. None of the cases reported desaturationin any of the groups . In our study, bradycardia was observed in a single case (3.3%) of dexmedetomidine group, while nausea / vomiting was observed in 4 (13.3%) cases of fentanyl group, and in 1 (3.3%) case of dexmedetomidine and control group each. There were 2 arterial puncture events (2.2%),out of which 1 (3.3%) in dexmedetomidine group and 1 (3.3%) in control group. No significant variation was observed between study groups on the adverse reaction profile (p-0.246).

Discussion

In our study , the mean time of onset and completion of sensory block in dexmedetomidine group (3.63±0.56 mins and 19.6±1.22mins) and fentanyl group (4.67±0.55mins and 22.7±0.79mins) was significantly lower than in the control group (6.17±0.79mins and 25.6±0.77mins); (p<0.01). Time of onset and completion of motor blockade in Dexmedetomidine group (5.23±0.77mins and 23.03±4.12 mins) and fentanyl group (6.43±0.73mins and 25.77±1.01mins) were significantly less as compared to control group (8.03±0.81mins and29.63±1.94 mins); (p<0.01). Earlier initiation and completion of the sensory and motor block was observed in the dexmedetomidine group than fentanyl group, on comparing the adjuvants, and this discrepancy was statistically significant (p<0.01).

In their analysis of the supraclavicular block conducted using landmark technique on 120 patients, Sahi P et al [8] found that the mean time of the onset of the sensory and motor block was lower in the fentanyl and dexmedetomidine groups compared to the plain ropivacaine group; (p<0.05). They found that the time taken in fentanyl and dexmedetomidine for the onset and completion of the sensory and motor block was less than the plain ropivacaine category and was statistically relevant (p<0.05); these results are consistent with our study. In a related analysis by Soma et al [9], 90 patients underwent surgical procedures under a nerve stimulator guided supraclavicular block, they found early onset and completion of sensory and motor blockade relative to control group in dexmedetomidine and fentanyl groups and the discrepancy was statistically significant; (p<0.05).

The patients who received fentanyl as adjuvant to ropivacaine had faster onset and sensory block completion, which can be explained by the peripheral effects of opioids. Fentanyl is soluble in lipid, can have a perineural effect, and it is also documented to have a local anesthetic activity that has possibly contributed to the early onset and complete block induction [9].

Similarly, a quicker establishment of the sensory blockade in patients with dexmedetomidine as a ropivacaine adjuvant may be related to the proposed theory, which involves vasoconstriction around the injection site, direct suppression of neuronal impulse transmission due to complex interaction with axonal ion channels or receptors, localised release of enkephalin like substances, a decrease in localized proinflammatory mediators and an increase in anti-inflammatory cytokines through an α2adrenoceptor mediated mechanism . Although the precise dexmedetomidine mechanism of action has not been thoroughly elucidated[10] .The disparity between the mechanisms of action of dexmedetomidine and fentanyl may be related to the variations observed between the time of onset and the duration of the sensory block completion between these two categories.

Kathuria S et al [1] observed acceleration in the onset of sensory block with 50mcg of dexmedetomidine added to 0.5 percent of ropivacaine relative to only ropivacaine in supraclavicular block, as observed in our study.

Contrary results were reported in the study by Farooq et al [11], they concluded that mean duration of sensory and motor block was more prolonged in fentanyl than dexmedetomidine group; the discrepancy was statistically significant; (p<0.001). The mean sensory block duration was considerably higher in the present study in dexmedetomidine group (520. 43±16.31mins) and fentanyl group(426.6±17.40mins) relative to ropivacaine alone (308.87±20.17mins); (p<0.01). In dexmedetomidine, fentanyl and control group, the cumulative duration of the motor block was 503.37±16.87mins, 412.0±17 15mins, and 295.53±16.56mins, respectively. The findings were statistically significant when adjuvant groups were compared with control group; (p<0.01). Comparing the adjuvant group, significantly prolonged sensory and motor block duration was found in the dexmedetomidine group as compared to the fentanyl group; (p<0.01).

In their analysis, Sahi P et al [8] found that in the dexmedetomidine group, the total duration of the sensory and motor block was significantly longer than in the group receiving fentanyl (p<0.05) and extremely significant relative to the ropivacaine group (P<0.001). Those results are in accordance with our study. Soma et al [9] found that mean sensory and motor block length in dexmedetomidine and fentanyl groups was significantly prolonged as compared to plain ropivacaine; (p<0.001).This is close to our research results. Ropivacaine, which is less lipophilic than bupivacaine, has selective effect on pain transmitting Aδ and C nerve fibers rather than Aβ fibers (large myelinatedfibers) involved in motor functions, which may explain the slower onset and the quicker recovery of motor functions compared to sensory functions, as seen in the present study[8].

The mean time of dexmedetomidine (552.93±28.69mins) and fentanyl groups (451.43±23.50mins) relative to the control group

(335.50±23.70mins) for first rescue analgesia, i.e., the duration of analgesia is statistically significant; (p<0.01). Analgesia duration prolongation was shown to be significantly greater in the dexmedetomidine group than the fentanyl group; (p<0.01). Rescue analgesia demand was higher in the control group than dexmedetomidine and fentanyl group (p<0.01) in 12 hours. All three classes had an average NRS Score below 4 at all assessed intervals except when rescue analgesia was given. The presence of exogenous and endogenous opioid receptorsin the peripheral nervous system and the regulation of anti- nociceptive activity by modulation of these receptors give the possibility of prolonged analgesia in fentanyl group. Another potential cause is its activity in the substantiagelatinosa after perineural injection due to centripetal axonal transport[12]. The activity of dexmedetomidine in the locus coerulus and dorsal horn of the spinal cord on the α2 receptors decreases central sympatholytic output, leading to increased firing of inhibitory neurons and thus to an analgesic effect. Peripheral activity of the α2 receptors can also lead to antinociception. The inhibitory activity is caused by hyperpolarization of the cell membrane and diminished firing of excitable CNS cells. Reducing calcium conductivity in cells, decrease neurotransmitters release. The nerve is blocked from firing and therefore stops adjacent impulses from expanding, providing analgesia in two different manner [10,13, 14].

In the Sahi P et al study[8], the mean analgesic duration in the dexmedetomidine group was highest, followed by the fentanyl group and least in the plain ropivacaine group; (p<0.001), as seen in our analysis. Studies performed by Farooq et al [11] revealed that patients receiving fentanyl as an adjuvant received rescue analgesia later than patients receiving dexmedetomidine and this disparity was considered to be statistically significant (p<0.001), in contrast to our study. However, several research comparing dexmedetomidine and fentanyl as adjuvants in other neuraxial blocks have found dexmedetomidine in terms of onset, duration of blockage and analgesic effect better than fentanyl[15-18] .

No significant difference in adverse reaction profile between test groups was observed in our study (p-0.246). In their research, Sahi P et al [8] found itching in 2 fentanyl group patients, hypotension in 1 fentanyl group patient (2.5 per cent), and bradycardia in 2 dexmedetomidine group patients (5 percent). Such side effects were of no statistically important significance. Soma C et al [9] found bradycardia in 2 patients receiving dexmedetomidine and hypotension was observed in 1 patient receiving fentanyl, Itching had been observed in 2 patientsof fentanyl group. These findings were not found to be statistically significant.

Conclusion

Both dexmedetomidine and fentanyl improve surgical readiness. Both adjuvants were safe to use, and had hemodynamic effects similar to use of ropivacaine alone. Dexmedetomidine provided a prolonged duration of motor and sensory block and postoperative analgesia as compared to fentanyl with ropivacaine or plain ropivacaine. Hence, when used as adjuvant to ropivacaine for brachial plexus block, dexmedetomidine appears to have an upper hand over fentanyl .

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