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Original Article

Comparative Study of Anesthetic Efficacy of 0.2% Ropivacaine Alone and 0.2% Ropivacaine with Fentanyl 50 μg in Intravenous Regional Anesthesia

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Abstract

Background: Ropivacaine for intravenous regional anesthesia (IVRA) provides prolonged analgesia over lidocaine and have a lower toxicity compared with bupivacaine. To reduce the amount of local anesthetic and to improve the quality of the block additives like opioids are used.

Aim: The present study was designed to assess the anesthetic efficacy and post-tourniquet analgesia of adding fentanyl with ropivacaine for IVRA.

Materials and Methods: A total of 50 patients undergoing hand surgery were randomized to receive IVRA with 40 ml of either ropivacaine 0.2% (Group 1, *n* = 25) or ropivacaine 0.2% with fentanyl 50 μg (Group 2, *n* = 25). The anesthetic efficacy regarding, onset of sensory block, onset of motor block, and duration of post-tourniquet analgesia were noted and compared.

Results: In this study, the sensory block onset time was lesser in ropivacaine plus fentanyl group (6.24 ± 1.714 min) when compared to ropivacaine group (7.88 ± 1.363 min). The onset time of motor block also more in ropivacaine group (11.8 ± 1.825 min) when compared to ropivacaine with fentanyl group (9.88 ± 1.691 min). The duration of post-tourniquet analgesia was higher in ropivacaine plus fentanyl group (137.52 ± 24.036 min) when compared to ropivacaine group (120.76 ± 20.755 min).

Conclusion: Ropivacaine 0.2% with fentanyl 50 μg in IVRA has good anesthetic efficacy, lengthened post-tourniquet analgesia, and less incidence of intraoperative tourniquet pain when compared to ropivacaine 0.2% alone.

Key words: Fentanyl, Intravenous regional anesthesia, Post tourniquet analgesia, Regional anesthesia, Ropivacaine

INTRODUCTION

Intravenous regional anesthesia (IVRA) was first described in 1908 by A.G. Bier; hence, the procedure is named Bier's block.[1] IVRA involves the intravenous administration of a local anesthetic into a tourniquet occluded limb. The local anesthetic diffuses from the peripheral vascular bed to nonvascular tissue such as axons and nerve endings.

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IVRA is a simple, effective method of providing anesthesia for short duration surgical procedures on the extremities.[2] Limitation of this block include anesthetic toxicity, slow onset, poor muscle relaxation, tourniquet pain, and minimal post-operative pain relief.[3]

Various drugs such as procaine, prilocaine, lignocaine, and bupivacaine have been used in IVRA. Among these, lignocaine is the drug commonly used, and it does not have post-tourniquet analgesia.[4] Bupivacaine provides post-tourniquet analgesia, but cardiovascular (CV) collapse reported after its use in IVRA. Ropivacaine is an amide local anesthetic that is structurally related to bupivacaine with duration of anesthesia almost as long as that of bupivacaine, however, with less CV toxicity presumably because it is pure S-enantiomer.[5] To reduce the amount of

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local anesthetic required or to improve the quality of the block or both, various additives such as opioids, muscle relaxants, alpha-2 agonists have been tried in IVRA with various results. Among this fentanyl, a synthetic opioid is used in this study along with ropivacaine.

In the present study, we have evaluated and compared anesthetic efficacy and post-tourniquet analgesia during IVRA using ropivacaine alone and ropivacaine with fentanyl for hand surgery.

MATERIALS AND METHODS

This study was a randomized, prospective controlled double-blinded study. It was done at K.A.P. Viswanatham Government Medical College from June 2016 to December 2016 after approval from the Medical Ethics Committee. 50 patients of American Society of Anesthesiologists physical status I and II of either sex, between the ages of 18 and 60 years undergoing hand surgery were assigned into two groups each containing 25 patients.

- Group 1: Patients in this group received 40 ml of 0.2% ropivacaine
- Group 2: Patients in this group received 40 ml of 0.2% ropivacaine with fentanyl 50 µg.

Pre-operative evaluation included history, general physical examination, and routine investigations. The procedure and the visual analog scale scoring system (VAS) were explained to the patient preoperatively, and a written informed consent was obtained. In VAS, the patient was asked to grade his/her pain on a numeric scale of 0-10 (0 = no pain and 10 = the worst pain). Patients with a history of any CV, respiratory, or central nervous system disorders were excluded from the study. Patients with hematological disorders such as sickle cell anemia and thalassemia, patients with known hypersensitivity to ropivacaine, patients with difficult airway, were also excluded from the study.

The patients were shifted into the operation theater. No premedication was given. The pulse oximeter, non-invasive blood pressure monitor, and electrocardiographic monitor were connected to the patient. The vital parameters were recorded. A separate intravenous line was started in the non-operated limb.

A vein in the dorsum of the hand of the operated limb was cannulated with 22G intravenous cannula. If the dorsum of the hand was involved in the surgery, a vein higher up in the forearm was chosen. It was firmly fixed, flushed with normal saline and stopper applied. Exsanguination was accomplished by elevation of the limb for 5 min followed by use of Esmarch bandage from fingertip to arm. In subjects where the application of Esmarch bandage was not feasible, emptying of veins was facilitated with compression of axillary artery with the limb elevated. At the proximal end of the Esmarch bandage, the first tourniquet was applied around the upper part of the arm over cotton wool padding. Proximal tourniquet was inflated to 150 mmHg above the patient's systolic blood pressure. The absence of radial artery pulsations and failure of pulse oximetry tracing in ipsilateral index finger was confirmed. Then 40 ml of local anesthesia solution was injected through the cannula at a rate of 1 ml/s by an anesthesiologist who was blinded to the study drug.

The sensory block was assessed by pinprick with a 23G hypodermic needle every 30 s. Patient response was evaluated in dermatomal sensory distribution of medial cutaneous, lateral cutaneous, median, radial, and ulnar nerves.[6] Sensory block onset time was noted as time interval after completion of injection of study drug to sensory block achieved in all dermatomes.

Motor function was assessed by asking the patient to flex and extend the wrist and fingers, and motor block onset time was noted when no voluntary movement was possible following Injection of study drug.

After ensuring complete analgesia below the first tourniquet, the second tourniquet was applied distal to the first tourniquet and inflated to 150 mmHg above the patient's systolic blood pressure. The first tourniquet was then removed. The patients were observed for any toxic manifestations of local anesthetics after release of the first tourniquet. The surgery was started only after sensory block was achieved. If a patient had no sensory or motor block, it was considered a failure of block and the patient was administered general anesthesia.

Intraoperative tourniquet pain, if perceived was noted and documented. Tourniquet was deflated following a minimum of 30 min after inflation and was not inflated for more than 90 min. The tourniquet was deflated by cyclic deflation technique at 10 s intervals.

At the end of surgery, post-tourniquet analgesia time was noted as time elapsed from tourniquet deflation to recovery of pain (VAS >5) in all dermatomes of the operated limb. Side effects after tourniquet release if any was noted.

Data are expressed as mean ± standard deviation. Independent samples *t*-test was used for evaluation of demographic data, duration of surgery and tourniquet, onset of sensory and motor block, and duration of post-

tourniquet analgesia. $P < 0.05$ was considered statistically significant. All analyses were done using SPSS version 16.0 statistical software

RESULTS

Demographic variables such as age, weight, and sex were comparable between the two groups (Table 1). The difference between both groups was statistically not significant ($P > 0.05$). The meantime of duration of surgery and tourniquet duration of both groups showed statistically no significant difference ($P > 0.05$).

In this study, the mean time of onset of sensory block was quicker in Group 2 (6.24 ± 1.714 min) when compared to Group 1 (7.88 ± 1.363 min) (Figure 1 and Table 2) and this difference was extremely statistically significant ($P = 0.0005$). The mean time of onset of motor block also more in Group 1 (11.8 ± 1.825 min) when compared to Group 2 (9.88 ± 1.691 min) (Figure 2 and Table 2). This was extremely statistically significant ($P = 0.0003$).

The mean duration of post-tourniquet analgesia was higher in ropivacaine plus fentanyl group (137.52 ± 24.036 min) when compared to ropivacaine group (120.76 ± 20.755 min), and this difference was statistically significant ($P = 0.011$) (Figure 3 and Table 2).

No side effect was reported in the intraoperative period in either of the groups except that tourniquet pain was reported in 4 patients in Group 1 and none in Group 2. The incidence of nausea and vomiting was slightly higher in Group 2 (Table 3). None of the patients had significant bradycardia or hypotension to require any intervention.

Table 1: Demographic variables, duration of surgery, and tourniquet

Variables	Group 1	Group 2	*P* value
Age	35.20±8.431	37.70±7.929	0.2855
Weight	55.00±6.843	58.12±6.629	0.1081
Sex (M:F)	18:7	16:9	0.805
Duration of surgery (min)	30.6±10.033	31.36±11.365	0.803
Duration of tourniquet (min)	37.4±7.921	38.00±9.574	0.810

Table 2: Sensory and motor characteristics

Characteristics	Group 1	Group 2	*P* value
Onset of sensory block (min)	7.88±1.363	6.24±1.714	0.0005
Onset of motor block (min)	11.8±1.825	9.88±1.691	0.0003
Duration of post tourniquet analgesia (min)	120.76±20.755	137.52±24.036	0.0112

Table 3: Side effects

Side effects	Group 1	Group 2
Intraoperative tourniquet pain	4	0
Light headedness	2	1
Perioral numbness	0	0
Nausea/vomiting	0	2
Dizziness	1	0
Vertigo	0	0

DISCUSSION

Ropivacaine use has increased in popularity because of its potential to offer prolonged and improved analgesia compared to lidocaine, but its onset of sensory and motor block is delayed compared to lignocaine. To improve the onset of the block and improve the post-operative analgesia fentanyl was used in our study.

In this study, the mean time of onset of sensory block was lesser in ropivacaine plus fentanyl group (6.24 ± 1.714 min) when compared to ropivacaine group (7.88 ± 1.363 min). These values were consistent with the findings of Niemi *et al.*[7] The peripheral analgesic effect of opioids is still controversial. Perineural fentanyl decreases the action potential in unsheathed peripheral nerves like that produced by local anesthetics.[8,9] Opioids suppress nerve conduction, and this may potentiate the effect of local anesthetic in IVRA.[10] This action is not related to opiate receptors as naloxone failed to inhibit this effect.[11]

The mean time of onset of motor block also longer in ropivacaine group (11.8 ± 1.825 min), when compared to ropivacaine with fentanyl group (9.88 ± 1.691 min). This finding correlated with the results of Lim and Ong.[12] They found that the addition of fentanyl and mivacurium to the prilocaine enhances the onset of motor blockade. Acalovschi *et al.*,[13] studied the effect of meperidine alone in IVRA. They concluded that the use of meperidine in IVRA developed sensory and motor block, demonstrating the local anesthetic action of the drug. The motor-blocking activities were more marked than the sensory blocking activities. Gobeaux *et al.*,[14] added 100 µg of fentanyl to lignocaine for brachial plexus block and reported enhanced intensity of the sensory and motor block.

In this study, the incidence of tourniquet pain is higher in ropivacaine group. Four patients in ropivacaine group perceived intraoperative tourniquet pain while this was nil in patients who received fentanyl along with ropivacaine. This finding correlated with the findings made by Hartmannsgruber *et al.*,[15] who compared ropivacaine 0.2% and lignocaine 0.5%. Puttappa and Patkar[10] observed that addition of fentanyl has shown excellent to good intraoperative analgesia.

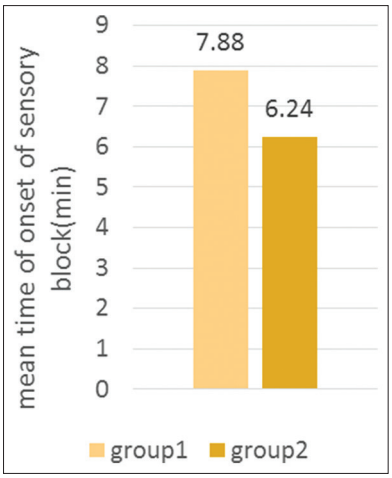

Figure 1: Comparison of onset of sensory block

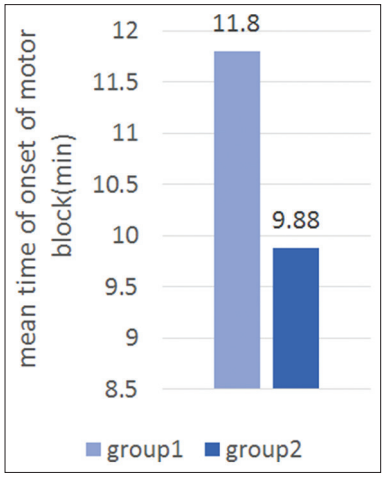

Figure 2: Comparison of onset of motor block

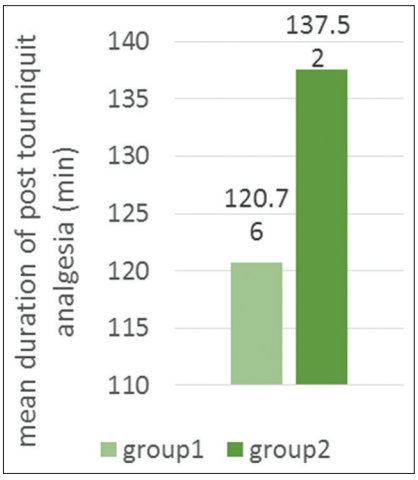

Figure 3: Comparison of duration of post-tourniquet analgesia

The duration of post-tourniquet analgesia was higher in ropivacaine plus fentanyl group (137.52 ± 24.036 min) when compared to ropivacaine group (120.76 ± 20.755 min). Lim and Ong[12] studied the effect of fentanyl with lignocaine and found postoperative pain was significantly reduced in patients receiving fentanyl 1 µ/kg. This finding also correlated with the results of Puttappa and Patkar.[10] In a similar study conducted by Sztark *et al.*[11] showed that the postoperative analgesia in fentanyl group was significantly prolonged as compared to lignocaine. Pitkänen *et al.*[6] conducted the study on the effect of the addition of fentanyl to prilocaine in IVRA and found out that post-operative analgesia was excellent.

The incidence of side effects was similar in both the groups. Patients who received fentanyl along with ropivacaine showed higher incidence of nausea and vomiting when compared to ropivacaine group. This side effect probably due entirely to the effect of fentanyl.[16] This result is like that of Pitkänen *et al.*[6] who studied the effect of fentanyl along with prilocaine in IVRA and found that the incidence of nausea and vomiting is higher in fentanyl group. The vital signs such as pulse rate and blood pressure were stable in all patients. There were no complications during and after the release of the tourniquet in all groups of patients. Our study results were also like study conducted by Puttappa and Patkar,[10] and Santhosh *et al.*[17]

CONCLUSION

We conclude that ropivacaine 0.2% with fentanyl 50 µg in IVRA has well anesthetic efficacy, lengthened post-tourniquet analgesia and less incidence of intraoperative tourniquet pain with minimal side effects after tourniquet release when compared to ropivacaine 0.2% alone.

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