

Comparative Study of Fentanyl versus Ketamine as Adjuvants for Prolonging Analgesia in Brachial Plexus Block via Supraclavicular Approach

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Abstract: Sixty patients between age of 18-60 years of ASA- 1st & 2nd undergoing orthopedic surgery in brachial plexus block were studied to compare the effect of adjuncts like fentanyl and ketamine in combination of Ropivacaine in brachial plexus block to study the onset & duration of block. These patients were randomly divided into 2 groups RF and RK to receive 15 ml of 0.75% ropivacaine and 15 ml of 0.75% Ropivacaine with Fentanyl and Ketamine as adjuvant respectively. Onset of sensory blockade was determined by pinprick method by a three point score and motor blockade by three point scale. Duration of post operative analgesia and any adverse effects were observed. It was found that there was faster onset of sensory and motor blockade and the postoperative analgesia was prolonged in group RF as compared to group RK. All the above findings were statistically significant. The study concludes that Fentanyl is a better option as an additive than Ketamine for sensory and motor block with prolonged post-operative analgesia.

Keywords: Brachial plexus block, Fentanyl, Ketamine

1. Introduction

Under brachial plexus block different type of procedures from simple superficial interventions to complex operations involving deep structures such as bones, joints, nerves, and blood vessels can be done. The brachial plexus is formed by the anterior primary rami of C5 through T1 and provides sensory and motor innervation of the upper extremity^[1]. The brachial plexus along with the axillary artery, can be considered as a large neurovascular bundle that travels in the axilla to supply the upper extremity. The region is densely packed with crucial neurovascular structures, including three major nerves (median, ulnar, and radial), numerous smaller nerves, major arteries and their branches, and a complex muscular and tendonal structure that facilitates fine motor skills and strength^[1]. Each surgical intervention, depending on the site and nature of the procedure, poses risks related to these structures, including potential nerve damage, vascular injury, and complications related to tendon and muscle manipulation.

The use of regional anaesthesia, specifically the supraclavicular brachial plexus block, represents a critical advancement in the management of perioperative pain for upper limb surgeries^[2]. The supraclavicular approach is favored for its comprehensive coverage of the upper limb, making it suitable for a wide range of surgeries from the shoulder to the hand^[3]. The introduction of ultrasound guidance has transformed this practice. Ultrasound allows real-time visualization of the brachial plexus at the supraclavicular fossa—the 'stop sign' appearance of the division between the subclavian artery and the brachial plexus is a key landmark^[3]. With this technology,

anaesthesiologists can directly observe the spread of local anaesthetic around the brachial plexus, ensuring that the anaesthetic envelops the nerves effectively. Studies have consistently shown that ultrasound-guided techniques in regional anaesthesia correlate with lower complication rates compared to traditional methods^[4].

Ropivacaine is frequently chosen for this purpose due to its favourable safety profile, including a lower propensity for cardio-toxicity and a longer duration of action compared to other local anaesthetics^[5]. However, there is a continuous need to enhance the effectiveness and duration of action of Ropivacaine, to improve patient comfort and outcomes. This is where the role of adjuvants such as Magnesium sulfate, Ketamine, Fentanyl, Morphine, Buprenorphine, Dexamethasone, Dexmedetomidine, Clonidine, Sodium bicarbonate become significant^[6]. These adjuvants are hypothesised to extend the duration of the anaesthesia, improve the quality of the block, and reduce the requirement for additional analgesics postoperatively.

Ketamine, also an NMDA receptor antagonist, has well-documented analgesic properties and has been used both as an adjuvant and a primary analgesic in various settings^[7]. Its use with local anesthetics in regional anesthesia is based on its potential to prolong the duration of analgesia and reduce postoperative pain scores. A number of opioids have been used as adjuvants with local anaesthetics for brachial plexus blocks with possibility of increasing duration of action, improving quality of analgesia and to reduce dose of local anaesthetic agents. Opioids like Morphine, Tramadol and Fentanyl have been added to enhance block characteristics of local anaesthetic agent^[8].

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Despite the promising attributes of these adjuvants, there is a paucity of comparative studies specifically evaluating their effectiveness and safety when used with ropivacaine for supraclavicular brachial plexus blocks in upper limb surgeries. The proposed study aims to compare the analgesic effectiveness and safety profile of ropivacaine with fentanyl versus ropivacaine with ketamine. Improved analgesia can lead to faster recovery times, reduced hospital stays, and potentially lower healthcare costs associated with postoperative care.

2. Methodology

This study is a Single centre, Hospital (in-patient) based, Cross-sectional, Observational study and was conducted at the Department of Anaesthesiology, L N Medical College & Research Centre and affiliated J K Hospital, Bhopal. A total of 60 surgeries were taken over a period of twelve months. Inclusion criteria was patients scheduled for upper limb surgery under Supra-clavicular Brachial plexus block, Adult patients aged between 18-60 years, Patients of both gender, Patients categorised belonging to ASA physical status I and II, Patients who gave written informed consent to participate in the study. While Exclusion criteria were Patients categorised belonging to ASA physical status III or higher, History of allergy to study drugs, Patients with a history of alcohol or drug abuse or any Neurological disorders, Patients who needed supplementation with General anaesthesia, Patchy or inadequate analgesia or block Failure, Patients with coagulation abnormalities and Sepsis, Patients with compromised Cardio-pulmonary profile, Patients with multiple trauma and Acute spinal cord injuries, Severe liver or renal diseases, Local skin infection, Contraindication to nerve block, Patient's refusal to take part in the study.

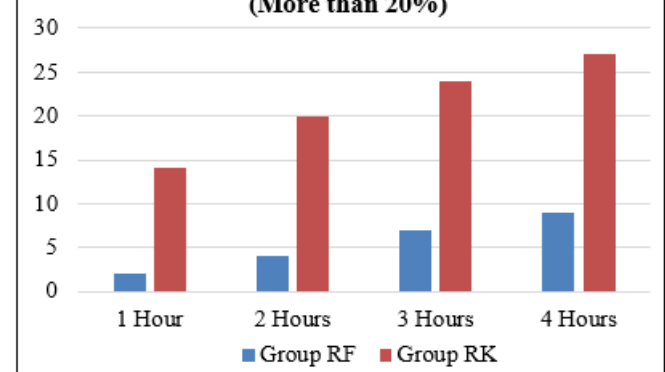
All study participants were visited one day before the surgery and a detailed pre-anaesthetic evaluation was completed. Appropriate laboratory and radiological investigations were conducted. Those patients scheduled for upper limb surgery were approached by the principal investigators and scrutinized using the inclusion and exclusion criteria. Thereafter, the shortlisted participants were asked to informed consent. On arrival in the operating room, the identity of the participant and the consent were verified again; the preoperative assessment was reviewed and updated. Various monitors were attached to measure the multiple vital parameters. Baseline haemodynamic parameters were recorded 15 minutes before giving nerve block. The participants were divided into Group RF & Group RK. Participants in the RF group were given Ropivacaine with Fentanyl for supraclavicular brachial plexus block [Ropivacaine (15 ml of 0.75%) + Inj. Fentanyl 1 mcg/kg]. Participants in the RK group were given Ropivacaine with Ketamine for supraclavicular Brachial plexus block [Ropivacaine (15 ml of 0.75%) + Inj. Ketamine 1 mg/kg]. Brachial plexus block was given by eliciting paraesthesia using the supraclavicular approach, Patients were placed in a supine position with the head extended and rotated to the contra-lateral side; the arm to be anaesthetized was pronated and directed to the ipsilateral knee. Under aseptic precautions and USG guided, the desired drug solution were given in both the groups between brachial plexus and clavicle. Then the needle was stabilized,

aspiration was attempted to exclude intravascular needle placement and the study drug was injected slowly with the repeated aspiration of every 2ml to rule out the accidental intravascular injection. Our Primary Outcome Parameter were Sensory Block following administration of Local Anaesthetics (Onset and Duration), Motor Block following administration of Local Anaesthetics (Onset and Duration), Changes in hemodynamic parameters following administration of Local Anaesthetics. While our Secondary outcome were prevalence of the any side effects (like Hypotension, Pruritis, Bradycardia, Nausea, Vomiting, Dizziness, Anxiety, Agitation, Perioral numbness and Arrhythmias. Sensory blocks were assessed using Pin-prick test (response to atraumatic prick with the blunt 27 G needle) and patients were asked about the sensation. This procedure was repeated every 2 minutes until the onset of the block. We also assessed onset, duration & intensity of sensory block. And motor block (Onset, duration & intensity) were assessed using the „Modified' Bromage scale every 2 minutes from the injection of the drug. Haemodynamic parameters (Heart rate, Blood pressure, Pulse oximeter, Respiratory rate & Temperature) were measured at an interval of 5 minutes starting from fifteen minutes before giving nerve block. Data collection included Demographic details and Pre-anaesthetic check-up, Pre, intra& post-operative details.

3. Results

This study included 60 patients by Coin sampling method. Patient's demographic data were statistical non-significant with a p-value of more than 0.1. Mean age of patients were 46 ± 0.8 years, Mean weight of patients were of 69 ± 0.1 kgs, & Mean height of patients were 161 ± 0.4 cms. We had observed the analgesic requirement in both the groups, by measuring intra-operative & post-operative hemodynamic variation as well as postoperative VAS score. In Table 1, we compared the mean heart rate during intra-operative & postoperative period. 0 hours is considered as time of induction. On comparing 2 groups, there was a very well differentiation of heart rate between 2 groups. As in group RF, Heart rate was very well maintained within normal range, with statistical significant (p-value< 0.003).

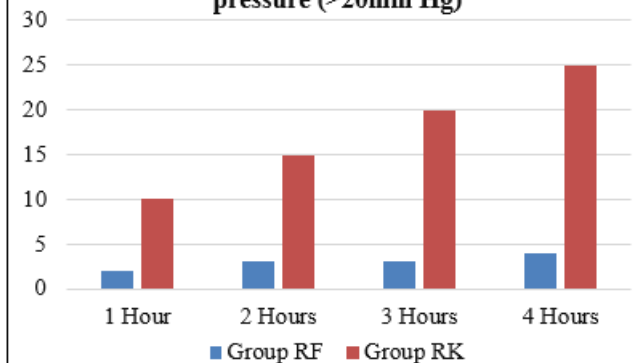
Table 1: Comparison of patients between 2 Groups on the basis of change in Heart Rate (More than 20%)



In Table 2, we compared the mean blood pressure during intra-operative & post-operative period. 0 hours is considered as time of induction. On comparing 2 groups,

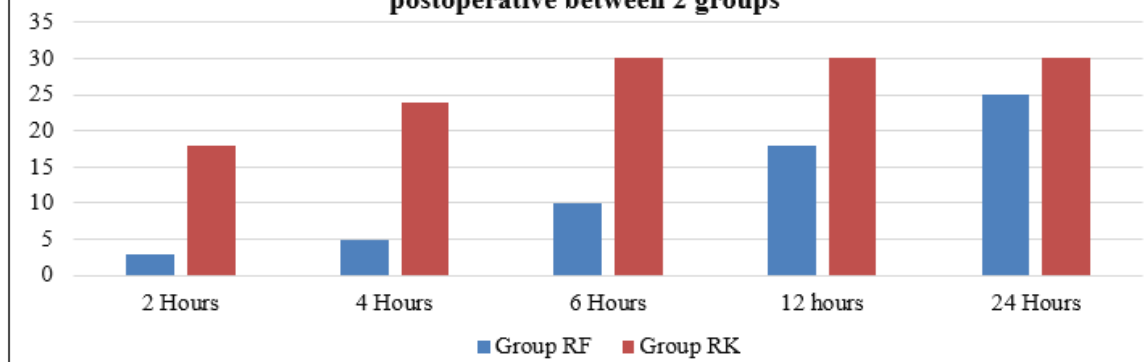
there was a significant difference in mean blood pressure between 2 groups. In group RF, at different time interval blood pressure was not fluctuating from normal range, and it was statistically significant also ($p\text{-value} < 0.003$).

Table 2: Comparison of patients between 2 groups on the basis of change in mean blood pressure ($>20\text{mm Hg}$)



In Table 3, we compared the analgesic requirement of patients both in intra-operative as well as postoperative period. 0 hour is considered as time of induction & time of nerve blocks. During intra-operative period, only 3 patients required analgesic supplement in RF group while a total of 18 patients required analgesic supplements in group RK. And if we compared post-operative analgesic requirement, almost all 30 patients requires analgesic drug in group RK while in group RF, approx. 50% of the patients doesn't required analgesic drug up to 6 hours of surgery. Certain patients doesn't feel any pain upto 24 hours of surgery. We gave Inj. Tramadol for mild ($\text{VAS} > 3$) to moderate ($\text{VAS} 3-6$) pain & Inj. Fentanyl for severe ($\text{VAS} < 7$) pain during postoperative period. For intra-operative period, we gave Inj. Tramadol as analgesic supplement. During post-operative period, patients of group RK was having moderate to severe pain while patients of group RF had only mild pain. 1 patients of group RK had PONV while only 4 patient of group RF had the same.

Table 3: Number of patients required analgesia intraoperative & postoperative between 2 groups



4. Discussion

Our study is a Comparative, Prospective, Observational study conducted at the Department of Anesthesia, LN Medical College, a facility equipped with advanced medical and imaging technologies, including high-frequency ultrasound machines, essential for precision in regional anesthesia procedures. In recent era, adequate postoperative pain management is very important to facilitate rehabilitation and to accelerate functional recovery after upper limb surgery to enable patients to resume normal activity as soon as possible. It serves to blunt the autonomic, somatic, and endocrine reflexes with a resultant potential decrease in postoperative morbidity. Ropivacaine is a newer long-acting pure S-enantiomer is considered to be less cardiotoxic with a better safety profile when used in brachial block than bupivacaine with similar pharmacodynamics properties. It is less likely to penetrate large, myelinated motor nerve fibers, resulting in a relatively reduced motor blockade. The difference between the 2 groups in regard to age, gender, height, weight and duration of surgery were found to be insignificant. Onset of sensory and motor block were earlier in Group RF as compare to Group RK. Also the total duration of analgesia was longer in Group RF than in Group RK.

Reza Akhondzadeh et. al^[9] in their study found that fentanyl is a better drug than ketamine for using as an adjuvant in the axillary block, which was similar with our findings. Sameh Abdelkhalik Ahmed, Mohamad Gamal Elmawy, Mohammed Awd^[10], also concluded that fentanyl was superior then ketamine in terms of onset, duration as an adjuvant in brachial plexus block. In the present study, the requirement for rescue analgesia was significantly lower in the RF group compared to the RK group, indicating that fentanyl provides more prolonged pain relief, thereby reducing the need for supplemental analgesics. This observation aligns with findings from similar studies that have assessed the impact of Fentanyl and Ketamine as adjuvant in brachial plexus blocks. Tejwant Rajkhowa et. al^[11] said that addition of fentanyl to ropivacaine significantly prolonged the duration of analgesia for supraclavicular brachial plexus blocks in patients undergoing forearm surgeries.

Overall, our present study, corroborated by similar research, suggests that fentanyl offers a slight improvement in the onset of sensory block compared to Ketamine. While both agents are effective, Fentanyl may provide a modest edge in terms of onset speed, though its primary value may lie in extending the duration of anaesthesia. Fentanyl has a beneficial impact on the onset of motor block, showing a trend toward faster onset compared to Ketamine. While the

differences are modest, Fentanyl appears to be a slightly more effective adjuvant for improving the onset of motor block, providing a practical benefit in clinical settings where rapid establishment of motor block is desired. Fentanyl is superior to Ketamine in extending the duration of sensory block in brachial plexus anaesthesia. This prolonged effect not only enhances surgical anaesthesia but also contributes to extended postoperative pain relief, improving patient comfort and reducing the need for additional analgesics. Fentanyl is more effective than Ketamine in reducing the need for rescue analgesia in patients undergoing brachial plexus blocks. These results suggest that Fentanyl could be considered a preferred adjuvant in clinical practice, particularly in procedures where prolonged postoperative analgesia is desirable.

5. Conclusion

Both drugs are useful for the supraclavicular brachial plexus block, but due to the less pain intensity and less need of analgesics in the fentanyl group, fentanyl may be a better drug for use as an adjuvant in the brachial plexus block in comparison to ketamine.

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