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Study to assess the effectiveness of Ropivacaine versus Ropivacaine plus Fentanyl combination in Brachial Plexus block by supraclavicular approach

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Abstract

Introduction: One of the primary aims of anesthesia is to relieve the patient's pain and agony, thereby the surgical procedures can be conducted without any discomfort. Relief of intraoperative and postoperative pain has gained importance in recent years, considering the central, peripheral and immunological stress response to tissue injury. Any expertise acquired in this field should be extended into the postoperative period, which is the period of severe, intolerable pain requiring attention. So there is need of extended analgesia without any side effects in the process of achieving this goal. “Regional anaesthesia” is the term first used by Harvey Cushing in 1901 to describe pain relief by nerve block [1]. Regional nerve blocks are based on the concept that pain stimulus conveyed by nerve fibers, which are amenable to interruption anywhere along their pathway [2]. Brachial plexus block is a valuable and safe alternative to general anesthesia in upper limb surgeries. Interrupting the acute pain which can help in limiting the development of chronic pain syndromes [3, 4]. The effects of opioids on regional blockade is controversial. So the present study is being undertaken to evaluate Fentanyl as an adjuvant to Ropivacaine in supraclavicular brachial plexus block. **Methodology:** Hospital based Prospective randomized single blinded study. Conducted on eighty patients of ASA I and II posted for upper limb surgeries under supraclavicular block. Patients were divided randomly by means of random number table generated by computer into two groups as A and B. Each group consisting of 40 patients. Prior to the study Institutional Ethical committee approval and consent from the patients were taken. The study was conducted in the Department of Anesthesiology, at Katuri medical college &Hospital, Guntur from January 2016 to October 2017.

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Inclusion criteria

1. Patients aged between 20-50yrs of either sex.
2. ASA Grade I & II.
3. Patients prepared for upper limb surgeries.

Exclusion criteria

1. Patients who refused to participate in the study.
2. Patients < 20 and > 50 years.
3. ASA Grade III & IV.
4. Patients with anticipated difficult intubation.
5. Obese patients (BMI >30).
6. Emergency surgical procedures.
7. Coagulation disorders.

All the selected patients pre-operatively evaluated by taking a detailed history along with the cardiovascular, respiratory and central nervous systems are examination. Investigations which are necessary for evaluation were carried out like Serum creatinine, Ecg, chest X-ray, Bleeding Time & Clotting Time and Viral markers Screening.

Results: Fentanyl as an adjuvant to Ropivacaine in brachial plexus anesthesia shortens the onset time of sensory and motor block and increases the duration of sensory and motor block.
Conclusion: Fentanyl is a useful adjuvant in brachial plexus anesthesia to improve the onset, quality, duration of anaesthesia.

Keywords: Brachial plexus block, ropivacaine, fentanyl, upper limb surgeries

Introduction

"Regional anaesthesia" is the term first used by Harvey Cushing in 1901 to describe pain relief by nerve block [1]. Regional nerve blocks are based on the concept that pain stimulus conveyed by nerve fibers, which are amenable to interruption anywhere along their pathway [2].Brachial plexus block is a safe alternative to general anesthesia in upper limb surgeries. Interrupting the acute pain can help in limiting the development of chronic pain syndromes [3], [4].There is also evidence supporting the concept that the use of peripheral nerve blocks for anesthesia reduces the operating room time as well as the length of hospital stay for ambulatory procedures [5]. Post anaesthetic nausea, vomiting and other side effects of general anaesthesia such as atelectasis, hypotension, ileus, dehydration and deep vein thrombosis are also reduced. Another advantage is that the pain free patient can be ambulated early. Ropivacaine [6] is an emerging local anaesthetic drug which has advantage of having long lasting anaesthetic action and less toxicity. Adjuvants are used with local anaesthetics to lower the dose of each agent and enhance the analgesic efficacy and reduce the incidence of adverse effects. Several studies demonstrated the analgesic effects of opioid [7] in local, spinal, epidural blocks when combined with local anaesthetic solution, but the use of opioids on regional blockade are controversial. The addition of opioids in brachial plexus block is reported to improve success rate and postoperative analgesia in few similar studies [8, 9, 10], on the other hand there are several studies which reported no effect was found [11, 12]. This led to research in examining analgesic effects of Fentanyl in peripheral neural blockades. So the present study is being undertaken to evaluate Fentanyl as an adjuvant to Ropivacaine in supraclavicular brachial plexus block. The aim of the study is to compare the onset and duration of supraclavicular brachial plexus block after injection of Ropivacaine 0.5% versus Ropivacaine 0.5% with Fentanyl 100 mcg as an adjuvant.

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Methodology

Hospital based Prospective randomized single blinded study. Conducted on eighty patients of ASA I and II posted for upper limb surgeries under supraclavicular block. Patients were divided randomly by means of random number table generated by computer into two groups as A and B. Each group consisting of 40 patients. Prior to the study Institutional Ethical committee approval and consent from the patients were taken. The study was conducted in the Department of Anesthesiology, at Katuri medical college & Hospital, Guntur from January 2016 to October 2017.

Inclusion criteria

1. Patients aged between 20-50yrs of either sex.
2. ASA Grade I & II.3.Patients prepared for upper limb surgeries.

Exclusion criteria

1. Patients who refused to participate in the study.
2. Patients < 20 and > 50 years.
3. ASA Grade III & IV.
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5. Obese patients (BMI >30).
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7. Coagulation disorders.

All the selected patients pre-operatively evaluated by taking a detailed history along with the cardiovascular, respiratory and central nervous systems are examination. Investigations which are necessary for evaluation were carried out like Serum creatinine, ECG, chest X-ray, Bleeding Time & Clotting Time and Viral markers screening. Statistical Analysis: The data collected is expressed as mean ± SD and percentage value of <0.05 was considered statistically significant. Age, weight, height and duration of surgeries were comparable in both groups using t-test. Gender distribution was compared in both groups using Chi-Square test.

Results

The present study was undertaken to evaluate the efficacy of Fentanyl (100mcg) as an adjuvant to Ropivacaine (0.5%) in comparison with Ropivacaine (0.5%) for brachial plexus block by supraclavicular approach.

Table 1: Age distribution among the study participants

Age	N	Mean Yrs.	S.D	T-value	P-value	Interpretation
Ropivacaine	40	29.7500	6.6439	0.3784	0.70617	Not Significant
Ropivacaine With Fentanyl	40	30.3000	6.3537			

The age was comparable between the two Groups. The t-value (0.3784) and its corresponding p-value (>0.05) there was no statistically significant difference in the age of patients, in both the groups. According to age patients were equally distributed in both the groups.

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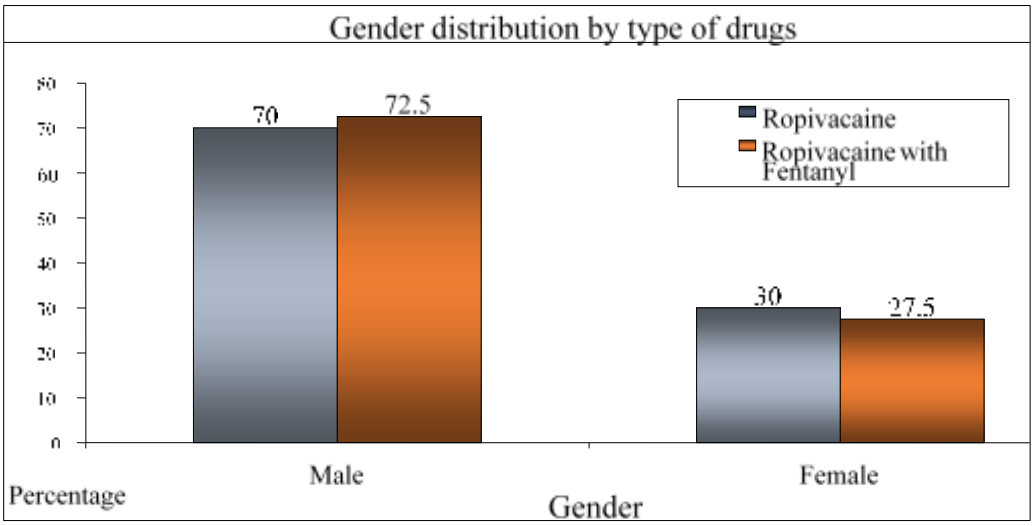

Fig 1: Gender distribution among the study participants

The chi-square value (0.061) and its P-value (0.805) describes that there was no significant association between gender and type of drug. Further, the average height of patients who were using Ropivacaine (158.85±8.2355) was greater than the average height of patients who were using Ropivacaine with Fentanyl (157.45±7.752). But the difference was not statistically significant (p value >0.05).The mean weight in Group A is 62.27 ± 7.88 and Group B is 58.85 ± 8.68**.**The weight was comparable between two Groups. But the difference was not statistically significant as per the P-value (>0.05).

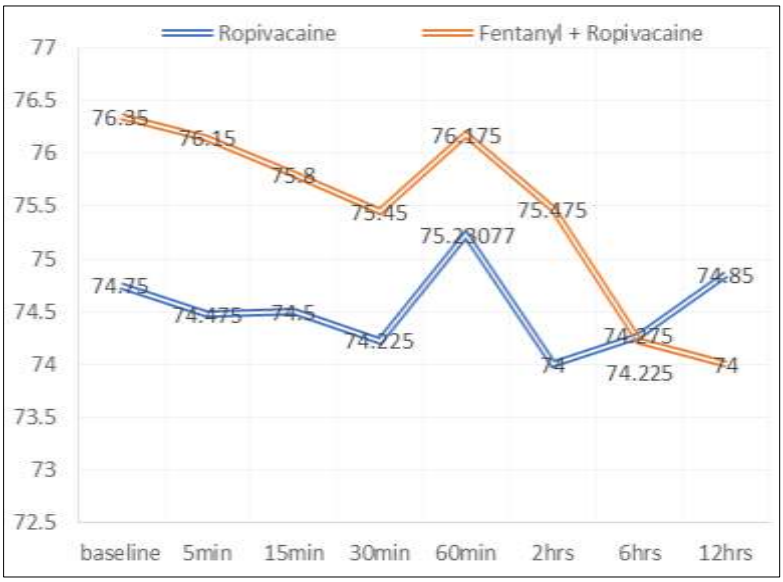

Fig 2: Heart rate versus the study participants among the two study groups

The heart rate was compared between Ropivacaine group and Ropivacaine with Fentanyl group at 0, 5,15,30,60 minutes, 2hrs, 6hrs and 12 hrs. The Mean value of HR in group A & group B were 74.75 ± 3. 535 & 74.35 ± 9.899, statistically significant with p value of 0.3239 at 0 ml. Thus adding Fentanyl of 100µg produced no significant effect on heart rate in patients of both the groups.

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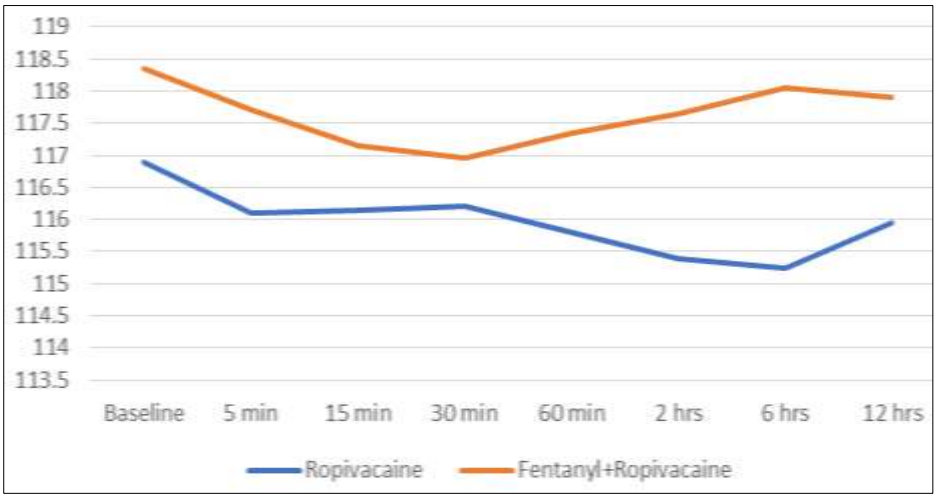

Fig 3: Systolic blood pressure versus the two study group participants

The systolic blood pressure was compared between Ropivacaine plain group and Ropivacaine with Fentanyl group at 0, 5, 15, 30, 60 minutes, 2 hrs. To 6 hrs. and 12 hrs. Mean values of SBP in Group A and Group B are116.90 ± 9.478 and 118 ± 8.3, statistically matched with p value of 0.471 at 0 min. The p values ranged 0.134 to 0.706 at several times which shows that these values are not statistically significant which indicate that adding Fentanyl of 100µg produced no significant effect on systolic blood pressure in patients.

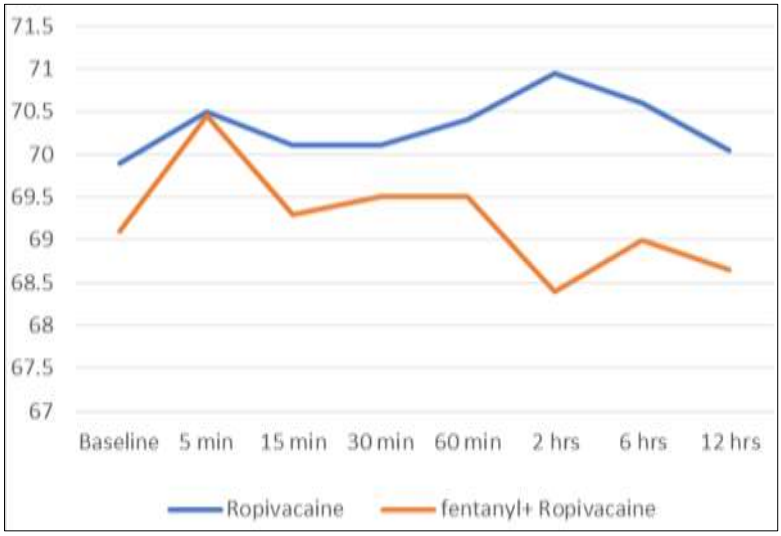

Fig 4: Diastolic blood pressure versus the two study group participants

The diastolic blood pressure was compared between Ropivacaine plain group and Ropivacaine with Fentanyl group at 0, 5, 15, 30, 60 minutes, 2 hrs. To 6 hrs. and 12 hrs. Mean values of DBP in Group A and Group B are 69.90 ± 5.22 and 69.10 ± 5.41, statistically matched with p value of 0.503 at 0 min. The p values ranged 0.189 to 0.9206 during various time intervals which shows that these are not statistically significant which indicate that adding Fentanyl of 100 µg produced no significant effect on diastolic blood pressure in patients.

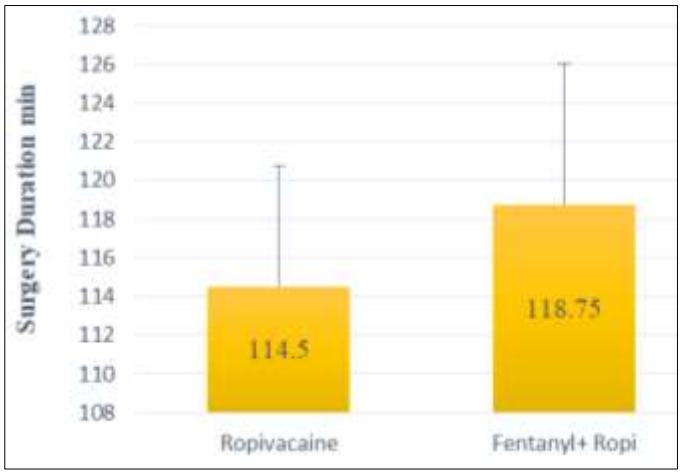

Fig 5: Duration of surgery versus both the study groups among the study participants

The minimum duration in Group A and B: 45 min, Maximum duration in Group A and B: 180 min. Mean DOS in Group A -114.50±39.46**.**Mean DOS in Group B -118.75±46.18.The t-test value (0.442) and its p-value (>0.05) explain that the difference was no statistical significance.

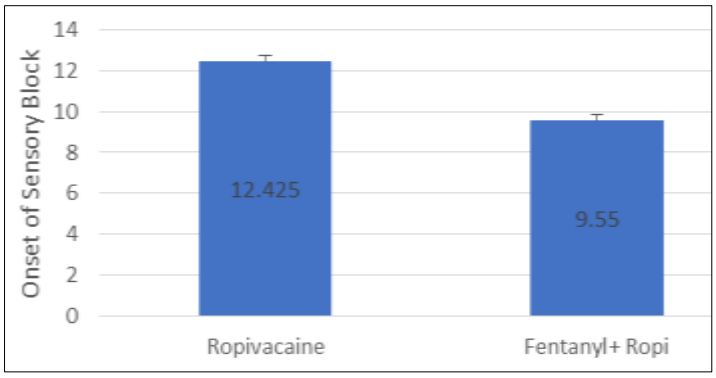

Fig 6: Sensory onset versus both the study groups

The mean time for onset of sensory block in group A was 12.42 $\pm$ 2.09 min and in group B was 9.55 $\pm$ 1.85 min. The difference in SOT between Group A and Group B remain highly significant with p value of< 0.0001.Hence onset of sensory block in Group B was faster when compared to Group A and highly significant.

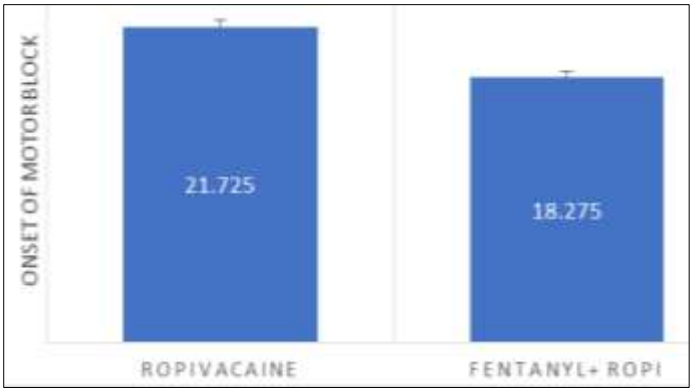

Fig 7: Motor onset time versus both the study groups

The P-value (0.0001) of the above t-test value signifies that the time required for motor onset

in Group A (patients who were using Ropivacaine drug) was significantly greater than Group B (patients who were using Ropivacaine with Fentanyl). This means that onset of motor block in Group B is faster compared to Group A and was highly significant

Table 2: Duration of sensory block versus both the study groups

DOSB	N	Mean(min)	S.D	T-value	P-value	Decision
Ropivacaine	40	322.25	49.637	14.928	<0.0001	Significant
Ropivacaine With Fentanyl	40	512.37	63.589			

Patients of both groups were observed for 24 hours. Time was noted when the patient asked for rescue analgesics. The mean duration of sensory block in group A was 322.25 $\pm$ 49.63 mins and in group B was 512.37 $\pm$ 63.58mins. The statistical analysis by student unpaired 't' test showed that the duration of sensory block in group B was significantly longer when compared to group A ($p < 0.0001$).

Table 3: Duration of motor block among the study groups

DOMB	N	Mean(min)	S.D	T-value	P-value	Decision
Ropivacaine	40	244.50	53.01	19.93	<0.0001	Significant
Ropivacaine With Fentanyl	40	489.35	56.76			

The p-value (<0.0001) of the t-test in the above table depicts that there was statistically significant difference between the two types of drugs on the average duration of motor block. The patients who were using Ropivacaine with Fentanyl was significantly greater than Ropivacaine. Hence duration of motor block was longer in Group B compared to Group A.

Table 4: Time of rescue analgesia in both the study group

TORA	N	Mean (min)	S.D	T-value	P-value	Decision
Ropivacaine	40	322.250	49.63714	15.182	0.0001	Significant
Ropivacaine With Fentanyl	40	513.125	62.272			

Rescue analgesic was given when the patient complained of pain of VAS score >5.The Average duration of sensory block and time of rescue analgesia in the patients who were using Ropivacaine with Fentanyl (513.12 ± 62.27) was significantly greater than patients who were using Ropivacaine (322.25±49.63) as per the significant p-value (<0.0001).

Discussion

A wide variety of receptors mediate anti-nociception on peripheral sensory axons. Therefore, administering appropriate adjuvants along with local anesthetics on peripheral nerves may have analgesic benefit and reduce systemic side effects. There are a wide variety of adjuvants like opioids, neostigmine, ketamine, sodium bicarbonate, buprenorphine, alpha-2 agonists like clonidine etc. being used in clinical practice. The aim of this study is to evaluate the additional anesthetic and analgesic effects of Fentanyl along with local anesthetic in brachial plexus block. Acute postoperative pain is the result of a complex physiological reaction to tissue injury. Local anesthetics as regional nerve blocks provide postoperative pain relief. Certain adjuvant drugs enhance the analgesic efficacy while reducing the incidence of adverse reactions related to local anesthetics. Fentanyl and tramadol were used as adjuvant to local anesthetics in brachial plexus block [13, 14]. Fentanyl exhibits agonist activity at the μ (mu) and k (kappa) opioid receptors. Stimulation of these receptors on central nervous system neurons cause an intracellular inhibition of adenylyl cyclase, closing the influx membrane calcium channels and opening of membrane potassium channels. This leads to

hyperpolarization of the cell membrane potential and suppression of action potential transmission of ascending pain pathways [15].

In this study 2 groups were compared i.e., Group A- Ropivacaine and Group B-Ropivacaine + Fentanyl. The demographic profile of the patients were comparable with respect to mean age, sex, weight and height. In this study, we observed that the onset of sensory block had a mean duration of 12.425 ± 2.098 min in Group A (i.e., Ropivacaine group) whereas it was9.550±1.852 min in Group B (i.e., Ropivacaine+ Fentanyl group). T-test was used to compare the data above which is consisting of one nominal (study groups) and one interval variable (onset of sensory block period). The T- value obtained is 6.495 and the corresponding resultant P value is 0.0001 which is considered statistically significant. From the above data, it can be concluded that onset of sensory block was significantly early in Group B for whom Fentanyl was used. This correlates with the study conducted by Fletcher *et al.* [11] which showed addition of 100 mcg of Fentanyl to 1.5% lignocaine with 1/200,000 epinephrine resulted in faster onset of analgesia in the musculocutaneous nerve trunk. Soma C. Cham [16] *et al.* compared the effects of Fentanyl (50 mcg) or dexmedetomidine (50mcg) in supraclavicular brachial plexus block achieved with Ropivacaine (0.5%). They concluded that onset of sensory analgesia and motor blockade was quicker in patients receiving either Fentanyl or dexmedetomidine as adjuvant. In a study conducted by Swetha M *et al.* [17] concluded that addition of 2mcg/kg Fentanyl to Ropivacaine 0.75% produced a quicker onset compared to the plain Ropivacaine. In this study, the onset time of motor block was 21.725 minutes with standard deviation of 2.943 in Group A (i.e. Ropivacaine group) whereas it was 18.275 minutes with standard deviation of 2.2071 in Group B (i.e. Ropivacaine + Fentanyl group). T-test was used to compare the data above which is consisting of one nominal (study groups) and one interval variable (onset of motor block period). The T- – value obtained is 5.9304 and the corresponding resultant p value is 0.0001 which is considered statistically significant. From the above data, it can be concluded that onset of motor block was significantly early with use of Fentanyl. This results are comparable with the study conducted by RS Moharari *et al.* [18] which showed addition of 75µgFentanyl to 1.5% lidocaine accelerated the onset of sensory and motor blockade during interscalene block. The possible mechanisms for acceleration of sensory and motor blockades created by Fentanyl in this study, suggested that Fentanyl might block the nerve conduction through the spinal roots. It means that the action of opioids injected into the perineural sheath may be more central due to diffusion or the axonal transport into epidural and subarachnoid spaces. Therefore, opioid transport is optimum for blockades adjacent to the spinal cord. In some studies, injection near the dorsal-root ganglion resulted in very effective impacts. Dr. B.N. Biswas *et al.* (2002) [19] used Fentanyl as an adjunct for intrathecal anesthesia and Chen-Hwan Chergn (2005) [20] in their study on Fentanyl as an adjuvant in epidural block demonstrated early onset of block by use of Fentanyl. They attributed this effect to the increased lipophilic nature of the drug. Kohki Nishikawa [21] *et al.* (2000) demonstrated the addition of 100µg Fentanyl to lignocaine in axillary block prolonged the onset of block. Their study implied that the IV administration of Fentanyl has no effects on the rate of success, onset time, or duration of the blockade. They postulated that the acidic nature of Fentanyl caused a decrease in the pH of local anesthetic solution which increased the latency of the block by reducing the rate of nerve penetration of lidocaine, thus resulting in a slower onset of analgesia. The amount of Fentanyl used in our study was 100 mcg which is same as that used in the study of Fletcher *et al.* (1994) [11], Kohki Nishikawa *et al.* (2000) [21]. Fentanyl, a synthetic opioid which proved its efficacy when added to Ropivacaine, was also shown to have a local anesthetic action [21, 22, 23] The effect of Fentanyl could be mediated through a direct action on the peripheral opioid receptors, in the primary afferent tissues (dorsal roots) [24] or through centrally mediated opioid receptor analgesia after being uptake into the systemic circulation [21]. The addition of opioids to local anesthetics showed a synergistic interaction in many previous studies [25, 26]. The duration

of sensory block, in this study was 322.25± 49.44 min in Group A (i.e. Ropivacaine group) and 512.37±63.58 in Group B (i.e. Ropivacaine + Fentanyl group).T-test was used and the value obtained is 14.928 and the corresponding resultant P value was 0.0001 which was considered statistically significant. The Average value of duration of sensory block and time of rescue analgesia (VAS score >5) in the patients who were using Ropivacaine with Fentanyl (513.125) was significantly greater than patients who were using Ropivacaine as per the significant P-value (0.0001). The duration was shown to be prolonged similarly in randomized double blind study conducted by Shirish G. Chavan, Alka R. Koshire, Prasad Panbude El [27] with significant prolongation of sensory block and postoperative analgesia. Fentanyl has also been studied in peripheral nerve blocks such as brachial plexus block by Kohki Nishikawa *et al.* (2000) [21] and Karakaya Deniz *et al.* [28] (2001) correlates with this study. In a study conducted by Maha M.I. Youssef [32], the time to first analgesic request was also prolonged in Fentanyl Group compared to Bupivacaine group. Sukran Geze1*et al.* [29] 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. Several studies have indicated that Fentanyl increase the quality of peripheral blockade and improved the duration of postoperative analgesia. Addition of opioids did increase the duration of analgesia by a study by Bazin *et al.* [30] Veil *et al.* [10] showed that injection buprenorphine into the brachial plexus sheath using supraclavicular technique is an efficient way to control postoperative pain after upper limb surgery [24]. In this study, the duration of motor block in Group A (i.e. Ropivacaine group) is 244.50min with standard deviation of 53.012 min and in study group (Group B i.e. (Ropivacaine + Fentanyl group) it was 489.35min with a standard deviation of 56.76 min. The t-test is used and T – value obtained is 19.93 and the corresponding resultant P value is <0.0001 which is considered statistically significant. This correlates with the study conducted by Ravi Madhusudhana *et al.* [31] which showed that addition of opioids (Fentanyl 50mcg, tramadol 50mg) to 0.75% Ropivacaine had beneficial effects on duration of sensory, motor blockade and VAS scores when compared to plain Ropivacaine alone.

Limitations

Efforts were taken to minimize the selection bias by choosing similar patients in both the groups with respect to age, sex, weight and height distribution of patients. A larger sample size could have added more precision to our result. Secondly, the incorporation of an ultrasound guided block localization technique could have drastically decreased the total volume of the local anaesthetics which were administered and this could have added new dimensions to our study.

Conclusion

Fentanyl as an adjuvant to local anesthetic solution (Ropivacaine), in brachial plexus anesthesia shortens the onset time of sensory and motor block and increases the duration of sensory and motor block. To conclude, Fentanyl is a useful adjuvant in brachial plexus anesthesia to improve the onset, quality, duration of anesthesia and analgesia with stable hemodynamics.

Conflict of Interest: None declared.

Funds: Nil.

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