

To compare the efficacy of fentanyl versus dexmedetomidine as adjuvant to 0.5% bupivacaine in ultrasound guided supraclavicular brachial plexus block in upper limb surgeries

Syed Abid Ali¹, Gandhay Madhavi², Kota Raju³, Rontala Saraiah^{4*}

¹Assistant Professor, Department of Anaesthesiology, Gandhi Medical College/Hospital Secunderabad, Telangana, India

²Assistant Professor, Department of Anaesthesiology, Gandhi Medical College/Hospital Secunderabad, Telangana, India

³Assistant Professor, Department of Anaesthesiology, Gandhi Medical College/Hospital Secunderabad, Telangana, India

⁴Assistant Professor, Department of Anaesthesiology, Gandhi Medical College/Hospital Secunderabad, Telangana, India

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Abstract

Aims: The study was undertaken to compare between Dexmedetomidine and Fentanyl as adjuvants to 0.5% Bupivacaine hydrochloride in Ultrasound guided Supraclavicular Brachial Plexus block. **Materials and methods:** This clinical study was conducted in 60 patients of both sex, of age group 18-50 years admitted to Gandhi Hospital for upper limb surgeries from 2016-2017. They were randomly divided into two groups of 30 patients each –Group F (Fentanyl) – was given conventional supraclavicular brachial plexus block with 30 ml of 0.5% Bupivacaine and 1 µg/kg of Fentanyl. Group D (Dexmedetomidine) – was given conventional supraclavicular brachial plexus block with 30ml of 0.5% Bupivacaine and 1 µg/kg of Dexmedetomidine. **Results:** The average age was 33.13 ± 9.179 years in group F, and 31.4 ± 8.295 years in group D. The average weights of the patients were 67.66 ± 8.38 kgs in group F and 69 ± 9.505 kgs in group D respectively. There was no significant difference in age and weight between the two groups. The mean time of onset of sensory blockade in group F was 6.83 ± 1.72min. In group D it was 7.03 ± 1.43 min. The slight delayed onset of sensory blockade in group D is however not statistically significant (p value >0.05). The mean time of onset of motor blockade was 11.13 ± 2.25 in group F when compared to 11.23 ± 2.23 in group D. This was not clinically or statistically significant (p value >0.05). The mean time for duration of analgesia was 357 ± 37.62 min in group F whereas in group D the mean was 489.66 ± 59.91 min. This was statistically significant with a p value of <0.0001. **Conclusion:** Dexmedetomidine (1 µg/kg) seems to be an attractive alternative to Fentanyl (1 µg/kg) as an adjuvant to bupivacaine in supraclavicular brachial plexus block. It provides good quality of intraoperative analgesia, hemodynamically stable conditions, minimal side effects, and excellent quality of postoperative analgesia.

Keywords: Ddexmedetomidine, Fentanyl, Bupivacaine

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Introduction

Pain is an unpleasant sensation associated with significant psychological and physiological changes during surgery and post-operative period. This can be overcome by the use of suitable drugs and techniques. Regional anaesthetic techniques have specific advantages both for anaesthesia and as analgesic supplements for intraoperative and postoperative care. Today regional anaesthesia is well established as equal to general anaesthesia in effectiveness & patient acceptability. Regional anaesthesia is the blocking of peripheral nerve conduction in a reversible way by using local anaesthetic agents, thereby one region of the body is made insensitive to pain and is devoid of reflex response to surgical stimuli.

In this the CNS is spared, so that the patient is conscious, fully awake during the surgical procedure without recognizing pain. Brachial plexus blockade is a time tested technique for providing anaesthesia and post-operative analgesia for upper limb surgeries. Among the various approaches of brachial plexus block, supraclavicular approach is considered safest and most effective[1].

The first brachial plexus block was performed by Halsted applied a solution of cocaine directly to surgically exposed plexus. In the first decade of this century, Kulenkampf and Hirschel blocked the brachial plexus percutaneously through a supraclavicular approach[1]. For the classical supraclavicular approach to the brachial plexus the local anaesthetic is deposited around the plexus where it crosses the first rib after eliciting paraesthesia. The use of ultrasound for nerve blocks is performed in supraclavicular brachial plexus block with the help of a Doppler US blood-flow detector to aid identification of subclavian artery and vein. Published reports of ultrasound guided regional anaesthesia have largely focused on brachial plexus blockade in the interscalene, supraclavicular, infraclavicular and axillary regions[2]. Bupivacaine is commonly used local anaesthetic for brachial plexus block and many other regional anaesthesia techniques. It is an amide linked local anaesthetic agent with long duration of action. Accidental IV injection of bupivacaine may result in precipitous hypotension, cardiac dysrhythmias and atrioventricular heart block.

*Correspondence

Dr. Rontala Saraiah

Assistant Professor, Department of Anaesthesiology, Gandhi Medical College/Hospital Secunderabad, Telangana, India

E-mail: saraiah30110@gmail.com

This can be overcome with the use of incremental aspiration technique before injecting the solution. Duration of peripheral nerve block anaesthesia depends on the dose of local anaesthetic, its lipid solubility, its degree of protein binding and use of vasoconstrictors like epinephrine. To prolong the duration of analgesia various drugs have been studied as adjuvant to local anaesthetic solution and techniques like the continuous catheter placement in the plexus have evolved. These adjuvant drugs ideally are expected to prolong the analgesic effect without causing any systemic side effects. Novel adjuncts studied to date include opioids, clonidine, neostigmine, and tramadol.

Dexmedetomidine is a potent alpha 2 adrenergic agonist that is short acting than clonidine and much more selective for alpha 2 vs alpha 1 receptors (dexmedetomidine = 1620:1; clonidine = 220:1). It causes dose dependent analgesia and sedation. Fentanyl is a phenylpiperidine derivative synthetic opioid agonist that is structurally related to meperidine. As an analgesic it is 75 to 125 times more potent than morphine. Hence the study is attempted to evaluate the efficacy of adding Dexmedetomidine (1 µg/kg) to 0.5% Bupivacaine Hydrochloride when compared to adding Fentanyl (1 µg/kg) to 0.5% Bupivacaine Hydrochloride in Ultrasound guided Supraclavicular brachial plexus block.

Materials and methods

The study was conducted in Gandhi Hospital, Secunderabad after obtaining approval from institutional ethical committee. A written informed consent was obtained from each patient. Sixty patients aged between 18 years and 50 years undergoing upper limb surgeries were included in the study.

The patients were randomly divided into two groups of 30 patients each – Group F (Fentanyl) – was given conventional supraclavicular brachial plexus block with 30 ml of 0.5% Bupivacaine and 1 µg/kg of Fentanyl.

Group D (Dexmedetomidine) – was given conventional supraclavicular brachial plexus block with 30ml of 0.5% Bupivacaine and 1 µg/kg of Dexmedetomidine.

Inclusion Criteria

Patients of age between 18 and 50 years of both sexes, American Society of Anaesthesiologists grade 1 and 2 physical status posted for various Upper limb elective surgeries.

Exclusion Criteria

Patients with history of hypersensitivity to local anaesthetics, Significant bleeding or coagulation abnormalities, with mental impairment, peripheral neuropathy, with significant pre-existing systemic diseases, Vulnerable patients (i.e. children, pregnant women, cognitively impaired). Patients with known allergy to Dexmedetomidine, Fentanyl and Bupivacaine, with failed Supraclavicular brachial plexus block.

All the patients underwent thorough pre-anaesthetic evaluation one day prior to surgery. All systems were examined including airway and the surface anatomy where the block was given. The procedure to be carried out was explained. They were informed about development of paraesthesia. Patients were reassured to alleviate their anxieties. All the patients were kept nil per oral as per the fasting guidelines. All of them received Tab. Diazepam 10 mg and Tab. Ranitidine 150 mg night before the surgery. A written informed consent was taken.

Blood investigations: Hb%, BT, CT, Blood Urea, Serum creatinine, Serum electrolytes, Fasting blood sugar, Blood grouping and cross matching.

Urine: Albumin, sugar and microscopy, ECG and Chest x-ray PA view.

Written informed consent obtained. Intravenous access – starting of an intravenous line with 18G intravenous cannula on the contra lateral

upper limb under aseptic techniques. Pre-medication – Injection midazolam 1 mg was given intravenously before the procedure.

Drug combination given under Ultrasound guidance was –

In group F – 20 ml of 0.5% Bupivacaine + 10 ml of normal saline + 1 µg/kg of Clonidine.

In group D – 20 ml of 0.5% Bupivacaine + 10 ml of normal saline + 1 µg/kg of Dexmedetomidine.

The onset of sensory blockade and motor blockade were noted. Intra-operatively, haemodynamic were monitored at regular intervals. Following completion of surgery, the patients were monitored to assess the quality and duration of post-operative analgesia. Thus, the patients were asked to classify analgesia as no pain, mild pain, moderate pain or severe pain every hour for the first 6 hours and then again at 8 & 10hrs. At the time of each subsequent assessment, patients were observed and/or questioned about any subjective and/or objective side effects (sedation, nausea, vomiting or respiratory depression, neurological injury).

The various parameters were noted:

- - Onset of sensory blockade.
- - Onset of motor blockade.
- - Duration of analgesia.
- - Changes in intra-operative haemodynamic
- - Incidence of complications.

Failure of block

It is defined as inadequate or patchy analgesia even after 30 mins of the drug administration. Depending on the effectiveness of the block the patient was administered sedative & analgesic in the form of IV midazolam & Injection Fentanyl. In case of complete failure general anaesthesia was administered and the case was excluded from the study.

Grading of sensory blockade

I = No difference, II = Some difference but pin prick still sensed in blocked arm III = No prick sensation in blocked arm

Grading of motor blockade (Bromage 3 point score)

0 = normal motor function with full flexion and extension of elbow, wrist and fingers, 1 = decrease motor strength with ability to move fingers and/or wrist only 2 = complete motor blockade with inability to move fingers

Following nerves were tested for motor block – • Musculocutaneous nerve-by flexion of arm, Radial nerve by extending the flexed arm & wrist, Median nerve by asking the patient to flex the wrist and also opposing the thumb to 2nd & 3rd fingers,

Ulnar nerve by flexing 4th & 5th fingers. Baseline hemodynamic parameters were recorded, then after giving the block parameters were recorded every 5 mins for first 30 mins, then every 10 minutes till the end of surgery.

Statistical Analysis

Results were statistically analysed using Unpaired t test and Fisher exact test. A 'p' value of <0.05 was considered as significant. All the values are mentioned as Mean ± Standard Deviation.

Results

The prospective, randomized, comparative study was conducted in the Department of Anaesthesiology & Critical Care Gandhi Hospital, Secunderabad on 60 patients aged between 18-50 years posted for upper limb surgeries. The purpose of study was to compare between Fentanyl and Dexmedetomidine when used as adjuvant to 0.5% Bupivacaine in supraclavicular brachial plexus block in terms of onset of sensory & motor blockade, duration of analgesia, intraoperative hemodynamic changes and complications / adverse effects.

Table 1 – Comparison of age and weight distribution between the two groups

Variables		Group F	Group D	P Value
Age (years)	Mean	33.13	31.40	0.4468
	SD	9.179	8.295	
Weight (in kgs)	Mean	67.667	69	0.5675
	SD	8.380	9.505	
Male	Number of cases	21	25	0.3604
Female		9	5	

The average age was 33.13 ± 9.179 years in group F, and 31.4 ± 8.295 years in group D. Youngest patient in the study group was 19 years and oldest was 50 years. The average weights of the patients were 67.66 ± 8.38 kgs in group F and 69 ± 9.505 kgs in group D respectively. There was no significant difference in age and weight between the two groups. Both groups had predominantly male population, accounting for nearly 3/4 of the total study population in each group. There were no clinical or statistically significant differences in the demographic profile of patients and the two groups were comparable.

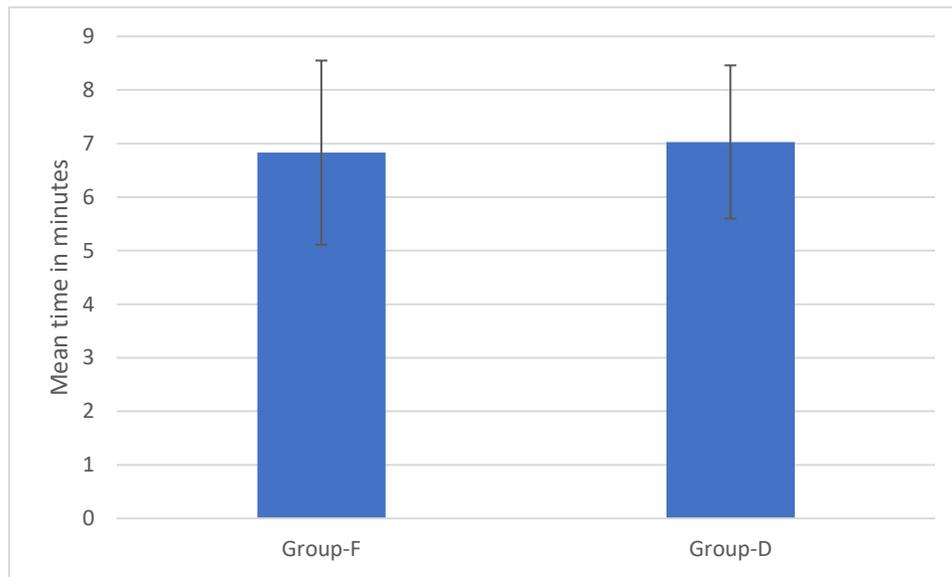


Fig 1: Onset of sensory blockade in the two groups

The mean time of onset of sensory blockade in group F was 6.83 ± 1.72 min. In group D it was 7.03 ± 1.43 min. The slight delayed onset of sensory blockade in group D was however not statistically significant.

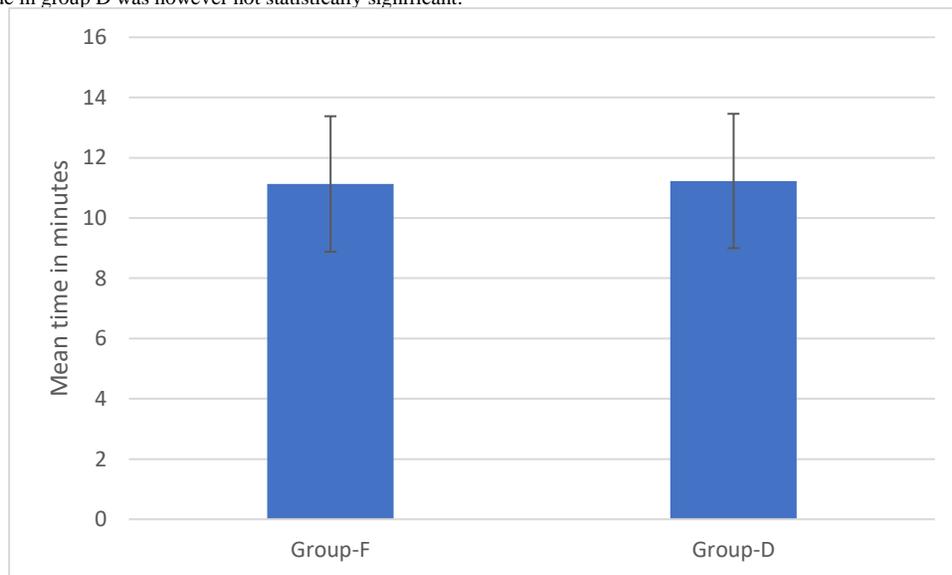


Fig 2: Onset of motor blockade

The mean time of onset of motor blockade was 11.13 ± 2.25 in group F when compared to 11.23 ± 2.23 in group D. This was not clinically or statistically significant.

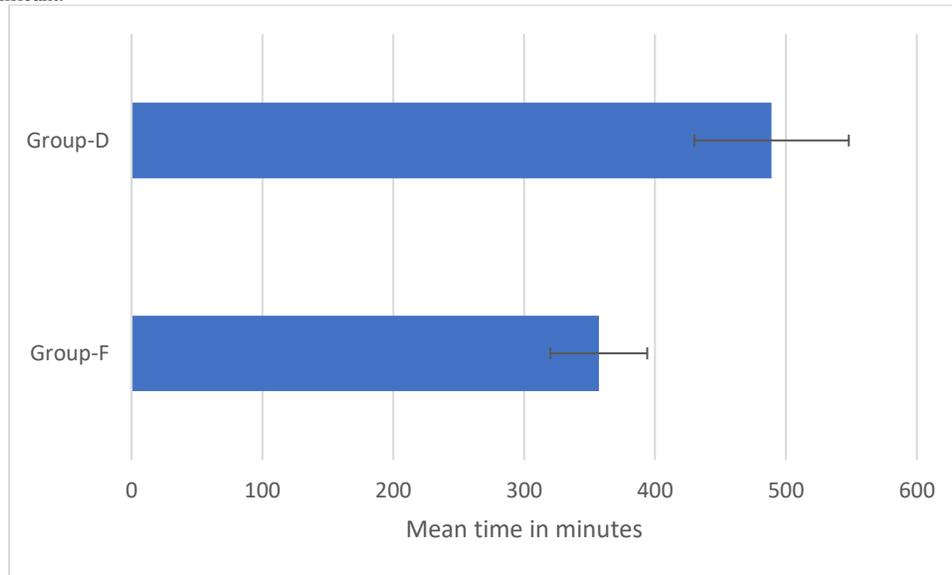


Fig 3 Duration of Analgesia

The mean time for duration of analgesia was 357 ± 37.62 min in group F whereas in group D the mean was 489.66 ± 59.91 min. This was statistically significant with a p value of <0.0001 .

Table 2: Hemodynamic parameters pulse rate

Comparison of Pulse rate (beats per min) in the two groups	Group F (MEAN±SD)	Group D (MEAN±SD)	P Value
BASELINE	81.6 ± 8.69	78.3 ± 9.46	0.1647
5 MIN	81 ± 9.5	77.9 ± 10.5	0.2354
10 MIN	81 ± 9.2	77.9 ± 9.83	0.2123
15 MIN	81.1 ± 9.36	78.7 ± 9.09	0.3179
20 MIN	81 ± 8.2	78.4 ± 8.79	0.2410
25 MIN	80.9 ± 7.57	78.2 ± 9.98	0.2426
30 MIN	80.3 ± 7.96	77.77 ± 9.43	0.2661
40 MIN	79.5 ± 7.08	77 ± 7	0.1743
50 MIN	80 ± 5.2	77.73 ± 4.54	0.0769
60 MIN	81 ± 8.6	77.8 ± 8.05	0.1422
70 MIN	80 ± 7.2	78.5 ± 4.46	0.3360
80 MIN	78 ± 6	75.83 ± 5.11	0.1370
90 MIN	80 ± 6.95	78.2 ± 8.73	0.3806
100 MIN	78 ± 5.4	77.26 ± 6.86	0.6442
110 MIN	77 ± 3.7	75.8 ± 5.44	0.3219
120 MIN	79 ± 7	76.03 ± 5.85	0.0798
Comparison of Systolic blood pressure (mm of Hg) changes in two groups			
BASELINE	125 ± 9.07	124.5 ± 10.75	0.8463
5 MIN	124 ± 8.28	122.4 ± 8.92	0.4744
10 MIN	123.47 ± 10.17	122 ± 8.90	0.5536
15 MIN	123 ± 11	123 ± 9.08	1.000
20 MIN	122 ± 10.6	121.9 ± 10.06	0.9702
25 MIN	121 ± 11.5	121 ± 10.27	1.0000
30 MIN	122 ± 11.9	121.7 ± 8.10	0.9095
40 MIN	124 ± 11	122.66 ± 5.27	0.5497
50 MIN	124 ± 7.8	123.93 ± 3.89	0.9651
60 MIN	123 ± 13.5	121.2 ± 7.91	0.5311
70 MIN	122 ± 10	122.53 ± 5	0.7961
80 MIN	122 ± 6.64	124.23 ± 4.59	0.1357

90 MIN	124 ± 11.7	121.1 ± 10.68	0.3202
100 MIN	123 ± 7.1	123.5 ± 5.87	0.7809
110 MIN	123 ± 5.4	124.7 ± 3.94	0.1617
120 MIN	125 ± 7.9	124.33 ± 5.32	0.7014
Comparison of Diastolic blood pressure (mm of Hg) changes in the two groups			
BASELINE	77.6± 6.02	78.8 ± 7.72	0.5046
5 MIN	76.6 ± 4.65	78.8 ± 7.02	0.1578
10 MIN	76.9 ± 5.86	77.6 ± 7.14	0.6796
15 MIN	76.7± 5.78	77.1 ± 7.39	0.8162
20 MIN	76 ± 6.5	76 ± 7.45	1.0000
25 MIN	76 ± 6.2	77.3 ± 7.4	0.4638
30 MIN	74.7 ± 7.3	76.6 ± 5.54	0.2593
40 MIN	77 ± 5.7	74.9 ± 4.5	0.1187
50 MIN	76 ± 4.7	76.66 ± 3.82	0.5529
60 MIN	75 ± 6.6	76.2 ± 6.04	0.4655
70 MIN	77 ± 3.7	75.16 ± 4.6	0.0931
80 MIN	76 ± 3.6	75.36 ± 4.32	0.5355
90 MIN	76.5 ± 6.75	79.2 ± 11.2	0.2628
100 MIN	75±4.6	75.33±4.68	0.7741
110 MIN	74±3.7	75.8±4.68	0.1038
120 MIN	74.5±4.32	76.2±4.51	0.1410

There was no statistically significant difference in the pulse rate, systolic blood pressure and diastolic blood pressure between the two groups during all the periods of study.

Discussion

Peripheral nerve blocks are cost effective anaesthetic techniques used to provide good quality anaesthesia and analgesia while avoiding airway instrumentation and hemodynamic consequences of general anaesthesia. Patient satisfaction, a growing demand for cost effective anaesthesia and a favourable postoperative recovery profile have resulted in increased popularity for regional techniques. Brachial plexus block is an easy and relatively safe procedure for upper limb surgeries. Various approaches like supraclavicular, interscalene, infraclavicular and axillary have been used for blocking the brachial plexus. Supraclavicular approach to brachial plexus block is associated with rapid onset and reliable anaesthesia[3]. Lanz et al[4] showed that blockade of the brachial plexus with a technique directed near the first rib (at the level of trunks and divisions of brachial plexus) provides the most reliable, uniform and predictable anaesthesia for upper extremity. Hence it is one of the most popular techniques used for upper limb blocks. Supraclavicular approach has been routinely used in our institution for upper limb surgeries and it has proven to be a safe technique as well.

Currently available local anaesthetics can provide analgesia for limited period of time when used as single injection. To extend the analgesia period beyond the operating rooms, various methods have been tried with the aim of prolonging the local anaesthetic action, like continuous infusion of local anaesthetics via indwelling catheters, use of different additives in local anaesthetics. Increasing the volume (dose) of LAs may prolong the duration of analgesia, but may also increase the risk of LA systemic toxicity. Although continuous catheter-based nerve blocks can extend postoperative analgesia, their placement requires additional time, cost, and skill. While a novel sustained-release encapsulated (liposomal) preparation of bupivacaine is presently undergoing investigation in phase III trials, a variety of perineural adjuvants, including buprenorphine, clonidine, dexamethasone, magnesium, and midazolam, have been used to prolong the duration of analgesia of nerve blocks with varying degrees of success[5]. Fentanyl Dexmedetomidine, an $\alpha 2$ adrenoceptor agonist, was first proposed as an adjuvant capable of prolonging duration of sensory and motor block produced by nerve blocks by Memis, and colleagues[6]. Kosugi et al[7] examined the effects of various adrenoceptor agonists including dexmedetomidine, tetracaine, oxymetazoline and clonidine, and also an α adrenoceptor antagonist

(atipamezole) on compound action potential (CAP) recorded from frog sciatic nerve, and found that CAPs were inhibited by α adrenoceptor agents so that they are able to block nerve conduction.

Keeping these facts in mind, it was decided to compare the action of fentanyl and dexmedetomidine with bupivacaine (0.5%), in peripheral nerve blocks so that by increasing the duration of analgesia with a single shot block, a longer duration of postoperative analgesia can be achieved without significant clinical side effects and hence we can avoid continuous catheterization.

A total of 60 patients within the age group of 18 – 50 were included in the study, 30 in each group. The patients were then randomized to one of two groups using a computer generated randomization table. Group F – which received 30 ml of 0.5% Bupivacaine hydrochloride and 1 μ g / kg Fentanyl and Group D – which received 30 ml of 0.5% Bupivacaine hydrochloride and 1 μ g / kg Dexmedetomidine. The sample size was comparable in demographic data and duration of surgery. There was no statistical difference in age and weight distribution between the two groups. Youngest patient in the study group was 19 years and oldest was 50 years. The average age was 33.13 ± 9.179 years in group F, and 31.4 ± 8.295 years in group D. Hence the two groups were comparable in age distribution. The average weights of the patients were 67.66 ± 8.38 kgs in group F and 69 ± 9.505 kgs in group D respectively. Hence the weight in two groups was comparable. Both the groups had a predominant male population accounting for nearly 34 th of the study group.

The mean time of onset of sensory blockade in group F was 6.83 ± 1.72min. In group D it was 7.03 ± 1.43 min. The slight delayed onset of sensory blockade in group D is however not statistically significant. The p value was >0.05 (0.5755).

In present study the mean time of onset of motor blockade was 11.13 ± 2.25 min in group F when compared to 11.23 ± 2.23 min in group D. This was not clinically or statistically significant. Sarita S Swami et al[8], conducted a randomised double blind prospective study to compare Dexmedetomidine and Clonidine as an adjuvant to local anaesthesia in Supraclavicular brachial plexus block. Sixty ASA grade I and II patients scheduled for elective upper limb surgeries under supraclavicular brachial plexus block were divided into two equal groups in a randomized, double blinded fashion. Group C received Clonidine 1 μ g/kg and Group D received Dexmedetomidine 1 μ g/kg added to bupivacaine 0.25% (35 cc). Onset of sensory block

was faster in Group D than in Group C, while onset of motor block was faster in Group C than in Group D, but the difference was not statistically significant. This observation matches well with our study. Esmoğlu et al [9] added dexmedetomidine to levobupivacaine for axillary brachial plexus block and showed that it shortens the onset time of both sensory and motor block, prolongs the duration of block and the duration of postoperative analgesia. This may be because peripheral α agonist produces analgesia by reducing release of norepinephrine, leading to α receptor independent inhibitory effects on nerve fiber action potentials. However, in our study, we found that onset of sensory and motor block was a little faster with Group C as compared with Group D, but it was statistically insignificant. The duration of analgesia in Group D was longer than in Group C, and it was statistically significant with a p value of <0.0001 . This observation supports the present study. In present study the mean time for duration of analgesia was 357 ± 37.62 min in group F whereas in group D the mean was 489.66 ± 59.91 min. This was statistically significant with a p value of <0.0001 . In present study, baseline hemodynamic parameters were observed before giving the block and for every 5 min for the first 30 min and then every 10 min till the end of surgery. It was observed that the changes in pulse rate, systolic blood pressure and diastolic blood pressure throughout the intraoperative period was not clinically and statistically significant.

Limitations of the study

Double blinding was not done in our study. Since USG was used for performing block the dose of local anaesthetic could be decreased because block is performed under visualization and spread of local anaesthetic could be noticed. But there are studies where 20 to 30 ml of local anaesthetic was used for performing block under USG guidance for example Cummings et al. Hence we recommend that a lower dose of local anaesthetic can be used to perform block in further studies.

Conclusion

From our study, we conclude that when Fentanyl ($1 \mu\text{g/kg}$) and Dexmedetomidine ($1 \mu\text{g/kg}$) are used as adjuvants to Bupivacaine (0.5%) in Supraclavicular brachial plexus block the duration of analgesia is prolonged with Dexmedetomidine as compared to

Fentanyl. No significant difference in onset of sensory and motor blockade is seen. No significant difference in hemodynamic variables in two groups (Pulse rate, Systolic BP, Diastolic BP) is seen. Dexmedetomidine ($1 \mu\text{g/kg}$) seems to be an attractive alternative to Fentanyl ($1 \mu\text{g/kg}$) as an adjuvant to bupivacaine in Supraclavicular Brachial Plexus Block. It provides good quality of intraoperative analgesia, hemodynamically stable conditions, minimal side effects, and excellent quality of postoperative analgesia.

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