Original Article

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Comparison of Buprenorphine Versus Fentanyl as an Adjuvant to Bupivacaine in Supraclavicular Brachial Plexus Block

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Abstract

Introduction: Adjuncts to local anesthetics for brachial plexus blockmay enhance the quality and duration of analgesia. Buprenorphine and Fentanyl both are opioids, known to produce antinociception and enhance the effect of local anesthetics. The purpose of this study was to compare the effect of Buprenorphine and Fentanyl added to brachial plexus block by supraclavicular approach.

Methods: This was a prospective study carried out for a period of 2 years. The study group consisted of 60 patients between 15 to 55 years undergoing upper limb surgeries under supraclavicular block. Patients were randomly divided into two groups: Group BF (n = 30) were administered 38mL of 0.25% Bupivacaine with Fentanyl (2 ml, 50µg) and Group BB (n = 30) were given 38mL of 0.25% Bupivacaine with Buprenorphine (2 ml, 0.3mg). The onset time and duration of sensory and motor blockade were recorded. Hemodynamic variables, sedation scores were recorded for 24 hr postoperatively.

Results: The duration of sensory block and analgesia was significantly longer in Group BBcompared to Group BF ($p < 0.05$). Hemodynamics and sedation scores did not differ betweengroups in the post-operative period.

Conclusion: Buprenorphine (0.3mg) in combination with 38ml of Bupivacaine(0.25%) increases the duration of sensory block, and improved postoperative analgesia when used in brachial plexus block, without producing any adverse events.

Keywords: Bupivacaine; Fentanyl; Buprenorphine; Supraclavicular Brachial Plexusblock.

Introduction

Brachial plexus block provides a useful alternative to general anesthesia for upper limb surgeries. They achieve near-ideal operating conditions by producing complete muscular relaxation, maintaining stable intra-operative hemodynamics and the associated sympathetic block. The sympathetic block decreases postoperative pain, vasospasm and edema,of various local anesthetics, Bupivacaine is used most frequently, as it has a long duration of action varying from 3 to 8 hours. However there are many limiting factors like delayed onset, patchy or incomplete analgesia, and sometimes short duration of action.

Various drugs like Neostigmine, Opioids, Hyaluronidase, and Clonidine etc [1-4]. have been added to local anesthetics in order to modify the block in terms of quick onset, good quality, prolonged duration and post-operative analgesia. But these are not without adverse systemic effects or of doubtful efficacy.

Buprenorphine and fentanyl both are opioids. These are known to produce antinociception and to enhance the effect of local anesthetics when given epidurally or intrathecally. Both produce this effect by its action on opioid receptors.

So the present study is being undertaken in a randomized manner to evaluate the onset time and analgesic efficacy of Buprenorphine- Bupivacaine (0.25%) combination compared to Fentanyl - Bupivacaine (0.25%) for brachial plexus block by supraclavicular approach.

Materials and Methods

This was a prospective study carried out in the department of

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Anesthesiology, in Osmania General Hospital, attached to Osmania Medical College, Hyderabad, from November 2013 to October 2015. The study group consisted of 60 patients between 15 to 55 years undergoing upper limb surgeries under supraclavicular block. Informed written consent was taken from all the patients, and parents wherever applicable.

Inclusion Criteria

- ASA CLASS I & II
- Aged between 15 to 55 years
- SBP: 100 – 139mm of Hg
- DBP: 60 – 89mm of Hg

Exclusion Criteria

- Patient refusal
- Known case of hypersensitive reaction to any of the drugs in this study
- Patients with medical complications like severe anemia, severe hypovolemia, shock, septicemia, etc.
- Patients with abnormal coagulation profile.
- Local infection at the proposed site of puncture for supraclavicular block.

All the patients underwent following tests: Haemoglobin, Total and differential leucocyte count(DLC), Bleeding and Clotting Time, Random Blood Sugar(RBS), Blood urea and Serum Creatinine, ECG, HIV, HBSAg. Written informed consent was obtained. Intravenous access with a 20 guage intravenous cannula on the contralateral upper limb under aseptic techniques.

Procedure

A total of 60 patients posted for upper limb surgeries under supraclavicular block were assigned to 2 groups, each containing 30 patients.

Group BF: received 38 ml of 0.25% Bupivacaine with Fentanyl (2 ml, 50µg)

Group BB: received 38 ml of 0.25%Bupivacaine with Buprenorphine (2 ml, 0.3mg)

- Patients lay supine, arms by the side and head turned slightly to the other side.
- The interscalene groove and mid-point of clavicle were identified.
- After aseptic preparation of the area, at a point 1.5 to 2.0 cm posterior and cephalad to mid-point of clavicle, subclavian artery pulsations were felt. A skin wheal was raised with local anesthetic just cephalo-posterior to the pulsations.
- Next, a 22 gauge, 5 cm needle, mounted on a 20 ml syringe, was passed through the same point, parallel to the head and neck, in a caudad, slightly medial and posterior direction, until either paresthesia was elicited or first rib was encountered.
- If the first rib was encountered, the needle was moved over the first rib until a paresthesia was elicited either in the hand or arm.
- After eliciting paresthesia the study medication was injected.
- All patients were monitored for anesthesia and analgesia upto 24 hours post-operatively.
- Sensory block was evaluated by temperature testing using spirit soaked cotton on skin dermatomes C_4 to T_2 whereas, motor block was assessed by asking the patientto adduct the shoulder and flex the fore-arm against gravity.
- Onset of sensory block was defined as the time elapsed between injection of drug and complete loss of cold perception of the hand, while onset of motor blockade was defined as the time elapsed from injection of drug to inability to adduct arm and flex fore arm against gravity (inability to touch one's nose).

Sedation score described by Culebras et al [4] was used to assess sedation.

1. Awake and alert
2. Ssedated, responding to verbal stimulus
3. Sedated, responding to mild physical stimulus
4. Sedated, responding to moderate or severe physical stimulus
5. Not arousable

Heart rate, non-invasive blood pressure and O_2 saturation were also monitored. Duration of sensory block (the time elapsed between onset of sensory block to perception of temperature using spirit soaked cotton), duration of motor block (the time elapsed between onset of motor block and complete return of muscle power) duration of analgesia (the time elapsed between onset of sensory block to the time when patient first complaints of pain at the site of surgery) were recorded.

Quantitative data was analysed by student's 't' test. Qualitative data was analysed by Chi-square test. A p value of < 0.05 was considered statistically significant.

Results

This was a prospective, randomized study and the study group comprised of 60 patients, the age ranging from 15 to 55 years.

The mean age of the patients in group BF was 35 ± 11 and in group BB was 33 ± 11 years. The p value was 0.48 which is not significant. Age incidences between the two groups were comparable.

Time for Onset of Sensory Block (min)

The mean time for onset of sensory block in group BF was 5.6 ± 1.8 minand in group BB was 6.2 ± 1.8 min. This was slightly faster in BF group when compared to BB group. The statistical analysis by student's unpaired 't' test showed that, the time for onset of sensory block in group BF was not significantly faster when compared to group BB (p>0.05).

Time for Onset of Motor Block in Minutes

The mean time for onset of motor block in group BF was 3.9 ± 1.3 min and in group BB was 4 ± 1.4 min. This was slightly faster in BF group when compared with BB group. The statistical analysis by student's unpaired 't' test showed that, the time for onset of motor block in group BF was not significantly faster when compared to group BB(p>0.05).

Duration of Sensory Block in Minutes

Patients of both groups were observed for 24 hours. The mean duration of sensory block in group BF was 526 ± 107 minutes and in group BB was 600 ± 127 minutes. The duration of sensory block in group BB was significantly longer when compared to group BF (p< 0.05).

Duration of Motor Block in Minutes

Patients of both groups were observed for 24 hours. The mean duration of motor block in group BF was 290 ± 59 minutes and in group BB was 301 ± 72 minutes. This was slightly longer in BB group when compared with BF group. The duration of motor block in group BB was not significantly longer when compared to group BF (p> 0.05).

Duration of Analgesia in Minutes

Patients of both groups were observed for 24 hours. The mean duration of analgesia in group BF was 661 ± 91.5 minutes and in group BB was 891 ± 105 mins. The duration of analgesia in group BB was significantly longer when compared to group BF(p<0.05).

Table 1: Sedation score

Time of Assessment	Scores*	Bupivacaine -Fentanyl (BF)	Bupivacaine -Buprenorphine (BB)	X^2 Value, Significance
0 min	1	50 (100)	50 (100)	-
	2	0	0	No Difference
5 min	1	50 (100)	50 (100)	-
	2	0	0	No Difference
15 min	1	50 (100)	40 (80)	$X^2 = 9.0$
	2	0	10 (20)	P<0.05 Sig
30 min	1	50 (100)	34 (68)	$X^2 = 16.74$
	2	0	16 (32)	P<0.05 Sig
60 min	1	50 (100)	37 (74)	$X^2 = 12.73$
	2	0	13 (26)	P<0.05 Sig
2 hr	1	50 (100)	50 (100)	-
	2	0	0	No Difference
6 hr	1	50 (100)	50 (100)	-
	2	0	0	No Difference
12 hr	1	50 (100)	50 (100)	-
	2	0	0	No Difference
24 hr	1	50 (100)	50 (100)	-
	2	0	0	No Difference

1. Aware and alert
2. Sedated responding to verbal stimulus
3. Sedated, responding to mild physical stimulus
4. Sedated, respond to moderate to severe physical stimulus
5. Not arousable

In group BF, all patients were awake and alert and had sedation score of 1. In group BB, sedation corresponding to score 2 was observed in some patients between 15 min from time of injection and 60 min. 20% of patients at 15 min, 32% of patientsat 30 min and 26% of patients at 60 min had sedation score of 2. None of the patients had sedation score of 3 and above during the study period. Statistical analysis of sedation score by chi-square test showed that the difference in sedation score was significant ($p< 0.05$).

Hemodynamic Variables

Pulse rate, systolic BP, diastolic BP, O_2 saturation were recorded at 0 min, 5 min, 15 min, 30 min, 60 min, 2 hours, 6 hours, 12 hours, 24 hours.

Table 2: Pulse Rate (beats/min)

Time of Assessment	Mean+/- SD			p Value	Significance
	Bupivacaine-Fentanyl	Bupivacaine -Buprenorphine			
0 min	82±7	83	± 8.7	> 0.05	NS
5 min	81 ± 6	83	± 9	> 0.05	NS
15 min	82 ± 6	82	± 10	> 0.05	NS
30 min	82 ± 6	83	± 9	> 0.05	NS
60 min	81 ± 6	83	± 9	> 0.05	NS
2 hr	81 ± 5	83±	6.6	> 0.05	NS
6 hr	82 ± 6	85±	9	> 0.05	NS
12 hr	82 ± 6	84	± 9	> 0.05	NS
24 hr	80 ± 6	83	± 11	> 0.05	NS

NS: Not significant

In group BF, the mean pulse rate ranged from 80 ± 6 to 82 ± 7 beats / min.

In group BB, the mean pulse rate ranged from 82 ± 10 to 85 ± 9 beats / min. There was no significant difference in pulse rate between the two groups ($p> 0.05$).

Table 2: Systolic blood pressure in mm Hg

Time of Assessment	Bupivacaine and Fentanyl	Bupivacaine and Buprenorphine	P value	Significance
0 min	119 ± 10.03	118 ± 9.6	>0.05	NS
5 min	119 ± 9.26	118 ± 10	>0.05	NS
15min	119 ± 11.3	118 ± 10	>0.05	NS
30 min	119 ± 9.75	118 ± 9.5	>0.05	NS
60 min	118 ± 10.2	118 ± 10	>0.05	NS
2 hr	119 ± 9.24	118 ± 9.1	>0.05	NS
6 hr	117 ± 9.56	117 ± 9.7	>0.05	NS
12 hr	117 ± 9.87	117 ± 9.9	>0.05	NS
24 hr	118 ± 9.19	117 ± 9	>0.05	NS

NS: Not significant

Table 3: Diastolic blood pressure in mm Hg

Time of assessment	Bupivacaine and Fentanyl	Bupivacaine and Buprenorphine	P value	Significance
0 min	77 ± 7.72	75 ± 6.7	>0.05	NS
5 min	76 ±7.77	76± 7.9	>0.05	NS
15min	77 ± 7.19	76± 7.4	>0.05	NS
30 min	76 ± 6.15	76 ± 6.9	>0.05	NS
60 min	77 ± 6.57	76 ± 6.9	>0.05	NS
2 hr	77 ± 7.4	76 ± 7.6	>0.05	NS
6 hr	77 ± 7.51	76 ± 7.5	>0.05	NS
12 hr	77 ± 7.31	76 ± 7.5	>0.05	NS
24 hr	77 ± 6.62	76 ± 6.8	>0.05	NS

NS: Not significant

In group BF, the mean systolic blood pressure ranged from 117 ± 9.56 to 119 ± 10.03 mm of Hg. In group BB, SBP ranged from 117 ± 9 to 118 ± 10 mm of Hg. There was no significant difference in systolic blood pressure between two groups (p > 0.05)

In group BF, the mean diastolic blood pressure ranged from 76 ± 6.15 to 77 ± 7.77 mm of Hg. In group BB, DBP ranged from 75 ± 6.7 to 76 ± 7.9 mm of Hg. There was no significant difference in diastolic blood pressure between two groups (p > 0.05).

Table 4: Oxygen saturation (%)

Time of Assessment	Mean+/- SD		P Value	Significance
	Bupivacaine-Fentanyl	Bupivacaine-Buprenorphine		
0 min	100 ± 0.61	100 ± 0.6	> 0.05	NS
5 min	100 ± 0.61	100 ± 0.5	> 0.05	NS
15 min	100 ± 0.67	100 ± 0.7	> 0.05	NS
30 min	100 ± 0.77	100 ± 0.6	> 0.05	NS
60 min	100 ± 0.9	100 ± 0.5	> 0.05	NS
2 hr	100 ± 0.67	100 ± 0.6	> 0.05	NS
6 hr	100 ± 0.6	100 ± 0.5	> 0.05	NS
12 hr	100 ± 0.82	100 ± 0.6	> 0.05	NS
24 hr	100 ± 0.61	100 ± 0.6	> 0.05	NS

NS: Not significant

In group BF, the mean O_2 saturation ranged from 100 ± 0.6% to 100 ± 0.9%.In group BB, the mean O_2 saturation ranged from 100 ± 0.5% to 100 ± 0.7. There was no significant difference in O_2 saturation between the two groups (p> 0.05).

Discussion

Brachial plexus blockprovides postoperative analgesia of short duration, even when a long-acting local anesthetic like Bupivacaine is used alone. Various adjuvant drugs like opioids, clonidine, neostigmine and hyaluronidase have been evaluated in conjunction with local anesthetics to prolong the period of analgesia. Fentanyl and buprenorphine are known to produce antinociception and to enhance the effect of local anesthetics when administered intrathecally and epidurally. Both these produce this effect by their action on opioid receptors. Opioid receptors are also found in peripheral nerves.

Hence, an attempt has been made to assess the efficacy of fentanyl and buprenorphine as an adjuvant to bupivacaine (0.25%) in brachial plexus block (supraclavicular approach) in terms of time of onset, duration of analgesia and sedation. Hemodynamic variables in first 24 hours were studied.

In our study, we found that the onset of sensory and motor blockwas slightly faster with BF group when compared to BB group. Onset of sensory block (group BF, 5.6 ± 1.8min; group BB, 6.2 ±1.8 min). Onset of motor block (group BF, 3.9 ± 1.3 min; group BB, 4 ± 1.4 min). The statistical analysis by student's unpaired 't' test showed that, the time for onset of sensory and motor block in group BF was not significantly faster when compared to group BB (p>0.05). This does not correlate with the study done by Kardash et al [5] who achieved the onset of the sensory and the motor blocks at 2.9 ± 1.9 min and 4.0 ± 3.1 min, respectively with fentanyl.As compared to the study done by Nishikawa et al [6] 100µg of fentanyl may have reduced the rate of nerve penetration of lidocaine, thus resulting in a slower onset of analgesia. With 100µg of fentanyl in 40 ml of 1.5% lidocaine with 1:2,00,000 epinephrine in the brachial plexus block by the axillary approach, they found a similar delay in the time which was required for the complete sensory block. They concluded that the decrease in pH of lignocaine from 6.2 to 5.2 by the addition of 100µg of fentanyl.

Jadon et al [7] examined the benefit of adding buprenorphine to 30 ml of 0.3% bupivacaine in the supraclavicular block. In their study, the onset time of the motor block (4.05 ± 0.94 min) was significantly faster than the onset of the sensory block (6.65 ± 1.18 min), which correlates with our study. This can be explained by the "core and mantle concept" of Winnie et al [8].

Klein et al [9] in their study, observed that the mean onset time for both the motor and sensory blockade was < 6 min when 30 ml of 0.5% bupivacaine, 0.5% ropivacaine and 0.75% ropivacaine was used in 3 different groups in the interscalene block. They premedicated their patients with intravenous midazolam (1-5 mg) and fentanyl (50-250 ìg), which probably enhanced the onset of the block, which does not correlate with our study [9].

Duration of motor block slightly longer in BB group

when compared with BF group (group BF, 290 ± 59 min; group BB, 301 ± 72 min) but this was not significant.

In our study, we found that the duration of sensory block and analgesia was significantly longer in patients who received a combination of Buprenorphine and Bupivacaine compared with Fentanyl and Bupivacaine. Duration of sensory block (group BF, 526 ± 107 min; group BB,600 ± 127 min). Duration of analgesia (group BF,661 ± 91.5min; group BB, 891 ± 105 min). Jadonet al [7] noted that the total duration of motor block with buprenorphine was 329.2 ± 28.4 min, whereas in our study, it was 301 ± 72 min, which is comparable. This can be explained by the fact that bupivacaine, a long acting local anesthetic, was used and buprenorphine as such, does not have effect on the motor block. From the above findings, we can suggest that opioids can be safely and effectively used in the brachial plexus block for post- operative analgesia even in day care surgery.

The more lipophilic the opioid (buprenorphine> fentanyl) the longer the effect seems to last.

In our study, a volume of 40 ml of local anesthetic agent was taken as this volume was associated with a more complete spread forbrachial plexus block as found by Winnie and colleagues [10]. The particular dose of Buprenorphine (0.3 mg) was selected fromprevious studies [11,12]. The duration of sensory blockade in our studygroup was significantly longer in Buprenorphine and Bupivacaine group, this resultis comparable with other studies which found no difference in onset of sensory block but found longer duration of blockade [13,14]. Post-operative analgesia was prolonged in buprenorphine group, in which our study and other studies [12, 15] came to similar conclusions. With addition of buprenorphine to local anesthetic agents, the onset and duration of motor blockade was comparable, this finding corroborated with other such studies [11,13]. Many studies suggest that Buprenorphine and other opioids have action on peripheral nerves [16,17] along with portable local anesthetics [18]. This suggests the usefulness ofBuprenorphine in peripheral perineuronal route administration [19].

Conclusions

The onset time of sensory and motor block and the duration of motor block with buprenorphine compared to fentanyl were almost the same. However, the duration of sensory block was longer with buprenorphine and also provided longer duration of analgesia compared to fentanyl. The intraoperative sedation was comfortable without any need for airway assistance with buprenorphine. There were no significant differences in hemodynamic variables of pulse rate, systolic BP, diastolic BP and oxygen saturation.The easy availability and lack of significant side effects like respiratory depression and sedation makes Buprenorphine an attractive choice as an adjuvant for brachial plexus block.

References

1. Bone HG, van Aken H, Brooke M, Burkle H, Brooke M, Burkle H. Enhancement of axillary brachial plexus block anaesthesia by coadministration of neostigmine. RegAnesth Pain Med 1999; 24:405-10.
2. Bazin JE, Massoni C, Bruelle P, Fenies V, Groslier D, Schoeffler P. The addition of local anaesthetics in brachial plexus block: The comparative effects of morphine, buprenorphine and sufentanil. Anaesthesia. 1997; 52:858-62.
3. Keeler JF, Simpson KH, Ellis FR, Kay SP. Effect of addition of hyaluronidase to bupivacaine during axillary brachial plexus block. Br J Anaesth. 1992; 68: 68-71.
4. Culebras X, Van Gessel E, Hoffmeyer P, Gamulin Z. Clonidine combined with a long acting local anesthetic does not prolong post-operative analgesia after brachial plexus block but does induce haemodynamic changes. AnesthAnalg. 2001; 92: 199-204.
5. Kardash K, Schools A, Concepcion M. Effects of brachial plexus fentanyl on supraclavicular block: A randomized double-blind study. Regional Anesthesia. 1995; 20(4):311–5.
6. Nishikawa K, Kanaya N, Nakayama M, Igarashi M, Trunoda K, Namiki A. Fentanyl improves analgesia but prolongs the onset of axillary brachial plexus block by peripheral mechanism.AnesthAnalg 2000; 91(2):384-7.
7. Jadon A, Panigrahi MR, Parida SS, Chakraborty S, Agrawal PS, Panda A. Buprenorphine improves the efficacy of bupivacaine in nerve plexus block: A double blind randomized evaluation in subclavian perivascular brachial block. J AnaesthClin Pharmacol. 2009; 25(2): 207-10.
8. Winnie AP, Tay CH, Patel KP, Ramamurthy S, Durrani Z. Pharmacokinetics of local anesthetics during plexus block. Anesth Analg.1977; 6(6):852-61.
9. Klein SM, Greengrass RA, Steele SM, D'Ercole FJ, Speer KP, Gleason DH et al. A comparison of 0.5% bupivacaine, 0.5% ropivacaine, and 0.75% ropivacaine for interscalene brachial plexus block.Anesth Analg. 1998; 87(6):1316-9.

10. Winnie AP, Radonjic R, Akkineni SR, et al. Factors influencing distribution of local anaesthetic injected into the brachial plexus sheath. AnesthAnalg1979; 58:225–234.

11. Franco CD**,** Candido KD, Khan MA, Winnie AP, Raja DS**.** Buprenorphine added to thelocal anesthetics for brachial plexus block to provide postoperative analgesiainoutpatients. RegAnesth Pain Med. 2001; 26(4):352-6.

12. Candido KD, Winnie AP, Ghaleb AH, Fattouh MW, Franco CD. Buprenorphine Added to theLocal Anesthetic for Axillary Brachial Plexus Block Prolongs Postoperative Analgesia. RegAnesth Pain Med 2002; 27:162 167.

13. Jadon A, Panigrahi MR, Parida SS, Chakraborty S, Agrawal PS, Panda A.Buprenorphine Improves the Efficacy of Bupivacaine in Nerve Plexus Block: ADouble Blind Randomized Evaluation in Subclavian Perivascular Brachial Block. TheInternet Journal of Anesthesiology 2008; 16: 2.

14. Boogaerts J, Lafont N. Mechanism of action and clinical use of opioids administered bythe peripheral perineural route. CahAnesthesiol. 1991; 39(2):91-5.

15. Bazin JE, Massoni C, Bruelle P,Fenies V, Groslier D, Schoeffler P. The addition of opioids to local anaesthetics in brachial plexus block: the comparative effects of morphine, buprenorphine and sufentanil. Anaesthesia1997; 52(9):858 –862.

16. Vitenbek IA, Zhakupov RK, Girshan AI, The perineural administration of opiates during regional conduction block of nerve trunks and plexuses. AnesteziolReanimatol.1991; (4):56-9.

17. Mays KS, Lipman JJ, Schnapp M .Local analgesia without anaesthesia using peripheral perineural morphine injections. AnesthAnalg. 1987; 66(5): 417-20.

18. Aaron GJ, Laverne GD, Datta S, John M, Benjamin CG. Effects of Fentanyl and Sufentanil on Peripheral Mammalian Nerves.AnesthAnalg1987; 66:1272-1276.

19. Stein Christoph, Priv Doz. Peripheral Mechanisms of Opioid Analgesia, AnesthAnalg1993; 76:182-191.