



Comparison of the Effects of Fentanyl and Dexmedetomidine in Supraclavicular Brachial Plexus Block Achieved with 0.5% Bupivacaine in Karpaga Vinayaga Medical College and Hospital, Maduranthagam

Authors

Dr.P.Manohar¹, Dr.M.Prakash²

¹Assistant Professor, Department of Anesthesia, Karpaga Vinayaga Medical College And Hospital, Maduranthagam.

²Associate Professor, Department of Anesthesia, Karpaga Vinayaga Medical College And Hospital, Maduranthagam.

Corresponding Author

Dr.P.Manohar

Assistant Prof, Dept of Anesthesia, Karpaga Vinayaga Medical College And Hospital, Maduranthagam.

Email: drmanoth@gmail.com, Mob No - 09500247609

Abstract

Background & Objectives: *Supraclavicular block of brachial plexus provides complete and reliable anesthesia for upper limb surgeries. Bupivacaine is an effective local anesthetic for brachial plexus anesthesia. It provides good sensory and motor blockade. We evaluated the anesthetic quality and length of analgesia with the addition of either Fentanyl or Dexmedetomidine to Bupivacaine for Supraclavicular brachial plexus block.*

Methods: *In a prospective clinical trial, 90 patients were randomly allocated to either receive 30 ml Bupivacaine 0.5% (Group B), 30 ml Bupivacaine 0.5% with Fentanyl 50 mcg (Group BF) or 30 ml Bupivacaine 0.5% with Dexmedetomidine 50 mcg (Group BD) in Supraclavicular brachial plexus. The characteristics for anesthesia and analgesia were assessed for the three groups.*

Observations: *Demographic profile was comparable in the groups. The onset of analgesia and time to complete analgesia was enhanced in Group BD and Group BF compared to Group B. Prolongation of sensory blockade and motor blockade with extended duration of postoperative analgesia was observed in Group BD and Group BF compared to Group B. There were minimum hemodynamic disturbances and side-effects in any group except for Grade 3 sedation score which was frequently noted in patients receiving Dexmedetomidine as adjunct.*

Results: *Compared to the use of Bupivacaine 0.5%, 30 ml alone for Supraclavicular brachial plexus block, the addition of 50 mcg Fentanyl or 50 mcg Dexmedetomidine to Bupivacaine enhanced onset of block and also increased duration of surgical anesthesia with prolongation of post-operative analgesia. Furthermore blockade characteristics improved better with addition of Dexmedetomidine than Fentanyl without increasing incidence of unwanted side-effects.*

Keywords: *Supraclavicular brachial plexus block, Bupivacaine, Fentanyl and Dexmedetomidine.*

I.INTRODUCTION

Brachial plexus block has been proved to be a superior alternative to general anesthesia for upper limb surgeries and also for the provision of postoperative pain relief. Reduced hospital stay, less financial burden and avoidance of complications due to general anesthesia are the many advantages of plexus block.

Local anesthetic, Bupivacaine, an amino-amide, blocks A β , A δ and C fibers and provides very good sensory and motor blockade. It has the disadvantage of cardiovascular toxicity when injected intravascular. Adjuvants like opioids have been administered concomitantly with local anesthetics with the possibility of providing post-operative analgesia in addition to improved quality of anesthesia. Addition of Fentanyl to local anesthetics is known to significantly improve duration of sensory and motor block and VAS scores in brachial plexus blocks.⁽²⁾

Dexmedetomidine, a centrally acting α 2 receptor agonist, is widely used for anesthesia, analgesia and monitored anesthesia care, has also been used as an adjunct to local anesthetics for brachial plexus block.^(3,4) The purpose of this study was to examine if Fentanyl or Dexmedetomidine added to Bupivacaine induced supraclavicular brachial plexus block improved blockade characteristics and enhanced duration of post-operative analgesia.

II.METHODS

This study was carried out as a prospective, randomized clinical trial on patients who underwent surgical procedures involving the distal arm and fore-arm. Following institutional ethical committee approval,

90 ASA grade I & II patients, aged between 20 and 50 years, weighing between 40 to 70 kg were included in the study. Study was conducted in Department of Anesthesia, Karpaga Vinayaga Institute of Medical Sciences.

After a thorough pre-anesthetic evaluation and minimal necessary investigation done, informed written consent was obtained from all patients

selected for the study. Patients who did not give consent for the procedure, with any hepatic, cardiopulmonary, renal, neurological, psychiatric or neuromuscular disease, any contra-indication to regional anesthesia or any of the study drugs and/or were pregnant or lactating, were excluded for the study.

Patients received Tab. Alprazolam 0.5mg as overnight sedation and a minimum 6 hr preoperative fasting status was ensured. In the pre-operative room, an intravenous access was secured and multipara monitor was attached for monitoring heart rate, respiratory rate, oxygen saturation, non-invasive blood pressure and electrocardiography. VAS score for postoperative pain was explained to the patient. Preoperative vitals were hence noted. Intravenous ranitidine 150 mg and midazolam 0.03mg/kg was given intravenously and later shifted to the operation room. Patients were then randomly assigned to one of the three groups of 30 patients each. Group B was to receive 0.5% Bupivacaine 30 ml, Group BF, 0.5% Bupivacaine 30 ml with 50 mcg Fentanyl and Group BD, 0.5% Bupivacaine 30 ml with 50 mcg Dexmedetomidine. After aseptic preparation of the skin, supraclavicular brachial plexus block was then performed with the help of nerve stimulator – locator (TOF-Watch). A 22 gauge 50mm insulated needle (Stimuplex® A 50, B Braün, Melsungen, Germany) was attached to the locator and inserted at an initial current output of 1.5mA and 2 Hz frequency. Once desired contractions i.e. flexion with supination of the forearm was appreciated, the current was decreased to 0.5mA and on persistence of contractions, the drug according to the randomly allocated group was injected following intermittent negative aspiration. Ringers lactate was administered as replacement and maintenance fluid.

Completion of injection was considered as time 0. Sensory and motor blockade evaluation was done every 2 min until complete sensory or motor block or till 30 min, whichever was earlier. The sensory block was evaluated using the pin-prick method

(Score 0: sharp pain; Score 1: touch sensation only; Score 2: No sensation). Onset time to sensory block was defined as the time from completion of injection (Time 0) to the time sensory block began to be detected (Score 1) in the distribution of any one of the major nerves. The time to complete sensory block was taken from time 0 to the achievement of a Score 2 in the distribution of all the major nerves. Total duration of sensory block was the duration from attaining complete block to the time score was ≤ 1 . Total duration of analgesia was taken from the time of complete sensory block to the request of rescue analgesic VAS ≥ 4 cm.

The motor block was evaluated using the Modified Bromage Scale (Score 1: Partial block, total forearm and partial arm flexion; Score 2: Almost complete block. Inability to flex the arm and decreased ability to flex the forearm; Score 3: Total block, inability to flex both arm and forearm).

Onset of motor block was taken as time from the time of completion of injection of study drug to detection of a motor block of Score ≥ 1 . The time from completion of drug injection to attainment of a Score of 3 was taken as the time to complete motor block. Total duration of motor block was the between time to attain complete motor block to time to achieve Score 0 motor blockade.

The block was judged to have failed, if anesthesia was found inadequate in any of the major nerve distribution after 30 min of institution of drug into the sheath and such patients were then excluded from the study.

The heart rate, respiratory rate, oxygen saturation, blood pressure (Systolic, diastolic and mean arterial) were noted hence every 5 min till 30 min and then every 30 min till regression of block. Hypotension was defined to be a fall in mean arterial pressure of $> 20\%$ of baseline values and treated with bolus of 100 ml fluid and if uncorrected, injection ephedrine 6 mg bolus, intravenously. Bradycardia was defined as pulse rate of ≤ 50 /min and treated with an intravenous bolus of injection Atropine 0.6 mg. Injection

Ondansetron were given to all patients at the end of surgery. They were hence, monitored in the postoperative period in the recovery room and then in respective wards for vitals, regression of block, VAS for pain and any other side effect – nausea, vomiting, shivering, itching, urinary retention, side effects of Supraclaviular block like respiratory distress for pneumothorax, Horner's syndrome and recurrent laryngeal nerve palsy.

Degree of sedation was monitored before institution of block and thence, at all intervals as that of vital parameter monitoring using the Ramsay Sedation Scale (1: awakened and alert; 2: sedated, but responding to verbal stimulus; 3: sedated, but responding to mild physical stimulus, 4: sedated, but responding to moderate or strong physical stimulus; 5: not arousable).

At the end of the surgery, quality of anesthesia was graded as: Excellent (3): No complaint from the patient, Good (2): Minor complaint that required supplemental analgesics and Unsuccessful (1): Patient required general anesthesia.

The sample size was determined after undergoing a pilot study and the number of patients to be included was calculated from the mean and standard deviation on the assumption of a minimum difference of increase of 25% in the duration of sensory block between the groups. 28 patients were required in each group in order to have a 90% chance at the two-tailed 0.05 level of significance to detect a difference between the groups and we included 30 patients in each group in our study. Data obtained were analyzed with the Statistical software STATA version 13.1. Statistical tests for categorical data were χ^2 test. For continuous data, analysis of variance (ANOVA) and the Student's t- test were applied. The level of significance was set at p value < 0.05 .

III.RESULTS

There was statistical no significant difference between the groups with respect to age, weight, sex ratio, ASA physical status, type of surgery,

duration of surgery (Table 1). Inadequate or failed block necessitating administration of general anesthesia was not required in any patient of the study. The onset of sensory analgesia and motor blockade was quicker in patients of receiving either Fentanyl or Dexmedetomidine as adjuvant, the difference being statistically significant. A complete sensory block as well as complete motor block was achieved in a shorter duration in all the patients of Group BD and Group BF compared to the patients in Group B. (Table 2).

The total duration of sensory block was significantly prolonged by almost 1½ hr in Group BD compared to Group B. Prolongation was also observed in Group BF, however, less than that observed in Group BD. Motor block also took a significantly longer time to regress in Group BD compared to both Group BF and Group B. The total duration of analgesia was significantly increased in Group BD (by 2½ hr) compared to Group BF and (by 1 hr) Group B. The three groups had an average VAS Score below 3 cm at all measured intervals except at the time of reception of Inj. Diclofenac, when highest Scores were observed.

Quality of anesthesia was Excellent in all patients of Group BD and most patients except for – in Group BF and Group B where 9 and 11 patients respectively required supplemental analgesia in the form of Inj. Fentanyl 50 mcg.

No episode of respiratory depression or hypoxemia was observed in any patient of the study intra-operatively and 24 hrs postoperatively. The trends in mean heart rate depict that they remained lower than mean baseline values in all the groups, however, this difference in mean heart rates compared to respective preoperative mean baseline values was found to be statistically significant ($p < 0.01$) in group BD. A mean MAP lower than mean baseline MAP was observed in Group BD, which was statistically significant from interval of 30 min onwards. However, a fall of $< 25\%$ of MAP was not observed in any patient of Group BD. Fluctuation in mean MAP was however, insignificant in Group B and BF (fig 1

and 2). Both, mean heart rate and MAP returned to preoperative mean values with the regression of sensory level.

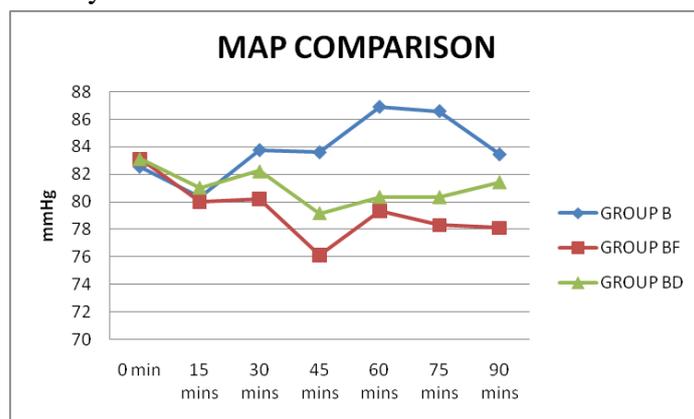


Fig 1. MAP Trend Between 3 Groups

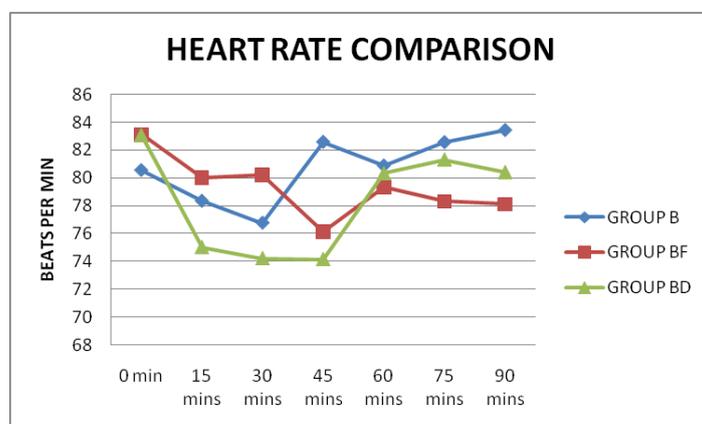


Fig 2. Heart Rate Trend In Three Groups

A sedation Score of 3 was most often noted in patients of Group BD (17 patients) compared to Group BF and B, a statistically significant observation. Bradycardia was observed in 2 patients in Group BD and Hypotension in 1 patient of Group BF. Itching was seen in 2 patients receiving Fentanyl as adjuvant.

Technical complication of supraclavicular brachial plexus block placement like hematoma formation, pneumothorax was not noted in patient of the study. (Table 3)

Table 1. Characteristics of Patients

	Group B	Group BF	Group BD
Age in years (mean±SD)	34.23±12.02	37.33±10.94	34.13±9.73
Weight in kg (mean±SD)	54.86±6.56	56.73±6.93	53.26±10.49
Height in cms (mean±SD)	164.4±3.83	164.46±3.84	164.12±3.77
male: female ratio	17:13	16:14	13:17
ASA I/II	28/2	26/4	24/6
Type of surgery Arm/ elbow/forearm	6/3/21	5/5/20	6/4/20
Duration of surgery	86.55±30.5	96±25	92.16±22.5
^/* p<0.05 ^^/** p<0.001			

Table 2. Characteristics of Blockade In Patients

	Group B	Group BF	Group BD
Onset of sensory block (in mins)	5.16±0.8	2.06±0.25 [^]	2.13±0.34 [*]
Onset of motor block (in mins)	7.16±0.69	3.06±0.25 [^]	3.26±0.45 [*]
Time to complete sensory block (in mins)	28.45±4.8	21±5.03 [^]	21.83±4.45 [*]
Time to complete motor block	36.33±3.14	27.83±2.84 [^]	28.5±3.25 [*]
Total duration of sensory block	415±19.56	458.15±20.62 [^]	511.33±30.45 ^{**}
Total duration of motor blockade	409.4±62.42	442±23.54 ^{^^}	508±25.37 ^{**}
Total duration of analgesia	503±24.51	569±36.04 ^{^^}	648±25.37 ^{**}
Quality of anesthesia (Excellent/good/unsatisfactory)	19/11/0	21/9/0	29/1/0
^/* p<0.05 , ^^/** p<0.001			

Table 3. Incidence of Side Effects

	Group B	Group BF	Group BD
Hypotension	-	1	-
Bradycardia	-	-	2
Sedation(grade 3)	-	-	17 ^{**}
Respiratory depression	-	-	-
Nausea vomiting	2	2	2
Pruritis	-	2	-
Pneumothorax	-	-	-
Horner syndrome	-	-	-
Recurrent laryngeal nerve palsy	-	-	-

IV.DISCUSSION

In the present study, we found that addition of Inj. Fentanyl 1mcg/kg or Inj. Dexmedetomidine 1mcg/kg to 30 ml 0.5% Bupivacaine led to earlier onset and duration of sensory and motor of block as well as increased duration of analgesia when compared to 0.5% Bupivacaine alone. However, except for the onset and establishment of block, the addition of Dexmedetomidine to Bupivacaine led to a significant improvement in the duration of sensory and motor blockade and prolonged analgesia compared to the addition of Fentanyl.

In our study, readiness to surgery with a faster

onset and establishment of block was observed in Group BD and Group BF compared to Group B. An earlier onset and completion of motor and sensory block in patients of Group BF compared to Group B may be related to the peripheral effects of opioids. The lipid solubility of Fentanyl may have a perineural effect and Fentanyl is also reported to have a local anesthetic action that has probably led to the quicker onset of action and establishment of complete block.⁽⁵⁾ Similarly, a quicker onset in Group BD compared to Group B could be attributed to the addition of Dexmedetomidine. Though the exact

mechanism of action of Dexmedetomidine has not been completely elucidated, the action of Dexmedetomidine on peripheral α_2 receptors could be a probable reason.⁽⁶⁾ Differences in local anesthetics, varying doses of Dexmedetomidine, approach to brachial plexus and assessment method of blockade characteristics could have led to these diverging observations.

In our study, a prolongation of sensory and motor as well as duration of analgesia was observed both in Group BF and Group BD, however, maximally observed in Group BD compared to Group BF and Group B. Addition of Fentanyl prolonged both surgical anesthesia and time to request for first analgesia by 30 min whereas Dexmedetomidine as an adjunct prolonged anesthetic duration by an hour and total analgesic duration by two hours compared to the patient receiving only Bupivacaine for achievement of block.

Addition of Fentanyl enhances postoperative analgesia, but the duration of this effect is too brief to be clinically useful which was stated Kardas K et al⁽⁷⁾ and in congruence with our observation in patients receiving Fentanyl as adjunct. Karakaya D et al⁽⁸⁾ observed that 100 mcg/kg Fentanyl added in axillary brachial plexus produced no difference in block characteristics of Bupivacaine 0.25% but doubled postoperative analgesia. Supportive observation in increase in duration of sensory and motor block with postoperative analgesia has also been observed in studies by Geze et al⁽¹⁵⁾ Sindjelic et al⁽¹⁶⁾ and Chavan SG et al⁽⁹⁾

The extended anesthetic and analgesic effect as observed in Group BF 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. It may also diffuse from the brachial plexus sheath to extradural and subarachnoid spaces and then bind with opioid

receptor in the dorsal horn to exert its action. Another cause could be ascribed to the action of Fentanyl in the substantia gelatinosa after its centripetal axonal transport after perineural injection.

A significant prolongation in surgical anesthetic and analgesic duration in patients receiving adjuvant - dexmedetomidine as observed in our study lend support to various studies by Ammar A et al,⁽³⁾ Esmaoglu et al,⁽¹¹⁾ Gandhi et al,⁽¹³⁾ with the use of Dexmedetomidine in dose ranging from 50–100 mcg. The action of Dexmedetomidine on the α_2 receptors in the locus coeruleus 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 α_2 receptors may also provide anti-nociception. The inhibitory action of α_2 receptor agonist is expressed by hyperpolarization of cell membrane and decreased firing of excitable cells of the CNS. Reduction of calcium conductance into cells, thus inhibiting neurotransmitter release is other prominent physiologic action ascribed to α_2 adrenoceptors. The nerve is prevented from firing and it also prevents propagation of signals to the neighbours, providing analgesia in two different ways.

It is unlikely that perineural administration of drug would produce significant systemic side effects, but a central effect that results from the systemic absorption of the drug cannot be excluded. Haemodynamic parameters were similar in all groups. No respiratory depression, fall in SpO₂ was observed in any patient of the study. Hypotension was noted in one patient in Group BF, bradycardia in 2 patients of Group BD. Incidence of nausea and vomiting were similar in all groups and insignificant in the study. Itching was observed in 2 patients receiving fentanyl as adjuvant. Abdallah et al⁽²⁰⁾ in the metaanalysis of perineural application of dexmedetomidine as a local anesthetic adjuvant stated that dexmedetomidine produced reversible bradycardia in 7% of brachial plexus lock patients with no incidence of hypotension.

Quality of anesthesia was excellent in Group BD and was excellent to good in Groups BF and Group B with no incidence of block failure necessitating induction of general anesthesia. 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.

V.CONCLUSION

To conclude, we would like to state that both Dexmedetomidine and Fentanyl improves readiness for surgery but Dexmedetomidine prolongs the duration of sensory and motor block and postoperative analgesia as compared with Fentanyl when used as an adjuvant to Bupivacaine in supraclavicular brachial plexus block without any significant side effect.

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