

# The Efficacy of Fentanyl as An Adjunct to Vertical Infraclavicular Brachial Plexus Block Performed with Lidocaine and Bupivacaine

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## Abstract

**Background and objective:** Different opioids have been added to local anaesthetics in the attempt to enhance the quality of anaesthesia and analgesia of the brachial plexus block. Our aim was to evaluate the effect of fentanyl on the quality of nerve block after vertical infraclavicular brachial plexus block and on the postoperative analgesia.

**Methods:** In this prospective, randomized, double blind and controlled study, 60 adult patients received a mixture of 30 ml of 1% lidocaine with adrenaline 1: 200000 and 10 ml of 0.5% bupivacaine. The Fentanyl group (n=30) received fentanyl 1µg kg<sup>-1</sup> diluted up to 5 ml of 0.9% saline. The control group (n=30) received 5 ml of 0.9% saline.

We evaluated the sensory block at 5, 10, 15 and 30 minutes and the motor block at 30 minutes after injection of the anaesthetic agents. The postoperative analgesia was recorded for the first 24 hours from the time immediately after injection of the anaesthetic agents.

**Results:** Two patients in group F and 3 patients in group C were excluded because of unsuccessful blockade. The loss of sensation of the radial nerve in group F at 5, 10, 15 and 30 minutes was significantly faster compared with group C ( $P < 0.001$ ). Otherwise, there was no difference between the two groups on both sensory and motor blocks ( $P > 0.05$ ). The duration of postoperative analgesia was slightly longer in the Fentanyl than in the control group, mean (10.3 h  $\pm$  2.4 vs. 9.4 h  $\pm$  2.5) with no statistical significance ( $P > 0.05$ ).

**Conclusion:** The addition of fentanyl 1µg kg<sup>-1</sup> to local anaesthetic mixture prolongs the duration of postoperative analgesia but does not provide clear benefits regarding the onset of sensory and motor block.

**Keywords:** Anaesthetic techniques, regional, brachial plexus, analgesics opioid, fentanyl.

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## **Introduction**

Different studies have investigated the use of numerous additives including Clonidine,<sup>1-3</sup> Tramadol,<sup>4-6</sup> Ketamine,<sup>7</sup> Neostigmine<sup>8</sup> and Dexamethasone<sup>9</sup> to local anaesthetics for peripheral plexus blockade in an attempt to enhance the quality and duration of anaesthesia and postoperative analgesia.<sup>10</sup>

Furthermore, several opioids have been added to local anaesthetics for brachial plexus block (BPB),<sup>11-14</sup> but the results remain inconclusive. Some investigators demonstrated prolonged anaesthesia and analgesia of BPB after adding opioids,<sup>11,12</sup> others found no benefits from its use for BPB.<sup>13,14</sup>

The use of fentanyl has not been investigated in the setting of vertical infraclavicular approach of the brachial plexus; therefore we decided to undertake a prospective, randomized, double blind and controlled clinical trial to study the efficacy of adding fentanyl to local anaesthetics; assuming that the hypothesis fentanyl provides benefits to the nerve block characteristics.

## **Materials and Methods**

After obtaining local Ethics Committee approval and written informed consent, 60 patients, with the ASA physical status I, II and III, aged 24-70 yr, weighing 55-86 kg scheduled for hand, forearm and elbow surgery were included in this study. The exclusion criteria were allergy to any study medication, morbid obesity and pregnancy. The patients were randomly divided into two groups using a sealed envelope technique. Group F (n=30) received fentanyl 1µg kg<sup>-1</sup> made up to 5 ml with 0.9% saline. Group C (n=30) received 5 ml of 0.9% saline as a control group.

All patients received 30 ml of 1% lidocaine with adrenaline 1: 200000 and 10 ml of 0.5% bupivacaine.

When the patients were in the anaesthetic room, an intravenous (i.v.) cannula was inserted into the contralateral arm, and a routine non-invasive monitoring was applied.

Vertical infraclavicular brachial plexus block was performed with the patient lying supine with the arm to be blocked on the abdomen. The head of the patient was facing away from the side of the block. We identified by palpation the coracoid process and the sternal clavicular head. The site of needle insertion was marked half way between the coracoid process and the sternal clavicular head, caudal in immediate proximity of the clavicle.<sup>15</sup>

Using a sterile technique and following cutaneous local anaesthesia with 1 – 2 ml of 2% Lidocaine, a 55 mm 22-gauge insulated short-bevel stimulating needle (Stimuplex ®D, B. Braun, Melsungen AG, Germany) attached to a nerve stimulator (Stimuplex® HNS11, B.Braun, Melsungen AG, Germany) was inserted vertical to the skin. The initial stimulating current was 1.0 mA.

Once the stimulation of the brachial plexus (hand twitches) was obtained, the intensity of the current was then progressively reduced until the sought response was present at 0.3 mA or less. After negative aspiration for blood, the local anaesthetics were injected with intermittent aspiration to rule out inadvertent intravascular injection of the local anaesthetics. At that point, the operating room stop clock was started. The same anaesthesiologist (first author) performed all blocks in both groups. An anaesthetist not otherwise involved in the study prepared the anaesthetic solution. An independent blinded observer evaluated the extent of sensory block at 5, 10, 15 and 30 minutes and motor block 30 minutes after injection of the anaesthetic solution. Sensory block of medial brachial cutaneous, medial antibrachial cutaneous, musculocutaneous, radial, median and ulnar nerves was assessed by pinprick (27-gauge needle) and compared to the same stimulation on the contralateral arm. Blockade of each nerve was rated by the patient on a verbal analogue scale from 100% (no sign of sensory blockade) to 0% (complete sensory blockade).

Motor block was evaluated by thumb abduction (radial nerve), thumb adduction (ulnar nerve), thumb opposition (median nerve) and flexion of

the elbow in supination and pronation of the forearm (musculocutaneous nerve). Motor block was determined according to a modified Lovett rating scale ranging from 0 (complete paralysis) to 6 (normal muscular force) (Table 1).<sup>6</sup>

**Table (1): Quantification of muscle force according to a modified Lovett rating scale.**

- 0 complete paralysis
- 1 almost complete paralysis
- 2 pronounced mobility impairment
- 3 slightly impaired mobility
- 4 pronounced reduction of muscular force
- 5 slightly reduced muscular force
- 6 normal muscle force

A complete sensory block was defined as a reduction in the sensibility to 20% or less. The patients were taken to the operating room when a complete block has been achieved in the area of surgery or 45 minutes after the completion of the local anaesthetic administration.

If adequate pinprick analgesia had not been achieved in the area of surgery after 45 minutes, the block was considered as a failure and the patient received general anaesthesia and was excluded from the evaluation.

The duration of postoperative analgesia was considered as the time from the completion of the local anaesthetic administration to the first analgesic request.

**Table (2): Clinical characteristics.**

<b>Variable</b>	<b>Control group (n=30)</b>	<b>Fentanyl group (n=30)</b>
Age (years)	48.2 ± 10.6	49.5 ± 14.2
Gender (F:M)	19:11	21:9
ASA I:II:III	17:7:6	14:9:7
Weight (kg)	70.3 ± 9.0	67.80 ± 7.627
Height (cm)	170.4 ± 4.7	172.9 ± 4.1
Duration of Surgery (min)	59.4 ± 24.3	62.9 ± 22.4
<b>Location of surgery</b>		
Forearm and Hand	15	16
Elbow trauma	9	7
Anticubital fossa	6	7
Unsuccessful blocks	3 (10%)	2 (6.7%)

**Results are expressed as mean ± standard deviation (SD) or absolute number or percentage. P values of comparison between groups were not significant.**

An anaesthetist or nurse, who was unaware of the anaesthetic solution used, recorded this time. At this time, the evaluation was stopped for the patient concerned.

Data were presented as mean and standard deviation. Statistical evaluation was done with the student's t-test and the chi-square test, incorporating Fisher's exact test where appropriate. P value ≤ 0.05 was considered statistically significant. Statistical calculations were performed using the Statistical Package for the Social Sciences Software Program version 13 (SPSS®, Inc).

### Results

Of the 60 patients enrolled in this study, 30 patients were randomly assigned to each treatment group. Analysis of patient characteristics demonstrated no significant differences between groups (Table 2).

Brachial plexus block was successful in 27 patients in Group C and in 28 patients in Group F. Three patients in group C and two patients in group F failed to achieve satisfactory levels of anaesthesia in the area of surgery. They underwent general anaesthesia and were excluded from the evaluation. The success rate at 30 minutes was overall 91.7%.

As shown in Table (3), the loss of sensation of the radial nerve in-group F at 5, 10, 15 and 30 minutes was significantly faster compared to group C ( $P < 0.001$ ). Significant difference in the quality of sensory block was not seen in any other peripheral nerve distribution.

**Table (3): Sensory blockade of vertical infraclavicular brachial plexus.**

Sensory Blockade <sup>+</sup>	Control group (n=27)				Fentanyl group (n=28)			
	5 min	10 min	15 min	30 min	5 min	10 min	15 min	30 min
MBCN	58.9±9.2	47.6±8.6	17.3±6.4	6.1±2.1	55.7±7.0	46.8±8.3	17.0±5.8	5.7±2.2
MACN	21.7±6.8	15.2±4.4	6.11±2.9	1.3±2.3	21.4±6.8	14.7±4.0	5.4±2.7	1.3±2.2
MC	54.3±7.4	37.6±6.0	22.3±2.9	2.9±2.8	53.2±7.0	38.0±6.2	21.4±3.0	3.6±3.3
RAD	67.2±7.4	54.4±8.2	26.1±5.3*	5.6±1.6	58.0±4.6*	42.9±7.9*	20.4±4.9*	3.8±2.0*
MED	36.5±11.6	19.3±6.3	4.0±1.9	1.0±0.9	35.2±10.8	21.3±6.5	4.0±2.2	1.0±1.5
ULN	32.6±7.9	10.4±5.2	5.2±3.0	2.2±3.2	35.0±5.6	10.4±5.6	5.0±2.4	2.5±3.2

Values are expressed as mean ± (SD).

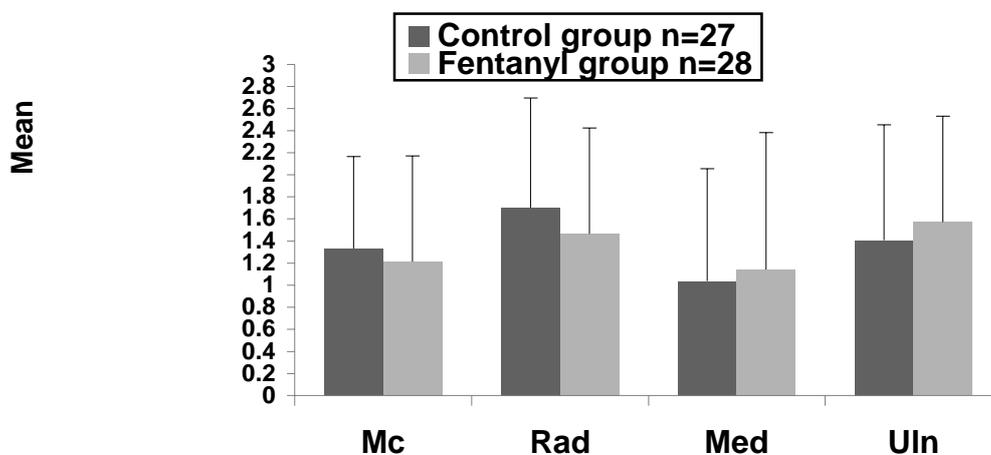
MBCN = Medial Brachial Cutaneous Nerve, MACN = Medial Antibrachial Cutaneous Nerve, MC = Musculocutaneous Nerve, RAD = Radial Nerve, MED = Median Nerve, ULN = Ulnar Nerve.

\* Significantly different from control group ( $p < 0.001$ ).

+Sensory blockade was assed by pinprick and compared to the same stimulation on the contralateral arm and rated on a scale from 0% (no sensation) to 100 % (complete sensation).

The motor block of vertical infraclavicular brachial plexus of each nerve distribution at 30-min point is presented in figure (1); no statistically significant differences were observed between the two groups (figure 1).

Five patients in group C (18.5%) and 7 patients in group F (21.4%) did not ask for pain medication in the first 24 h. The duration of satisfactory analgesia was slightly longer in the Fentanyl than in the control group, (mean  $10.3 \pm 2.4$  h vs.  $9.4 \text{ h} \pm 2.5$ ,  $P > 0.05$ ), but that was not statistically significant ( $P > 0.05$ ).



**Figure (1): Motor blockade of the four nerves at 30 minutes after completion of block procedure.**

Mc = Musculocutaneous Nerve, Rad = Radial Nerve, Med = Median Nerve, Uln = Ulnar nerve.

Values are expressed as mean and SD. Motor block was determined according to a modified Lovett rating scale ranging from 6 (normal muscular force) to 0 (complete paralysis).

## **Discussion**

The main finding of our prospective, randomized, double-blind and controlled study was that adding a small dose of fentanyl 1µg kg<sup>-1</sup> to a mixture of local anaesthetic in a brachial plexus block, using the vertical infraclavicular approach, does not improve the nerve block characteristics in terms of onset time, quality of nerve blockade, or duration of postoperative analgesia.

The analgesic mechanism of opioids administered into the brachial plexus has not been elucidated. It may be by a direct local action on the nerve itself, facilitation of local anaesthetic action, or systemic absorption.<sup>16</sup> Several opioids have been added to local anaesthetics in the attempt to enhance the brachial plexus block analgesia, but the results are conflicting. Some authors reported prolonged analgesia,<sup>11,12</sup> and others reported results close to ours.<sup>13,14</sup> One suggestion for such inconclusive results is that certain opioids may be unable to penetrate layers of myelin. These are particularly numerous on the proximal nerve axons found in the brachial plexus.<sup>17</sup>

Bazin et al.<sup>11</sup> reported that the more lipophilic the opioid, the longer was the effect on postoperative pain relief after peripheral nerve block with a lidocaine-bupivacaine mixture. In our study, we used the highly lipophilic opioid fentanyl in a dose of 1µg kg<sup>-1</sup>, but we did not find any effects on the time to onset of nerve block or time to first request for postoperative pain medication, although our study demonstrated improvement in the onset of anaesthesia in one peripheral nerve distribution. Improvement was not seen in any other distribution or in the development of paresis. These findings are therefore unlikely to be clinically important.

Similar results were reported by Kardash et al.<sup>18</sup> who failed to demonstrate any clinically-relevant effect of fentanyl on supraclavicular block characteristics.

To our knowledge, the use of fentanyl has not been investigated in the setting of vertical infraclavicular approach of the brachial plexus. In our centre, the vertical infraclavicular approach of the brachial plexus is routinely used for the surgical procedure of the distal arm, forearm and hand to overcome the limitations of the axillary approach such as the difficulty to block the musculocutaneous nerve.<sup>19</sup> In our study, anaesthesia was documented for this nerve in 100% of patients in both groups. Three patients in the control group and 2 patients in the fentanyl group (approximately 8.34% of the patients in this study) failed to achieve satisfactory levels of anaesthesia in the area of surgery after 45 minutes and required induction of general anaesthesia. These 5 patients were excluded from the evaluation. The success rate of 91.7% (n=55) is comparable to success rates that have been reported in some previous studies on various local anaesthetics. Sufficient surgical analgesia was reported by Rettig et al.<sup>20</sup> in 90%, by Kilka et al.<sup>15</sup> in 95% of the patients at 30 min. and by Neuburger et al.,<sup>21</sup> who was specifying the time of assessments, in 88% of the patients.

In our study, we found a slightly prolongation of postoperative analgesia in the fentanyl group (10.3 h vs. 9.4 h). This prolongation did not reach statistical significance. Our method for the evaluation of postoperative analgesia was based on subjective character and not objective.

However, the same method has been applied in other clinical studies assessing the duration of postoperative analgesia.<sup>11,13</sup>

The use of bupivacaine as long-acting local anaesthetic agent and adrenalized Lidocaine may have masked the effect of fentanyl.

In Conclusions, our data do not support the hypothesis that adding fentanyl as an opioid in the local anaesthetic solution prolongs its duration of action in brachial plexus block. We did not demonstrate a clinically-important local anaesthetic or peripheral analgesic effect of fentanyl 1µg kg<sup>-1</sup> as an adjunct to vertical infraclavicular brachial plexus block with adrenalized lidocaine and bupivacaine.

The degree of improvement in quality of postoperative analgesia anaesthesia is unlikely to render this technique clinically useful.

What is clear from our study is that the vertical infraclavicular brachial plexus block with admixture of 30 ml of adrenalized 1% lidocaine and 10 ml of 0.5% bupivacaine gives satisfactory postoperative analgesia.

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## كفاءة إضافة الفنتانيل إلى البوفيفاكابين والليدوكاين على الإحصار تحت الترقوي للضفيرة العضدية

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### الملخص:

الخلفية والهدف: لقد تم إضافة العديد من مختلف افونيات المفعول إلى المخدرات الموضعية في المحاولة لتحسين نوعية تخدير الضفيرة العضدية ونوعية فقدان الشعور بالألم.

هدف هذه الدراسة هو تقييم إضافة الفنتانيل الى الإحصار العمودي تحت الترقوي للضفيرة العضدية وعلى نوعية هذا الإحصار وعلى نوعية فقدان الشعور بالألم ما بعد الجراحة.

الطرق: اجريت هذه الدراسة على 60 مريضاً بالغاً تتراوح اعمارهم من 24 إلى 70 عاماً وينتمون إلى الدرجات الاولى والثانية والثالثة حسب تصنيف جمعية التخدير الامريكية والذين اجريت لهم عمليات جراحية تحت التخدير العمودي تحت الترقوي للضفيرة العضدية، حيث تم توزيع هؤلاء المرضى عشوائياً الى مجموعتين.

تم حقن جميع المرضى تحت الترقوة بخليط مكون من 30 مليلتر 1% ليدوكاين بالأدرينالين 1:200000 و 10 مليلتر 0.5% بوفيفاكابين. مجموعة الفنتانيل (30 مريضاً) اعطيت فنتانيل 1ميكروغرام لكل كغم مخففاً الى 5 مليلتر من محلول كلوريد الصوديوم 0.9%. اما المجموعة القياسية (30 مريضاً) اعطيت 5 مليلتر من محلول كلوريد الصوديوم 0.9%.

تم تقييم الاحصار الحسي 5، 10، 15 و 30 دقيقة والاحصار الحركي 30 دقيقة بعد الحقن و فقدان الشعور بالألم ما بعد الجراحة للساعات الـ 24 الأولى منذ الوقت مباشرة بعد حقن ادوية التخدير الموضعية.

النتائج: مريضان من مجموعة الفنتانيل و3 مريض من المجموعة القياسية تم استثنائهم من الدراسة بسبب الإحصار غير الناجح. فقدان الاحساس في العصب الكعبري في مجموعة الفنتانيل بعد 5، 10، 15 و 30 دقيقة كانت أسرع مقارنة بالمجموعة القياسية ( $P > 0.001$ ) ما عدا ذلك لم يكن هناك إختلاف بين المجموعتين فيما يتعلق بالاحصار الحسي والاحصار الحركي ( $P < 0.05$ ). مدّة فقدان الشعور بالألم ما بعد الجراحة كانت أطول قليلاً في مجموعة الفنتانيل من المجموعة القياسية.

الخاتمة: إضافة فنتانيل 1ميكروغرام لكل كغم إلى خليط المخدر الموضعي يُطيل مدّة فقدان الشعور بالألم ما بعد الجراحة لكن ليس له منافع واضحة بخصوص بداية ونوعية الاحصار الحسي والحركي.

الكلمات الدالة: التخدير النَّاحِي، ضفيرة عضدية، احصار تحت الترقوي، فنتانيل.