**International Journal of Multidisciplinary Research and Development**
**Online ISSN: 2349-4182, Print ISSN: 2349-5979, Impact Factor: RJIF 5.72**
**www.allsubjectjournal.com**
**Volume 4; Issue 1; January 2017; Page No. 121-123**

# Fentanyl as an adjuvant to bupivacaine in infraclavicular brachial plexus block

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**Abstract**
**Background:** Several adjuvants have been suggested to enhance the analgesic effect of local anesthetics. This study aimed at comparing the analgesic efficacy of fentanyl when added to bupivacaine for infraclavicular brachial plexus block in forearm orthopaedic surgeries.
**Methods**: Sixty ASA I and II patients were divided into 2 groups, group B (30) and BF (30).Ultrasound guided infraclavicular brachial plexus block was performed in group B using 0.5% bupivacaine 30 ml plus 1 ml NS (total 31 ml) and in group BF using 0.5% bupivacaine plus 1 µg/kg fentanyl in 1 ml NS (total 31 ml). Onset times of sensory and motor block, duration of sensory and motor block were recorded.
**Results:** Group BF showed a significant greater duration of sensory and motor blockade (*P*=0.0001) than group B.
**Conclusions:** Addition of fentanyl to bupivacaine significantly prolongs the duration of analgesia compared to bupivacaine for infraclavicular brachial plexus block.

**Keywords:** brachial plexus block-ultrasound guided-fentanyl

## 1. Introduction
For surgery in the upper limb brachial plexus block remains the only practical choice if general anesthesia is not suitable. Moreover it provides a superior analgesia and avoids the common side effects associated with general anesthesia. It can be extremely useful in patients with significant co-morbidities such as severe cardiovascular and respiratory disease. In addition, it is easy to manage other disease conditions such as diabetes mellitus, where perioperative fasting can be minimized, and conscious level continuously monitored. Single-shot peripheral nerve blocks as an alternative to general anesthesia and an opioid-sparing analgesic have become a standard anesthesia practice all over the world. Unfortunately commercially available local anesthetics have a limited duration of analgesia. So, adjuvants to local anesthetics have been used to improve the quality or onset of the regional blockade or to prolong the postoperative analgesia time.
Studies have shown an increase in the block duration and success rate of brachial plexus block on addition of fentanyl adjuvant [1, 2], but some studies show no additional benefit [3]. This enhanced antinociception may have been mediated via activation of peripheral opioid receptors [4]. There are also reports that Fentanyl may have local anaesthetic like action [5]. The infraclavicular approach is reliable and safe for brachial plexus blockade for any surgery involving the upper extremity, but not the shoulder. This study was carried out to study the effect of adding (1µg/kg) fentanyl to 30 ml bupivacaine (0.5%) for ultrasound guided infraclavicular brachial plexus block in orthopedic surgery.

## 2. Materials and methods
### 2.1 Materials
This clinical study was carried out in our university hospital between June 2013 and August 2015. After approval of the local ethics committee an informed written consent was obtained from all study participants. The study was a prospective double blinded controlled study that aimed at comparing the effect of adding fentanyl to bupivacaine in infraclavicular brachial plexus block. Sixty five ASA I or II patients scheduled for elective orthopedic upper limb surgeries were included, five cases were excluded due to block failure. Patients were excluded from the study if their ages <18 or >60, obese patients with BMI >30, suspected coagulopathy, hypersensitivity to the study drugs, localized or systemic infection, cardiovascular, renal disease and patients having brachial plexus neuoropathy or chronic pain.
Based on a computer generated random table, patients were randomly allocated into 2 groups: Group B (n=30) received 0.5% bupivacaine 30 ml plus 1 ml NS (total 31 ml) in infraclavicular brachial plexus block, Group BF (n=30) received 0.5% bupivacaine plus 1 µg /kg fentanyl in 1 ml NS (total 31 ml). All the drug containing syringes were prepared by a third anesthesia physician not participating in this study.

### 2.2 Methods
In the pre-operative room, an intravenous access was secured and a monitor was attached to the patient 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 midazolam 0.03mg/kg was given intravenously and later shifted to the operation room.

### 2.3 Technique
Under proper monitoring, aseptic technique and after wrapping the ultrasound transducer inside a sterile sheath, the ultrasound probe was applied sagitally under the clavicle just medial to the coracoids process. A 21 gauge echogenic needle was inserted with an "in plane technique" through the pectoralis major and minor muscles to reach the posterior cord

of the brachial plexus just under the axillary artery. After gentle aspiration 20 ml of the local anesthetic was injected near the posterior cord and 10 ml around the lateral cord. A nerve stimulator was also used to confirm the proper position of the tip of the needle and to avoid intra-neural injection.

### 2.4 Data collection

Evaluation of sensory and motor block onset was performed every 3 minutes interval after needle withdrawal, up to 30 minutes. Sensory block was evaluated by the pinprick test on a three-point scale (0, normal sensation; 1, blunted sensation; 2, no perception). Assessment of motor block was derived from the technique described by Bromage [6] on a three-point scale (0, normal motor function with full flexion and extension of elbow, wrist, and fingers; 1, decreased motor strength with ability to move fingers only; 2, complete motor block with inability to move fingers). Failed block was defined as patient complaining of considerable pain to surgical stimulus at the operative site 30 minutes after brachial plexus block. In cases of failed block conversion to general anesthesia was done. Postoperatively motor and sensory block assessment was done every 30 minutes by anesthesia doctor performing the block. Duration of motor block was deemed from the time of injection of nerve block till the return of all range of motor movements in the hand. Duration of sensory block was deemed from the time of injection of nerve block till the return of full sensation. Duration of analgesia was deemed from the time of administration of nerve block till a VAS score of ≥4 was noted. Rescue analgesia in the form of injection ketorlac 30 mg slow IV was administered when a VAS scores of ≥4 cm was recorded.

### 2.5 Statistical Analysis

All data were represented and analyzed using SPSS version 22. Data were represented as numbers, ratios and mean ± SD as appropriate. For comparison between parametric data, student t-test was used. For qualitative data (type of operation and gender) Chi square test or Fisher exact test was used. Power of significance $P < 0.05$was considered to be statistically significant.

## 3. Tables and figures

**Table 1:** Demographic parameters of the studied groups

| | | Group B (n= 30) | Group BF (n= 30) | P-value |
|---|---|---|---|---|
| Age (years) | | 30.17 ± 10.08 | 34.00 ± 9.99 | 0.083 |
| Sex: No. (%) | Male | 25 (83.3%) | 24 (80.0%) | 0.739 |
| | Female | 5 (16.7%) | 6 (20.0%) | |
| Weight (kg) | | 76.07 ± 3.58 | 76.77 ± 4.97 | 0.361 |
| Height (cm) | | 167.00 ± 4.02 | 165.67 ± 4.10 | 0.200 |
| BMI (Kg/ $m^2$) | | 27.30 ± 1.46 | 28.00 ± 1.98 | 0.125 |
| ASA: No. (%) | ASA I | 26 (86.7%) | 27 (90.0%) | 0.688 |
| | ASA II | 4 (13.3%) | 3 (10.0%) | |
| Duration of surgery (min) | | 100.33±10.33 | 101.67±12.62 | 0.598 |

Data were represented as mean±SD unless otherwise indicated Group B= Bupivacaine group Group BF=Bupivacaine fentanyl group

**Table 2:** block characteristics

| | Group B (n= 30) | Group BF (n= 30) | P-value |
|---|---|---|---|
| Complete sensory block onset (min) | 14.77 ± 2.56 | 14.03 ± 1.77 | 0.331 |
| Complete motor block onset (min) | 26.40 ± 3.64 | 24.23 ± 2.63 | 0.221 |
| Duration of sensory block(hours) | 9.73 ± 1.14 | 13.40 ± 1.45 | 0.000* |
| Duration of motor block(hours) | 7.90 ± 1.27 | 11.40 ± 1.96 | 0.000* |
| Duration of analgesia (hours) | 10.77 ± 1.10 | 14.57 ± 1.04 | 0.000* |

Data are represented as Mean ± SD Group B= Bupivacaine group Group BF=Bupivacaine fentanyl group

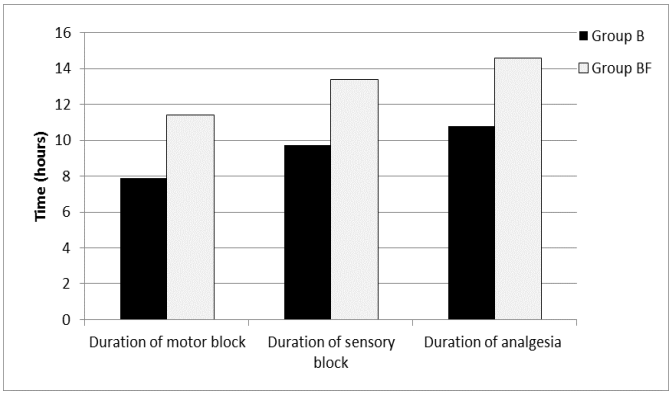


**Fig 1**

## 4. Results & Discussion

### 4.1 Results

The age, sex, weight, height and other demographic data were comparable between both groups. The operative procedures performed were predominantly orthopedic surgeries followed by soft tissue surgeries (i.e. tendon transfer). Regarding the block characteristics we found that the onsets of sensory and motor block were almost comparable in both study and control groups. Motor block duration was also significantly prolonged (13.40 ± 1.45) hours in the study group compared to (7.90 ± 1.27) hours the control group. Sensory block duration was significantly prolonged (11.40 ± 1.96) hours in the study group compared to (9.73 ± 1.14) hours the control group. There was also a significant prolongation of analgesia time in BF group compared to control group. First analgesic request was after (14.5±1.04) hours compared to 10.7±1.1 hours in control group.

### 4.2 Discussion

The results obtained show that the addition of fentanyl (1 µg /kg) to bupivacaine 0.5% (30 ml) for infraclavicular brachial plexus blocks significantly prolonged the duration of sensory and motor blockade but the sensory and motor block onset times were almost comparable in both groups. Tow possible mechanisms of action for the improved analgesia produced by the peripheral application of fentanyl; First, fentanyl could act directly on the peripheral nervous system. Primary afferent tissues (dorsal roots) have been found to contain opioid-binding sites [7]. Because the presence of bidirectional axonal transport of opioid-binding protein has been shown [8]. Fentanyl may penetrate the nerve membrane and act at the

dorsal horn. This could also account for the prolonged analgesia. However, fentanyl is reported to have a local anesthetic action [5]. Second, fentanyl may potentiate local anesthetic action via central opioid receptor–mediated analgesia by peripheral uptake of fentanyl to systemic circulation [9]. Some studies have similar results supporting our study;

Karakaya *et al.* studied the effect of adding 100 µg fentanyl to 2 different concentrations of bupivacaine (0.25% and 0.125%) in axillary brachial plexus block and he concluded that the addition of 100 µg fentanyl to 0.25% bupivacaine almost doubles the duration of analgesia following axillary brachial plexus block when compared with 0.25% bupivacaine alone [2].

Geze *et al.* compared the effect of adding tramadol or fentanyl as adjuvant agents to local anesthetic mixtures in axillary plexus block for orthopedic upper extremity surgery. He concluded that the addition of tramadol or fentanyl to local anesthetic mixtures as an adjuvant agent for axillary block provide better postoperative analgesia for orthopedic upper extremity surgery. Furthermore tramadol more improves the block quality than fentanyl [10].

Madhusudan *et al.* studied the effect of adding fentanyl or tramadol to ropivacaine in supraclvicular brachial plexus block for upper limb orthopedic surgeries. They concluded that there is a significant beneficial effect from addition of opiods to local anesthetics on duration of sensory, motor blockade and VAS scores compared to plain ropivacaine alone [11].

Sindjelic *et al.* studied the effect of adding fentanyl to local anesthetic mixture for cervical plexus block in carotid end arterectomy (CEA). Sindjelic *et al.* concluded that the addition of fentanyl to local anesthetics improved the quality and prolonged the duration of cervical plexus block in patients undergoing CEA [12].

In 2000, Nishikawa *et al.* found that the addition of fentanyl to axillary blocks with lidocaine plus epinephrine increased block duration by approximately one hour, but delayed block onset in all branches. It was speculated that this delay was caused by differences in pH of the injectates [1].

However other studies showed no benefit of adding fentanyl to local anesthetics.

Kardas *et al.* stated that 75 µg fentanyl did not produce any change in blockade characteristics in 1.5% mepivacaine induced supraclavicular brachial block.

Bhuvaneswari *et al.* found that addition of fentanyl to 0.25% bupivacaine plus epinephrine paravertebral blocks prolonged analgesia to 18 hours, which was comparable to the duration of blocks with 0.5% bupivacaine plus epinephrine [13].

These conflicting results are probably caused by differences in local anesthetics or techniques for nerve blockade. It is well known that the injection site of the local anesthetic attribute varying clinical effects in addition to the concentration and the approach to the brachial plexus.

Our study did not evaluate the intraoperative haemodynamic parameters, sedation scores of patients or causes of block failure. Moreover we did not obtain fentanyl serum level to know whether the analgesic effect was due to local effect or due to systemic absorption.

## 5. Conclusion

The addition of fentanyl to bupivacaine for infraclavicular brachial plexus block prolongs the duration of sensory, motor and analgesia time, but it has no effect on the onset of sensory and motor block compared to bupivacine.

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