Comparative Evaluation of the Effects of Fentanyl and Dexmedetomidine as an Adjuvants in Supraclavicular Brachial Plexus Block Achieved with Ropivacaine

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ABSTRACT

Introduction: Supraclavicular brachial plexus block provides complete and reliable anaesthesia for upper limb surgeries. Ropivacaine, is a potent blocker of C and Aδ fibres, rendering good sensory effect but less motor blockade. We evaluated the anaesthetic quality and duration of analgesia with the addition of either fentanyl or dexmedetomidine to ropivacaine 0.5% for brachial plexus block.

Material and methods: In a double blind randomized prospective clinical trial, 120 patients were randomly allocated to either receive 30 ml ropivacaine 0.5% (Group 1), 30 ml ropivacaine 0.5% with fentanyl (Group 2) or 30 ml ropivacaine 0.5% with Dexmedetomidine (Group 3) in brachial plexus.

Results: Compared to the use of ropivacaine 0.5%, 30 ml alone for brachial plexus block, the addition of fentanyl or dexmedetomidine to ropivacaine enhanced onset of block and also increased duration of anaesthesia with prolongation of post-operative analgesia.

Conclusion: Blockade characteristics improved better with addition of dexmedetomodine then fentanyl without increasing incidence of unwanted side effects.

Keywords: Supraclavicular Brachial Plexus Block, Ropivacaine 0.5%, Fentanyl, Dexmedetomidine.

INTRODUCTION

Brachial plexus block is the most popular technique to deal the upper limb surgeries. There are many approaches followed to achieve this block like supraclavicular, infraclavicular, interscalene and also the axillary approach. But amongest all of them, the supraclavicular approach to achieve the brachial plexus block is the easiest technique and most consistent method for anesthesia in surgeries below the shoulder joint.

William Halsted (1852–1922) performed the first brachial plexus block[1,2] applied cocaine to the plexus by using surgical approach. The supraclavicular and infraclavicular approaches are associated with the greatest diffusion of local anesthetic solution after a single injection because, at these levels, the brachial plexus is the most compact.

The main aim of modern anesthesia is not only limited to diminish pain during surgery but to maintain this period in convalescence too.

Limited duration of action and requirement of high doses are the two practical difficulties that come across when thinking about optimal post operative analgesia.

Here comes the role of adjuvants. These adjuvants when combined with local anaesthetics improve quality of block.

Local anaesthetic, ropivacaine, an amino-amide, is similar to bupivacaine in terms of onset and duration of block but, with lesser toxicity than bupivacaine when accidental intravascular injection occurs. Addition of fentanyl to local anesthetics is known to significantly improve duration of sensory and motor block in brachial plexus blocks. Dexmedetomidine, a centrally acting α2 receptor agonist, is widely used for anaesthesia, analgesia and monitored anaesthesia care, has also been used as an adjunct to local anaesthetics for brachial plexus block. The purpose of this study was to examine if fentanyl or dexmedetomidine added to ropivacaine induced supraclavicular brachial plexus block improved blockade characteristics and enhanced duration of post-operative analgesia.

MATERIAL AND METHODS

This double blind, prospective, randomized controlled study was conducted in the Department of Anaesthesiology and Critical Care, MLB Medical College, Jhansi (UP). Following approval of ethical committee, patients admitted for upper limb below shoulder surgeries, between the age of 18 and 60 years and belonging to ASA grade I and II were taken as subjects of study. All the selected patients were subjected to a detailed history and clinical examination along with all routine investigations including Hb, TLC, DLC, Blood Sugar, Blood urea, Serum Creatinine, and urine examination. Specific investigations were prescribed as and when required.

Exclusion criteria

- Patients aged <18 years or >60 years.
- Patients having body weight <40 kg and >70 Kg
- Patients having peripheral neuropathy or hypersensitivity to local anaesthetic agents.
- Patients having history of seizures.
- Patients having bleeding disorders or receiving anti-coagulation.

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- Hepatic or renal failure

After obtaining written and informed consent, 200 patients were selected for study than 80 patients were excluded from study after application of exclusion criteria. Remaining 120 Patients were randomly assigned using "slips in a box technique" to one of the following groups.

Group-1: 40 Patients were given 30ml Inj. Ropivacaine (0.5%)

Group-2: 40 Patients were given 30 ml inj. Ropivacaine (0.5%)+ 1µgm/Kg Fentanyl

Group-3: 40 Patients were given 30 ml inj. Ropivacaine(0.5%)+ 1µgm/Kg Dexmedetomidine

Reason for exclusion of 80 patients

1. 61 patients were excluded because of co-morbidity
2. 12 patients were excluded because of non-cooperation
3. 07 patients were excluded because of failure of technique / block requiring general anaesthesia

Advice to patient

Patients received Tab. Alprazolam 0.5 mg as overnight sedation and then half the overnight dose was administered in morning with a sip of water and 6 am following fasting for 6-8 hours.

Armamentarium

Multichannel monitor for NIBP, SpO_2, pulse rate monitoring and ECG monitoring

Autoclaved sponge holding forceps, gauze pieces, apron, gloves.

Disposable syringe (20 ml, 10 ml) and needles.

- Inj. Ropivacaine 0.5% (20 ml ampoule)
- Inj. Fentanyl (2 ml ampoule – 50 mcg/ml)
- Inj. Dexmedetomidine (1 ml ampoule – 100 mcg/ml)

Emergency drugs – inj. Atropine, Inj. Adrenaline, Inj. Hydrocortisone,

Inj. Deriphyllin, Inj. Ranitidine

All resuscitation equipments.

Anaesthetic Technique

After shifting to the operation theatre, the monitors were applied and baseline pulse rate, blood pressure, respiratory rate and SpO_2 were recorded. IV line was established with 18Guaze cannula, patients were started infusion of Ringer's lactate solution.

Position: The patient was placed in a supine position and wedge is placed in between the scapulae, with the head turned to the opposite side. The arm on the operative side is adducted and internally rotated, the shoulder is down and the hand is extended along the ipsilateral side.

Landmark for supraclavicular approach is 2 cm above to the mid point of clavicle in the interscalene groove, lateral to the clavicular head of sternocleidomastoid (palpation of subclavian artery confirms the accuracy of position). A small skin wheal of local anesthetic was raised at this level and the needle was directed caudad, slightly medial and posterior to elicit paresthesia or motor response. Then local anesthetic solution was slowly injected with frequent aspirations.

All patients were monitored before starting until at least 1 hour after completion of the procedure using NIBP, SpO_2, and ECG monitoring. Baseline values were taken a few minutes earlier to block.

Sensory block was assessed by the Temperature sensitivity method. Complete sensory block was considered when there was a complete loss of sensation to temperature in the upper limb.

Assessment of motor block was carried out by the observer at every minute interval following drug injection up to 30 minute. Motor block was determined according to Modified Bromage scale for upper extremities.

The block was considered incomplete when any of the dermatome did not have analgesia even after 30 minutes of drug injection. These patients were supplemented with IV Inj. Fentanyl (1-2 µgm/kg). When more than 1 nerve remain unaffected, it was considered a failed block. In this case general anesthesia was given intra operatively.

Patients who required general anesthesia or supplemental analgesia were excluded from the study.

All patients stayed in hospital overnight and a printed assessment chart for timing and distribution of return of sensation, movement, pain was given to them to complete with the help of the ward nurse. Patients were also assessed for total block failure, nerve distributions unblocked, need for supplementation of block, time to first postoperative analgesia and total postoperative analgesia requirements.

Duration of analgesia was recorded as per numeric rating scale of 0 to 10. The numeric rating scale was recorded post operatively every 30 minutes till the score of 5. The rescue analgesia was given in the form of inj. Diclofenac sodium (1.5 mg/kg) intramuscularly at the Numeric Rating Scale of 5 and the time of administration was noted.

The duration of sensory block was defined as the time interval between the first loss of sensation of cold/hot and the complete resolution of anesthesia on all nerves.

The duration of motor block was defined as the time interval between the first feeling of heaviness/reduction in movement and recovery of complete motor function.

The following parameters were recorded.

- Sensory block: onset time, duration
- Motor block: onset time, duration and degree.
- Quality of block
- Duration of analgesia
- ***Demographic data*** **-** Name, age, sex, weight, height, diagnosis, and surgery underwent.
- ***Heart rate*** **-** Basal and 2,5,10,15,20,30,60,90 and 120 minutes
- ***Blood pressure*** **-** Basal and 2,5,10,15,20,30,60,90 and 120 minutes
- ***SpO_2*** **-** Basal and 2,5,10,15,20,30,60,90 and 120 minutes
- Side effects (e.g. Drug reaction, nausea, vomiting, hypotension, bradycardia, sedation)

STATISTICAL ANALYSIS

The data was analyzed by SPSS (Statistical Package for Social Sciences), software. ANOVA and multiple comparison tests was applied for demographic data, hemodynamic

parameters, onset and duration of sensory and motor blockade and duration of analgesia.

RESULTS

There was statistical no significant difference between the groups with respect to age, weight, height, sex ratio, (Table 1). Demographic variations in present study are coincidently identical in each group (Table 1).

The distribution of onset of sensory block in all the three groups. Mean ± SD of 5.05±0.89 min, 2.32±0.51 min and 2.53±0.48 min in group 1, 2 and 3 respectively. Comparison for onset of sensory block among these three groups revealed that the time taken for onset of sensory block for group 2 and 3 were less than group 1 which was significant ($p<0.05$) (Table-2).

In majority of patients onset of motor block was within 8 min for group 1, 4 min for group 2, 5 min for group 3. The mean time of onset was earliest in group 2 (3.56±0.55 mins) followed by group 3 (4.32±0.50 min) maximum in group 1 (7.63±0.89 min).

Comparison for onset of motor block among these three groups revealed that the time taken for onset of motor block for group 2 and 3 are less then group 1 which was significant ($p<0.05$) (Table-2).

In majority of patients time to complete sensory block was within - 30 min for group 1, 20 min for group 2, 25 min for group 3.

The mean time to complete sensory block was earliest in group 2 (18.65±2.53 mins) followed by group 3 (21.4±3.03 min) maximum in group 1 (28.7±2.95 min).

Comparison for time to complete sensory block among these three groups revealed that the time taken for complete sensory block for group 2 and 3 were less then group 1 which was significant ($p<0.05$) (Table-2).

In majority of patients time to complete motor block was within -35 min for group 1, 25 min for group 2, 25 min for group 3.

The mean time to complete motor block was earliest in group 2 (23.32±2.28 mins) followed by group 3 (24.72±2.40 min) maximum in group 1 (35.5±2.60 min).

Comparison for time to complete motor block among these

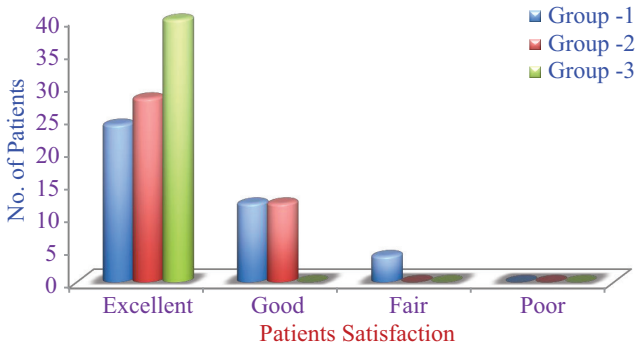

Figure-1: Patients satisfaction

	Group 1	Group 2	Group 3
Age (in years) Mean ± SD	35.75± 10.89	36.30± 11.20	37.12± 11.16
Weight (in Kg) Mean ± SD	58.52±7.77	61.67±7.93	62.67±7.09
Height (in cm) Mean ± SD	162± 4.05	163± 2.08	163.5±3.06
Male: Female ratio	28/12	27/13	26/14
Patient satisfaction Ex/G/F/P	24/12/4/0	28/12/0/0	40/0/0/0

Table-1: Characteristics of patients in the study

	Group 1	Group 2	Group 3
Onset of sensory block (in min) Mean ± SD	5.05±0.89	2.32±0.51	2.53±0.48
Onset of motor block (in min) Mean ± SD	7.63±0.89	3.56±0.55	4.32±0.50
Time to complete sensory block (in min)	28.7±2.95	18.65±2.53	21.4±3.03
Time to complete motor block (in min)	35.5±2.60	23.32±2.28	24.72±2.40
Total duration of motor block (in min)	404±18.20 P<0.004	430.12±12.31 P<0.0004	509.82±28.09 P<0.0001
Total duration of sensory block (in min)	438.92±18.37 P<0.003	474.82±10.87 P<0.0004	582.47±20.96 P<0.0002
Total duration of analgesia (in min)	505.57±19.24 P<0.003	559.82±21.66 P<0.0003	619.92±21.67 P<0.0002

Table-2: Characteristic of blockade in patients

Adverse effects	Group 1		Group 2		Group 3	
	No	%	No.	%	No.	%
Drug reaction	0	0	2	5	0	0
Hypotension (fall in MAP < 20% of baseline)	0	0	1	2.5	0	0
Bradycardia (pulse rate<60/min)	0	0	0	0	2	5
Nausea	0	0	0	0	0	0
Vomiting	0	0	0	0	0	0
Sedation	0	0	0	0	0	0

Table-3: Adverse effects

three groups revealed that the time taken for complete motor block for group 2 and 3 are less then group 1 which is significant ($p<0.05$) (Table-2).

In majority of patient's total duration of motor block was in range- of 391-420 min in group 1, 421-450 min in group 2 and 511-540 min in group 3.

Total duration of motor block was longest in group 3 (509.82±28.09 min) then in group 2 (430.12±12.31min) and was shortest in group 1 (404.12±18.20 min).

The total duration of motor block was significantly prolonged in group 3 compared to group 2 ($p<0.05$) and highly significant compared to group 1 ($P<0.001$) (Table-2).

In the majority of patients, the duration of sensory block was between 401-450 min in group 1 and 451-500 min in group 2 and 551-600 min in group 3.

Mean duration of the total sensory block was maximum in group 3 (582.47±20.96 mins) and least in group-1 (438.92±18.37) and in between for the group-2 (474.82±10.87).

The total duration of sensory block was significantly prolonged in group 3 compared to group 2 ($p<0.05$) and highly significant compared to group 1 ($P<0.001$) (Table-2).

In majority of patients duration of analgesia was in range of-491-520 min in group 1, 551-580 min group 2 and 611-640 min in group 3.

Mean duration of total analgesia was maximum in the group 3 (619.92±21.67 min.), followed by group 2 (559.82±21.66 min) and was least in group 1 (505.57±19.24 min).

Comparison of these three revealed significant difference among them. ($p<0.001$) (Table-2). There was no appreciable drop in Systolic pressure, Diastolic pressure, Mean arterial pressure seen in any of the groups.

Difference in change in S.B.P., D.B.P., M.A.P among all groups are not significant ($p>0.05$) at any point of time. Change in pulse rate among all the group at any point of time is not significant ($P>0.05$). No respiratory depression is observed in any group as change in SpO_2 is not significant ($p>0.05$).

Table-3, shows the incidence of adverse effects among the groups. None of the above adverse effects were noticed in any patients except itching in 2 patients of group 2, hypotension in 1 patient of group 2, and bradycardia in 2 patients of group 3.

Quality of anaesthesia was excellent in Group 3 and was excellent to good in Groups 2 and Group 1 with no incidence of block failure necessitating induction of general anaesthesia.

Sedation of score 3 was most frequently observed in patients receiving dexmedetomidine and resolved with recession of block. Achievement of score 3 sedation with the lack of haemodynamic or any other side effect, can make 50 mcg dexmedetomidine an attractive choice for supraclavicular brachial plexus block.

Despite prolonged periods of surgery, in some cases, no tourniquet pain was seen in any group.Patients weighing < 40 kg were excluded to avoid the potential risks of administering excessive doses.

DISCUSSION

Ropivacaine is relatively new drug, which have been commonly used for central neuraxial blockades, but based on extensive studies, it is well accepted for peripheral nerve blocks. Also it is proved superior then Bupivacaine, and relatively less lipid solubility which makes it less cardiotoxic and neurotoxic.

Ropivacaine provides longer duration of block and post operative analgesia as compared to Bupivacaine. But in Ropivacaine the motor effect is not as good as bupivacaine so to overcome this drawback of ropivacaine we add adjuvant in it like Fentanyl and Dexmedetomidine to enhance its quality of anaesthesia, duration of sensory and motor block[3].

The present study was carried out to compare the onset time and duration of both sensory and motor blocks as well as duration of analgesia among the three groups.

Demographic variations in present study are coincidently identical in each group (Table 1)

Results regarding sensory block (table 2) during present study were also comparable with previously discussed studies having similar results.

These results were comparable with similar study done by Soma C. Cham and Medha A. Sangawar[4] in 2015 comparison of the effects of fentanyl and dexmedetomidine in supraclavicular brachial plexus block achieved with ropivacaine with mean onset of sensory block for ropivacaine-group 1 (5.16 ± 0.8), group 2 (2.06 ± 0.25), and group 3 (2.13±0.34). And similarly duration of sensory block for group 1 (415 ± 19.56 min), group 2 (458.15 ± 20.62 min) and group 3 (511.33±30.45 min).

The study done by Ammar AS et al[5] Kaygusuz K et al[6]found an earlier onset in sensory block only with no difference in onset of motor block.

Ropivacaine is less lipophilic than bupivacaine therefore, it has selective action on pain transmitting Aδ and C nerves fibers rather than Aβ fibers (large myelinated fiber) which are involved in motor functions, this may be the reason for faster recovery of motor functions in our study.

Results regarding motor block (table 2) during present study were also comparable with previously discussed studies having similar results. Such as-

Also study done by Gandhi S *et al.*,[7] in their study found that motor block onset was hastened by the use of dexmedetomidine adjuvant in brachial plexus block with bupivacaine.

Nishikawa K et al[8] and Chavan SG et al[9] mentioned that onset time of analgesia was prolonged in every nerve trunk by adding fentanyl to axillary brachial plexus block, probably due to changes in pH on addition of 100 mcg.

Differences in local anaesthetics, varying doses of dexmedetomidine, approach to brachial plexus and assessment method of blockade characteristics could have led to these diverging observations.

A faster onset of action could be achieved by increasing the concentration of ropivacaine to 0.75% but was kept to 0.5% in the present study since increasing the concentration of

ropivacaine failed to improve blockade characteristics and that the risk of increasing the total milligram dose of local anaesthetic may not be warranted.

In our study, a prolongation of sensory and motor as well as duration of analgesia was observed both in Group 2 and Group 3, however, maximally observed in Group 3 compared to Group 2 and Group 1. Addition of fentanyl prolonged both surgical anaesthesia and time to request for first analgesia by 30 min whereas dexmedetomidine as an adjunct prolonged anaesthetic duration by an hour and total analgesic duration by 2 hours compared to the patient receiving only ropivacaine for achievement of block.

The extended anaesthetic and analgesic effect as observed in Group 2 could be attributed to fentanyl directly acting on the peripheral nervous system. The existence of endogenous and exogenous opioid receptors in the peripheral nervous system and the initiation of anti-nociceptive action by the activation of such receptors offer the possibility of extended analgesic action and in the substantia gelatinosa after its centripetal axonal transport after perineural injection.

The action of dexmedetomidine on the α2 receptors in the locus coerulus and dorsal horn of spinal cord reduces central sympatholytic output, resulting in increased firing of inhibitory neurons and hence producing analgesia is a known feature. Peripheral α2 receptors may also provide anti-nociception. Reduction of calcium conductance into cells, thus inhibiting neurotransmitter release is other prominent physiologic action ascribed to α2 adrenoceptors.

Haemodynamic parameters were similar in all groups. Abdallah et al in the metaanalysis of perineural application of dexmedetomidine as a local anaesthetic adjuvant stated that dexmedetomidine produced reversible bradycardia in 7% of brachial plexus lock patients with no incidence of hypotension.[10]

Despite prolonged periods of surgery, in some cases, no tourniquet pain was seen in any group.

CONCLUSION

It can therefore be concluded that-

Both dexmedetomidine and fentanyl enhances readiness for surgery. Dexmedetomidine produced a more prolonged duration of motor and sensory block and postoperative analgesia as compared to fentanyl, which is significant and highly significant as compared to ropivacaine. Hence dexmedetomidine shows to have an upper edge over fentanyl when used as adjuvant to ropivacaine for brachial plexus block, and thus promises to be yet another addition to the already vast armamentarium of the present day anaesthetist.

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