

## ORIGINAL ARTICLE

# Ropivacaine is a better alternative to lidocaine in intra-venous regional anesthesia

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## ABSTRACT

**Aims & Objectives:** This study was conducted to study the analgesic efficacy of ropivacaine and compare it with that of Lidocaine in intravenous regional anesthesia.

**Methodology:** Fifty patients of physical status ASA I and II, aged 20-50 years undergoing ambulatory hand surgery were randomly allocated to two equal groups of 25 each. Patients in either group received either 40 ml of 0.5% lidocaine or 40 ml of 0.2% ropivacaine.

**Results:** The onset, duration and recovery times of sensory and motor block, time to the request for first analgesic, incidence of rescue medication and total analgesic consumption in first 24 hours were recorded. The recovery time of sensory block was significantly prolonged but the onset of sensory block was delayed in Ropivacaine Group as compared to patients in Lidocaine Group. Time to the request for first analgesic was significantly prolonged while the incidence of rescue medication and total analgesic consumption was significantly low in patients receiving ropivacaine. No statistically significant difference was found in onset and duration of motor block between the two groups.

**Conclusions :** It was concluded that ropivacaine is a better alternative to Lidocaine for intravenous regional anesthesia and provides a prolonged post-tourniquet release pain relief as compared to Lidocaine.

**Key Words :** Ropivacaine, Intravenous regional anesthesia, Lidocaine.

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## INTRODUCTION

Intravenous regional anesthesia, by definition is a technique of producing surgical anesthesia by intravenous injection of a local anesthetic into a limb whose circulation has been interrupted by a tourniquet.<sup>1</sup>

Intravenous regional anesthesia is technically straightforward and does not require specific anatomical knowledge. The technique is effective, safe<sup>2</sup> and reliable.<sup>3</sup> It has a rapid onset of action<sup>4</sup> so that surgical preparation and draping may proceed immediately after local anesthetic injection. The anesthetic effect disappears rapidly after tourniquet deflation.<sup>5</sup> Intravenous regional anesthesia is often a safer option than general anesthesia, particularly if the patient is elderly, or has cardiovascular, respiratory or any other systemic disease.<sup>6</sup> In fact it is ideal anesthetic technique for short surgical procedures involving distal extremities on

day care basis.<sup>7</sup>

However, the technique has its own disadvantages. It lacks effective postoperative analgesia after tourniquet release.<sup>8</sup> Tourniquet pain, a dull aching sensation arising from the tourniquet site due to ischemia of muscles and nerves limits its use to surgeries lasting for less than 90 min.<sup>9,10</sup>

Lidocaine is most widely used local anesthetic for intravenous regional anesthesia.<sup>11</sup> It produces rapid onset of anesthesia after injection and termination of analgesia after tourniquet release.<sup>5</sup> The analgesia after tourniquet release does not last long and the need for rescue medication may often arise.<sup>12</sup>

An ideal drug for intravenous regional anesthesia should have features such as rapid onset of action, reduced dose of local anesthetic, prolonged post tourniquet release analgesia and wider margin of safety.

Ropivacaine is a newly amide local anesthetic that is structurally related to bupivacaine with duration of anesthesia almost as long as that of bupivacaine, however, with less CNS and CVS toxicity presumably because it is pure S-enantiomer.<sup>13</sup> Bupivacaine has been used for intravenous regional anesthesia and provides sustained analgesia after tourniquet release; however, reports of seizures and cardiac arrest after intravascular absorption have resulted in eventual discontinuation of bupivacaine for IVRA.<sup>14-19</sup>

The clinical use of ropivacaine is well established in epidural anesthesia and peripheral nerve blocks.<sup>13</sup> Therefore the use of a local anesthetic that would provide longer lasting post tourniquet release analgesia and with least incidence of toxic effects prompted us to study the effectiveness of ropivacaine in intra-venous regional anesthesia.

## METHODOLOGY

This study was conducted in SK Institute of Medical Sciences, Srinagar, J&K (India) from January 2010 to January 2012. After institutional ethical committee approval and written informed consent, a total number of 50 patients of ASA physical status I and II, aged 20 to 50 years undergoing ambulatory hand surgery were recruited in the study. Sample size was calculated using information from a previous study<sup>20</sup> in which effect size was larger. After taking medium effect size into consideration with 5% level of significance and 80% power of the study, this sample size was calculated. Statistical software used was G 3.1.5.

The patients were randomly divided into two groups. As this study was not blinded and the group size was specific, randomization was done on the basis of allocating alternate patient to either of the groups.

**Lidocaine Group** (Control group): Patients in this group received 40 ml of lidocaine 0.5%. This group consisted of 25 patients.

**Ropivacaine Group** (Study group): Patients in this group received 40 ml of ropivacaine 0.2%. This group also consisted of 25 patients.

All the patients were clinically evaluated and investigated before undergoing surgery as per the protocol.

Patients with Raynaud's disease, scleroderma, sickle cell disease, myasthenia gravis, uncompensated cardiac disease, diabetes mellitus, peptic ulcer, liver or renal insufficiency and history of allergic reaction to lidocaine were not included in the study.

All the equipment and drugs needed for resuscitation were kept available before administration of intravenous regional anesthesia. The tourniquet was checked for any leaks.

On arrival in the operating room, non-invasive blood pressure, electrocardiogram and peripheral oxygen saturation monitoring was started. Intravenous access using an 18G cannula was established in the non surgical arm and an intravenous infusion of dextrose saline was started as per the routine practice in our institution. Midazolam 1 mg IV was given as premedication.

A 22G cannula was inserted in the operative arm as distally as possible. The operative arm was elevated for 2 min and then exsanguinated using an Esmarch bandage. A double cuffed tourniquet was applied on the arm with generous layers of padding, ensuring that no wrinkles were formed and the tourniquet edges do not touch the skin. The proximal cuff was inflated to approximately 150 mmHg greater than the systolic blood pressure (absence of radial pulse confirmed adequate tourniquet pressure).

After confirming the absence of a palpable radial pulse, the study solution was injected slowly over 90 seconds. After onset of sensory and motor block, the distal cuff was inflated to approximately 150 mmHg greater than systolic blood pressure and the proximal cuff was released. Time at inflation of tourniquet and drug administration was noted. The tourniquet was not deflated before 30 min and was not inflated for more than 90 min. Tourniquet deflation was carried out by cyclic deflation at 10 second intervals.

Sensory block was assessed by pinprick test using 22G hypodermic needle, every minute after injection of drug to note the time of onset, and after tourniquet deflation to note the time of return of sensations. Onset of sensory block was taken as time from injection of drug until sensory block was achieved in all dermatomes.

Motor block was assessed by asking the patient to flex and extend the wrist and fingers every minute after administration of drug to note the time of onset, and after deflation of tourniquet to note the time of return of motor functions. Complete motor block was taken when no voluntary movement was possible. Onset of motor block was taken as time from injection of drug until complete motor block was achieved.

Duration of sensory block was taken as the time interval from cessation of pinprick sensation in all dermatomes until the return of pinprick sensation.

Duration of motor block was taken as the time interval from cessation of finger and wrist movements until the return of these movements.

Recovery time of sensory block (time from tourniquet deflation to the recovery of pain in all dermatomes determined by pinprick test) and recovery time of motor block (time from tourniquet deflation to the movement of fingers) was noted.

Pain was assessed intraoperatively and for 24 hours

## Intra-venous regional anesthesia

postoperatively using the visual analogue scale (VAS) where a score of zero was given for no pain and 10 for worst pain imaginable. Patients were advised to receive 50 mg of diclofenac sodium orally at VAS of more than 3 as rescue medication. Time to the request for first analgesic after tourniquet deflation and total analgesic consumption in 24 hours was noted in all patients.

Data was analyzed with the help of student's independent t-test and chi-square test. All the results were discussed with 5% level of significance, i.e. the results less than 0.05% were considered significant. The statistical analysis was done with the help of statistical software SPSS version 16.

## RESULTS

All 50 patients enrolled in the study completed the investigation successfully. The two groups were comparable with respect to age, gender, duration of surgery and duration of tourniquet inflation. The mean age of the patients in control group was 35.64 years and 33.72 years in study group (P value=0.63). In control group 76% of the patients were males and 24% were females against 60% males and 40% females in study group (P value=0.225). The mean duration of surgery in control group was 41.52 min against 39 min in study group (P value=0.34). The mean tourniquet inflation period was 52.12 min in control group and 53.72 min in study group (P value =0.52).

No statistically significant was found in the onset and

duration of motor block between the two groups. The mean onset of motor block in control group was 3.68 min and 3.92 min in study group (P value = 0.406). The average duration of motor block was 48.96 min in control group and 49.88 min in study group (P value=0.72).

There was a significant difference in the onset of sensory block between the two groups. The mean onset of sensory block in control group was 3.08 min and 4.04 min in study group. So the onset of sensory block was significantly delayed in Ropivacaine Group (P value =0.001).

The recovery time of sensory block was significantly prolonged in Ropivacaine Group as compared to control group. The mean recovery time of sensory block was 4.64 min in control group and 6.52 min in study group (P value <0.0001).

The time to the request for first analgesic was also significantly prolonged in study group as compared to control group. In control group it was 285.23 min and in study group it was 334.57 on an average (P value < 0.0001). None of the patients from either group required rescue analgesic intraoperatively.

The total analgesic consumption in 24 hours and the number of patients requiring analgesic was significantly less in study group in comparison to control group. Total analgesic consumption in 24 hours in study group was 86 mg and 153 mg in control group. In control group 84% of patients required analgesia whereas in study group only 56% patients required rescue medication.

**Table 1 : Showing the various variables.**

S. no	Parameter	Group	n	Mean	Std. Deviation	Std. Error of Mean	P-value
1.	Onset of sensory block (min)	Control	25	3.08	0.909	0.182	0.001
		Study	25	4.04	0.978	0.196	
2.	Recovery time of sensory block (min)	Control	25	4.64	1.150	0.230	< 0.0001
		Study	25	6.52	1.782	0.356	
3.	Time to the request for first analgesic (min)	Control	22	285.23	52.041	11.095	< 0.0001
		Study	23	334.57	31.727	6.616	
4.	Total analgesic consumption in 24 hrs.	Control	25	64	43.34	8.6	0.039
		Study	25	40	36.08	7.21	

**Table 2: Showing number of patients requiring analgesic**

Group	n (%)	Total no of patients	Remarks
Control	21(82)	25	Chi-square=4.66
Study	14(56)	25	P value=0.031

**Table 3: Showing the details of various procedures performed.**

S. No	Operation	Study Group n (%)	Control Group n (%)	Total n (%)
1.	Release of contracture	5 (20)	1(4)	6 (12)
2.	Tendon repair	7(28)	13 (52)	20 (40)
3.	Nerve repair	2 (8)	0 (0)	2(4)
4.	Re-implantation	1 (4)	2 (8)	3 (6)
5.	Fixation of fracture	1 (4)	0 (0)	1 (2)
6.	Grafting	3 (12)	1 (4)	4 (8)
7.	Primary closure	5 (20)	3 (12)	8 (16)
8.	Debridement	3 (12)	2 (8)	5 (10)
9.	Amputation	4 (16)	1 (4)	5 (10)
10.	Deformity correction	1 (4)	0 (0)	1 (2)
11.	Stump closure	1 (4)	0 (0)	1 (2)
12.	Flap detachment	0 (0)	1 (4)	1 (2)
13.	Flap placement	0 (0)	1 (4)	1 (2)
14.	Excision	0 (0)	1 (4)	1 (2)
15.	Thinning of flap	0 (0)	1 (4)	1 (2)
16.	Radial artery repair	2 (8)	0 (0)	2 (4)

## DISCUSSION

Regional anesthesia is based on the concept that pain is conveyed by the nerve fibres which are amenable to interruption anywhere along their pathway. In 1908, August Bier, professor of surgery in Berlin, devised a very effective method of bringing about complete anesthesia and motor paralysis of a limb which he called "Direct Vein Anesthesia". He used procaine, the first safe injectable local anesthetic that had been synthesized in 1904. However, the technique did not become popular until it was reintroduced by Holms in 1963 using lidocaine as the anesthetic agent.<sup>11</sup>

Intravenous regional anesthesia is a safe, simple to administer and effective method of providing anesthesia for surgery on extremities. It is ideal for short procedures on an ambulatory basis. Local anesthetics such as lidocaine and prilocaine are commonly administered for IVRA. However, lidocaine, the most often used local anesthetic for IVRA has a relatively short duration of action which may affect the duration of intraoperative and post tourniquet release analgesia and tourniquet tolerance.<sup>13</sup>

Theoretically it would be beneficial to use a long acting drug such as bupivacaine, but it is considered too risky for IVRA because it binds too tightly to myocardium sodium channels and may lead to irreversible cardiac arrest if it escapes into the systemic circulation.<sup>18,19</sup> Ropivacaine has a

similar duration of action as that of bupivacaine, but with less depression of cardiac conduction presumably because it is a pure S-enantiomer.<sup>13</sup>

In our study the two groups did not differ with respect to age, gender, duration of surgery and the average period of tourniquet inflation.

There was no statistically significant difference in onset and duration of motor block between the two groups. Our results correlate with those of Ibrahim Asik et al<sup>20</sup> and Peter G et al<sup>21</sup> who also found no significant difference in onset and duration of motor block between the two groups. However, our results contradict with those of Maxmillan et al<sup>13</sup> who found that motor block was prolonged with ropivacaine.

The onset of sensory block was delayed (4.04 min) in Ropivacaine Group as compared to Lidocaine Group where it was quicker (3.08 min) on an average. The quicker onset of sensory block with lidocaine may be attributed to its pKa value (7.86)<sup>22</sup> which is close to physiological pH. Due to this property, the ionized fraction of Lidocaine increases, leading to a quicker penetration into nerves and quicker onset as compared to ropivacaine. Ibrahim Asik et al and Peter G et al also found a delayed onset of action as compared with ropivacaine, although it did not reach the significant level.

The recovery time of sensory block in Ropivacaine Group was significantly prolonged (6.52 min) as compared to Lidocaine Group (4.64 min). The longer duration of residual analgesia after tourniquet release with ropivacaine may be attributed to more complete and persistent binding and slower release into systemic circulation.<sup>13</sup>

The potency of ropivacaine is 3 times that of lidocaine.<sup>23</sup> We used a 0.2% solution as it was commercially available concentration that closely achieves equipotency with the typically used concentration of lidocaine for IVRA.

The terminal half life of ropivacaine after IV administration is longer (108 min)<sup>24</sup> as compared to lidocaine, which also leads to its prolonged action. Our results correlate with those of Ibrahim Asik et al and Peter G et al who found that recovery time of sensory block was significantly prolonged in Ropivacaine Group.

In our study, we found that time to the request for first analgesic was also prolonged in Ropivacaine Group. The incidence of rescue analgesic and total analgesic consumption were significantly lower in patients who received ropivacaine. Peter G and Ibrahim Asik also found similar results in their studies.

No patient in our study had any cardiac or CNS effects in either of the groups. The margin of safety may be greater with ropivacaine than bupivacaine. Intravenous injection of ropivacaine is reported to cause fewer CNS symptoms than equivalent doses of bupivacaine.<sup>25</sup> This may be

## Intra-venous regional anesthesia

attributed to the less lipid solubility of ropivacaine, being intermediate between that of lidocaine and bupivacaine and about one half to one third that of bupivacaine.<sup>13</sup> The low lipid solubility of ropivacaine explains its higher threshold for CNS. Ropivacaine is extensively (94%) bound to plasma proteins<sup>26</sup> and as the systemic toxicity is related to unbound drug concentration, the clinical safety profile

of ropivacaine may be more favorable.

## CONCLUSION

In conclusion, prolonged recovery time of sensory block and a lesser need for rescue analgesics make ropivacaine an effective alternative to lidocaine in IVRA.

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