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A Clinical Comparision of Analgesia between Fentanyl and Clonidine as Adjuvant To 0.5% Levobupivacaine in Supraclavicular Brachial Plexus Block for Upper Limb Surgeries

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Abstract

This clinical study evaluates the analgesic efficacy of Fentanyl and Clonidine as adjuvants to 0.5% Levobupivacaine in supraclavicular brachial plexus blocks for upper limb surgeries. Effective pain management is essential during anesthesia, particularly in perioperative and postoperative periods. Peripheral nerve blocks, like the brachial plexus block, offer prolonged analgesia and various advantages over general anesthesia, such as reduced opioid use, fewer side effects (e.g., nausea, vomiting), and faster recovery times. The supraclavicular approach to brachial plexus block is especially notable for its high success rate, rapid onset, and ability to provide dense anesthesia for upper limb procedures.

Levobupivacaine, a long-acting local anesthetic with a duration of up to 8 hours, is commonly used for these blocks due to its excellent safety profile, particularly in reducing cardiotoxicity risks. Adjuvants like Fentanyl and Clonidine are often added to enhance the block's characteristics by promoting faster onset, extended analgesia duration, and improved overall quality of anesthesia. Fentanyl, a synthetic opioid, works by stimulating the μ-opioid receptor, enhancing postoperative pain relief. Clonidine, a selective partial α2-adrenoceptor agonist, has multiple analgesic mechanisms, including central effects, vasoconstriction, anti-inflammatory properties, and direct action on peripheral nerves. This study compares the onset and duration of sensory and motor block, as well as postoperative analgesia, between patients receiving Fentanyl and Clonidine (50 μg) with 25 ml of 0.5% Levobupivacaine. The results aim to determine which adjuvant provides superior analgesic outcomes, potentially reducing postoperative opioid consumption and enhancing patient comfort. By exploring these

effects, the study seeks to optimize pain management protocols for upper limb surgeries under regional anesthesia and improve patient recovery while reducing complications.

Keywords: Brachial plexus block, Supraclavicular approach, Levobupivacaine, Fentanyl, Clonidine, Postoperative analgesia, Peripheral nerve block, Upper limb surgery.

Introduction

Pain, as defined by the International Association for the Study of Pain (IASP), is an "unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage [1]." Effective pain relief during surgery and the postoperative period is a cornerstone of anesthesia, aiming to enhance patient comfort and reduce complications [2]. Managing pain effectively is especially critical for surgeries involving the upper limbs, where adequate analgesia can greatly influence recovery. Regional anesthesia offers numerous advantages over general anesthesia for upper limb trauma surgery [3]. Among these are improved perioperative analgesia, decreased opioid consumption, and a reduction in the incidence of postoperative nausea and vomiting (PONV). Additionally, patients undergoing regional anesthesia often experience shorter stays in the post-anesthesia care unit and earlier hospital discharge. These factors not only enhance patient satisfaction but also contribute to better clinical outcomes and reduced healthcare costs [4] .Peripheral nerve blocks, specifically brachial plexus blocks, are extensively used in upper limb surgeries. Brachial plexus blocks provide extended postoperative analgesia with minimal side effects [5]. Unlike general anesthesia, which can impair cognitive function, peripheral nerve blocks better preserve mental function, particularly in elderly patients [6]. Additionally, the risk of aspiration is lower due to the preservation of pharyngeal and laryngeal reflexes. Brachial plexus blocks also eliminate the need for intubation, reducing the risk of intubation-related complications. The supraclavicular approach to the brachial plexus block, first introduced by Kulenkampff in 1911, is widely regarded for its ease of administration, high success rate, and reliability [7]. This approach targets the brachial plexus at the level of the trunks, resulting in a rapid onset and dense block. This makes it ideal for upper extremity surgeries, where timely and effective analgesia is crucial.

Levobupivacaine, an amino-amide local anesthetic, is commonly used in brachial plexus blocks due to its long duration of action, which can last from 3 to 8 hours [8]. Importantly, Levobupivacaine has a lower risk of cardiotoxicity compared to other local anesthetics, making it a safer option for patients undergoing these procedures. To enhance the effectiveness of brachial plexus blocks, various adjuvants such as opioids (e.g., Fentanyl), Neostigmine, Dexamethasone, Hyaluronidase, and Clonidine have been added to local anesthetics. These adjuvants are used to improve the onset and duration of anesthesia, enhance the quality of the block, and extend postoperative analgesia [9]. While some studies report that adding opioids to local anesthetics increases the success rate and improves postoperative pain control, others have found no significant effect. Clonidine, a selective partial agonist of the α2 receptors, has been shown to enhance the efficacy of nerve blocks through several mechanisms [10]. These include centrally mediated analgesia, vasoconstriction through α2-adrenoreceptor activation, attenuation of the inflammatory response, and direct action on peripheral nerves. The drug’s ability to inhibit nociceptive impulses

at postjunctional α2 receptors in the spinal cord makes it a valuable addition to regional anesthesia [11]. Fentanyl, a synthetic opioid, is another commonly used adjuvant. It acts primarily on μ-opioid receptors to provide analgesia, but it can also activate other receptors, such as δ and κ, further enhancing its pain-relieving properties [12]. Fentanyl's molecular structure allows it to target specific opioid receptor systems within the brain, which contributes to its powerful analgesic effects [13]. This study aims to compare the analgesic efficacy of Fentanyl and Clonidine when used as adjuvants to Levobupivacaine in supraclavicular brachial plexus blocks for upper limb surgeries [14]. Specifically, it will examine the onset and duration of sensory and motor blocks, as well as the duration of postoperative analgesia, to determine which adjuvant offers superior pain management [15].

Material and Method

The study was conducted at Kempegowda Institute of Medical Sciences and Research Centre, involving patients undergoing elective upper limb surgeries. An ethical approval has been obtained from the Ethical Approval Committee. A prospective, randomized clinical study was designed over a period of 18 months, including 70 patients meeting inclusion criteria. The participants were randomized into two groups: Group C, receiving 25 mL of 0.5% Levobupivacaine with 50 μg of Clonidine, and Group F, receiving 25 mL of 0.5% Levobupivacaine with 50 μg of Fentanyl. Preoperative assessments were conducted, and routine protocols were followed. Parameters such as onset and duration of sensory and motor blockades, and postoperative analgesia were recorded, with statistical analysis performed using SPSS version 22.0.

Result

In Group C, 23 out of 35 subjects (65.7%) were males, while 12 (34.3%) were females. Similarly, in Group F, 24 subjects (68.6%) were males, and 11 (31.4%) were females, showing no significant difference in gender distribution between the groups. Regarding ASA grading, both Group C and Group F had identical distributions, with 17 subjects (48.6%) classified as ASA grade 1 and 18 subjects (51.4%) as ASA grade 2 in each group.

Table 1: Distribution of Side Effects in the Groups

Variable	Category	Group C (n = 30)	Group F (n = 30)	p-value
Side Effects	Present	0 (0.0%)	0 (0.0%)	..
	Absent	30 (100.0%)	30 (100.0%)	

The table compares side effects between Group C and Group F. In both groups, none of the patients experienced any side effects, with 100% reporting no adverse reactions. As a result, there is no significant difference between the two groups, indicated by the identical distribution and lack of statistical variation.

Table 2: Comparison of Mean Weight and Height between the Groups

Parameters	Groups	N	Mean	SD	Mean Diff	p-value
Weight (kg)	Group C	35	70.8	10.76	-3.89	0.12
	Group F	35	74.69	9.61		
Height (cm)	Group C	35	167.77	8.77	-2.43	0.25
	Group F	35	170.2	8.78		

The table compares the mean weight and height between Group C and Group F using the Independent Student t-Test. Group F had a slightly higher mean weight (74.69 kg) than Group C (70.80 kg) with a mean difference of -3.89, but this was not statistically significant (p = 0.12). Similarly, height differences were also not significant (p = 0.25).

Figure 1: Comparision of the Heart Rate between the Groups

Group F had a consistently higher mean heart rate compared to Group C at each time interval. From 25 minutes onward, the heart rate in Group F was significantly higher (P = 0.001), though it remained within normal limits throughout the study.

Figure 2: Comparision of SBP between the Groups

Group F consistently showed a higher mean systolic blood pressure (SBP) compared to Group C. However, at 3 hours and 30 minutes, Group F's SBP was significantly higher than Group C's (P = 0.04), despite remaining within normal limits during the study.

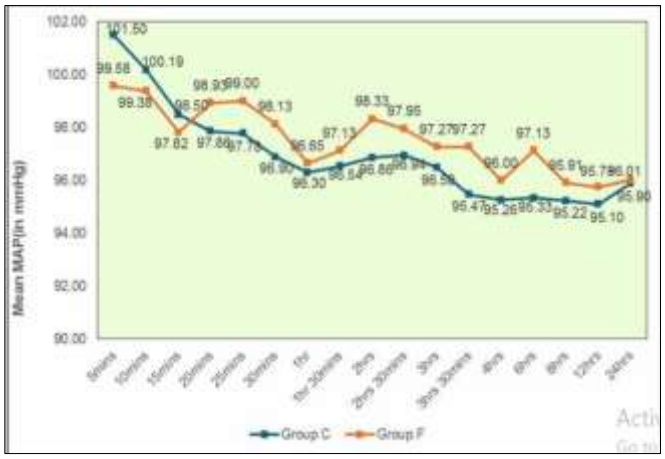

Figure 3: Comparision of Map between the Groups

Mean MAP was comparable between both groups throughout the study, with no significant differences observed at any time point. The values remained consistent between the groups, indicating no meaningful variation in mean arterial pressure (MAP).

Table 3: Comparision of Mean Time of Onset of Sensory and Motor Blockade between the Groups

Parameter	Group	N	Mean	SD	Mean Diff	p-value
Onset of Sensory Block (mins)	Group C	35	8.2	0.67	-3.23	<0.001*
	Group F	35	11.43	1.04		
Onset of Motor Block (mins)	Group C	35	9.71	0.58	-4.09	<0.001*
	Group F	35	13.8	1.23		

Group C exhibited a faster onset of both sensory and motor blocks compared to Group F, with this difference being statistically significant (P < 0.001).

Table 4: Comparision of Mean Duration of Surgery between the Groups

Parameter	Group	N	Mean (mins)	SD	Mean Diff	p-value
Duration of Surgery	Group C	35	134.57	39.4	4.14	0.65
	Group F	35	130.43	35.96		

The table presents a comparison of the mean duration of surgery between two groups. Group C had a mean duration of 134.57 minutes (SD 39.40), while Group F had a mean of 130.43 minutes (SD 35.96). The difference was not statistically Significant (P = 0.65).

Table 5: Comparision of Mean Duration of Analgesia between the Groups

Parameter	Group	N	Mean (mins)	SD	Mean Diff	p-value
Duration of Analgesia	Group C	35	839.17	18.55	94.29	<0.001*
	Group F	35	744.89	28.98		

Group C demonstrated a significantly longer mean duration of analgesia at 839.17 minutes (±18.55) compared to Group F, which had 744.89 minutes (±28.98). This difference was statistically significant, indicating better analgesic efficacy in Group C (P<0.001).

Table 6: Comparision of Mean Duration of Motor Blockade between the Groups

Parameter	Group	N	Mean	SD	Mean Diff	p-value
Duration of Motor Blockade	Group C	35	564.23	15.33	6.72	0.03*
	Group F	35	557.51	8.56		

Group C exhibited a longer mean duration of motor blockade compared to Group F, with durations of 564.23 ± 15.33 minutes versus 557.51 ± 8.56 minutes, respectively. This difference was statistically significant (P = 0.03).

Table 7: Comparision of Spo_2 Levels between the Groups

Parameter	Group	N	Mean	SD	Mean Diff	p-value
SpO_2 levels	Group C	35	98.03	1.27	0.00	1.00
	Group F	35	98.03	1.27		

SpO2 levels were measured periodically, as shown above, and no significant difference was observed between Group C and Group F. Both groups had identical mean SpO2 levels, indicating no variation in oxygen saturation between the two groups (P = 1.00).

Discussion

Postoperative pain is a common issue in upper limb surgeries, often impacting recovery due to reduced mobility and sleep disturbances [16]. Opioids, though effective, have side effects like dependency, while alternatives like paracetamol may cause other complications. Brachial plexus block offers a safer, more effective solution by providing prolonged anesthesia without the risks associated with general anesthesia [17]. It meets essential criteria for postoperative pain relief—being effective, safe, and feasible. Local anesthetics generally provide temporary relief, but methods to extend this duration include continuous infusion or adding adjuvants like Clonidine or Fentanyl [18]. Clonidine is known for prolonging analgesia through mechanisms such as centrally mediated analgesia, vasoconstrictive effects, and attenuation of the inflammatory response [19]. Fentanyl is also used to enhance anesthesia duration. Our study compared the duration of analgesia between 70 patients undergoing upper limb surgeries, divided into two groups. Group C

received Clonidine with Levobupivacaine, while Group F received Fentanyl with Levobupivacaine [20]. Both groups were comparable regarding age, gender, weight, and height, and no significant differences were observed in these demographics. In Group C, 48.6% of patients were ASA grade 1, and 51.4% were ASA grade 2, the same distribution seen in Group F. The onset of sensory and motor blocks was significantly faster in Group C than Group F ($P<0.001$) [21][22]. The mean onset of sensory block was 8.20 ± 0.67 minutes in Group C versus 11.43 ± 1.04 minutes in Group F. Motor block onset was similarly faster in Group C (9.71 ± 0.58 minutes) compared to Group F (13.80 ± 1.23 minutes) [24]. Both groups showed similar heart rates, though Group F had a significantly higher rate at 25 minutes. Mean systolic blood pressure was also higher in Group F at 3 hours 30 minutes ($P<0.04$), but no significant differences were seen for diastolic pressure, MAP, or SpO2. Regarding the duration of motor blockade, Group C had a longer mean duration (564.23 ± 15.33 minutes) compared to Group F (557.51 ± 8.56 minutes, $P<0.03$). The total duration of analgesia was significantly longer in Group C (839.17 ± 18.55 minutes) versus Group F (744.89 ± 28.98 minutes, $P<0.001$). These findings align with previous studies demonstrating Clonidine's efficacy in prolonging analgesia. No side effects were noted in either group, consistent with other research on perineural Clonidine and Fentanyl [25].

Conclusion

Both Clonidine and Fentanyl, when administered perineurally, prolonged analgesia in Supraclavicular Brachial Plexus Block. Clonidine proved more effective than Fentanyl in extending motor blockade and improving analgesia quality. Both reduced postoperative analgesic requirements in the first 24 hours. Clonidine can be considered a superior alternative for prolonging analgesia in upper limb surgeries. This randomized clinical study involved 70 patients undergoing upper limb surgeries at Kempegowda Institute of Medical Sciences, Bangalore. Clonidine showed faster onset and longer duration of sensory and motor blockade compared to Fentanyl, with no observed side effects, making it the more effective adjuvant.

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