

ORIGINAL ARTICLE

A clinical prospective, randomized study to compare intrathecal isobaric bupivacaine – fentanyl and isobaric ropivacaine – fentanyl for lower abdominal and lower limb surgeries

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ABSTRACT

Introduction: Opioids have been used intrathecally as adjuvant to bupivacaine and ropivacaine for improvement in quality and extending the duration of spinal blockade. We hypothesized that intrathecal ropivacaine provides similar anaesthesia with lesser motor blockade as compared to bupivacaine. So, we conducted this prospective, randomized, double blind study with an aim of comparing the effect of isobaric bupivacaine with fentanyl to isobaric ropivacaine with fentanyl with regards to sensory blockade, motor blockade and quality of analgesia in postoperative period.

Methodology: After ethical committee approval and consent, 100 patients, aged 18 to 60 years, undergoing lower abdomen and lower limb surgery were included in the study. The patients were randomly divided into two groups: Group I received 3 ml 0.5% isobaric bupivacaine plus 20 µg fentanyl. Group II received 3 ml 0.5% isobaric ropivacaine plus 20 µg fentanyl. The subarachnoid block was administered in sitting position in L3-L4 inter vertebral space and the study drugs were given at a rate of 0.2 ml/second. The patient was placed in supine position till maximum effect was achieved. The parameters observed included time of onset of sensory blockade, extent of sensory blockade, degree of motor blockade and duration of analgesia. The heart rate, blood pressure, oxygen saturation and respiratory rate were recorded. All the parameters were recorded just after giving spinal anaesthesia, at 5 minute intervals till 15 minutes, then at 15 minute intervals till 180 minutes. Bradycardia and hypotension was treated with inj. atropine, crystalloid solutions and inj. ephedrine IV. Inj. tramadol 1mg/kg was administered as a rescuer analgesic if the patient's VAS score was >3. Any side effects were recorded.

Results: The demographic parameters, duration of surgery and the types of surgery were comparable in the two groups. The time taken to achieve T10, T8 and T6 level of sensory block was significantly more ($p < 0.05$) in Group II as compared to Group I, but time to sensory block level was comparable ($p = 0.981$). Mean time taken to achieve maximum grade of motor blockade was lesser in Group I as compared to Group II ($p < 0.001$). The sensory block regression to S2 was faster in Group II as compared to Group I ($p = 0.025$). The motor recovery was comparable in the two groups ($p = 0.264$). The duration of analgesia was prolonged in Group I as compared to Group II ($p = 0.027$). The mean pulse rate was comparable in the two groups ($p > 0.05$). The mean arterial blood pressure (MAP) was comparable ($p > 0.05$) except between 10 min to 30 min intervals where MAP was relatively lower in group I ($p < 0.05$). The episodes of hypotension was higher in Group I ($p = 0.001$).

Conclusion: We conclude that intrathecal administration of ropivacaine-fentanyl has faster onset and regression of sensory block, delayed onset but comparable regression of motor block and shorter duration of analgesia as compared to intrathecal bupivacaine-fentanyl.

Keywords: Subarachnoid block; Isobaric; Bupivacaine; Ropivacaine; Fentanyl; Sensory block; Motor block

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INTRODUCTION

Spinal anaesthesia is an accepted technique for lower abdominal and lower limb surgeries. The local anaesthetic drugs like bupivacaine and ropivacaine have been used intrathecally for these surgical procedures. Bupivacaine, an amide type local anaesthetic, has high potency, slow onset and long duration of action but has been associated with prolonged motor block, central nervous system (CNS) and cardiac toxicity. Ropivacaine is an amide local anaesthetic with local anaesthetic properties similar to those of Bupivacaine.^{1,2} Ropivacaine produces an equivalent sensory block but shorter duration of motor block than intrathecal bupivacaine and thus quicker regression of motor block, early mobilisation and early recovery.³ Ropivacaine produces CNS and cardiovascular toxicity at a higher plasma concentration than bupivacaine and thus the incidence is lower than bupivacaine.^{4,5}

Opioid analogues have been used as additives in spinal anaesthesia to improve the onset of action, prolong the duration of block and to improve the quality of perioperative analgesia.^{6,9} Fentanyl (a lipophilic opioid) has a rapid onset and short duration of action following intrathecal administration. The co-administration of opioids reduces the total dose of local anaesthetics required for anaesthesia and significantly prolongs the duration of complete and effective analgesia without prolonging the duration of motor block. It prolongs the duration and reduces analgesic requirement in early postoperative period following spinal block.¹⁰

We hypothesized that intrathecal ropivacaine provides similar anaesthesia with lesser motor blockade as compared to bupivacaine. So, we conducted this prospective, randomized, double blind study with an aim of comparing the effect of isobaric bupivacaine with fentanyl to isobaric ropivacaine with fentanyl with regards to sensory blockade, motor blockade and quality of analgesia in postoperative period.

METHODOLOGY

After approval from the institutional ethical committee, 112 patients, aged 18 to 60 years, of either sex, undergoing lower abdomen and lower limb surgery and belonging to American Society of Anaesthesiology (ASA) class I or II, from November 2009 to October 2010, were screened for the study. A thorough pre-anaesthetic check up including the detailed history and physical examination was done. Patients having any major cardiovascular, neurological or respiratory illness were excluded from the study. Other exclusion criteria were any vertebral deformity or history of trauma to spine, skin infection at the site of lumbar

puncture, any contraindication to spinal anaesthesia and patient's refusal for the procedure. Twelve patients were excluded from the study.

Informed consent was taken. The patients were kept fasting as per standard guidelines. Patients were explained about the procedure and about visual analogue scale. The patients were premedicated with alprazolam 0.25 mg and ranitidine 150 mg orally the night before and on the morning of surgery.

The randomization was done using a computer-generated sequence of numbers and the sealed envelope technique. The 100 patients were randomly divided into two groups: Group I received 3 ml of isobaric bupivacaine (preservative free) 0.5% (15 mg) with 20 µg (0.4ml) of inj. fentanyl (total volume 3.4 ml). Group II received 3 ml of 0.5% (15 mg) isobaric ropivacaine (preservative free) with 20 µg (0.4ml) of inj. fentanyl (total volume 3.4 ml). An independent anaesthesiologist prepared the drug under all aseptic precautions in similar disposable syringes and was not involved in further management or observation of the patients. The person performing the spinal anaesthesia had no knowledge about the contents of the syringes.

In the operating room, standard monitoring included 5 lead electrocardiogram, non-invasive automated blood pressure and pulse oximeter. Baseline heart rate, blood pressure, respiratory rate and haemoglobin oxygen saturation were recorded. An 18 G cannula was secured into a peripheral vein and 15 ml/kg body weight lactated Ringer's solution was administered. The patient was placed in sitting position on the operating table with a stool provided as foot-rest and a pillow placed in the lap. An assistant maintained the patient in a vertical plane while flexing the patient's neck and arms over the pillow to open up the lumbar interspinous space. With full aseptic precautions, inter vertebral space between L3-L4 vertebra was identified and a small skin wheal was raised with 2-3 ml of lignocaine 2%. A 25 G Quinke spinal needle was inserted, advanced and subarachnoid space recognized. The study drugs were given at a rate of 0.2 ml/second. The patient was placed in supine position till maximum effect was achieved.

After assessing time of onset of action of drug and level of blockade, the surgery was allowed. Level of sensory blockade was assessed by pinprick using short bevel needle while the patient's eyes were covered. The parameters observed included time of onset of sensory blockade (time between administration of drug and onset of tingling and numbness in the lower limb), extent of sensory blockade (by pinprick method), degree of motor blockade tested by James Modified Bromage score¹¹ [0 = no weakness, able to raise leg straight against resistance, 1 = unable to raise leg

straight but able to flex knee, 2 = unable to flex knee but with free movement of feet, 3 = unable to move leg or feet], duration of analgesia (time from administration of intrathecal drug to very first complaint of pain). The heart rate, blood pressure, oxygen saturation and respiratory rate were also recorded. All the parameters were recorded just after giving spinal anaesthesia (0 min), then at 5 minute intervals till 15 minutes, after that 15 minute intervals till 180 minutes.

A drop in heart rate below 60 beats/min was managed with atropine 0.2 mg increments IV, and a fall in blood pressure $\geq 20\%$ of baseline was initially managed with bolus of 5 ml/kg of lactated Ringer's solution, followed by inj. ephedrine 6 mg boluses IV. Oxygen 3-4 lit/min was given with face mask if SpO₂ fell below 94%. If respiratory movement were paradoxical or the patient complained of dyspnoea and oxygen saturation could not be maintained with above-mentioned measures, respiratory assistance was given with or without endotracheal intubation.

When the patient's VAS score was >3 , analgesia was supplemented with 1 mg/kg of tramadol IV. Any side effects like sedation, respiratory depression, nausea, vomiting, pruritus, urinary retention were recorded.

Statistical analysis: To detect a 30-min difference in mean duration of analgesia between the groups for type error of 0.01 and a power of 90%, a group size of 42 patients was necessary. We included 50 patients to adjust any drop outs. The statistical analysis was done using SPSS for Windows version 15.0 software. Data are presented as median, mean (\pm SD) or frequencies as appropriate. Demographic data and haemodynamics were compared using student's 't' test between the two groups. Block characteristics were compared using the two-tailed Mann-Whitney U-test. To test the significance of two means for motor blockade, time taken for sensory blockade, the student 't' test was used. To compare the change in a parameter at two different time intervals paired 't' test was used. P value <0.05 was considered significant.

RESULTS

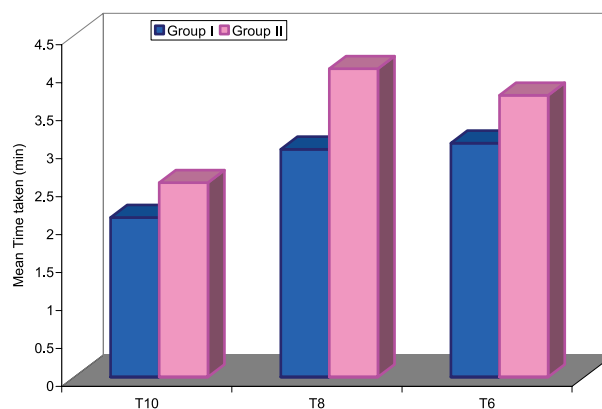
Out of 112 patients, 12 patients did not meet the inclusion criteria of the study and a total of 100 patients undergoing lower abdomen and lower limb surgery were enrolled in the study. All patients were included for analysis and no patient was excluded from the study after inclusion in the study and randomization in the groups. The demographic parameters, duration of surgery and type of surgeries were comparable in the two groups (Table 1).

Table 1: Demographic profile in two groups

Parameters	Group I (n-50)	Group II (n-50)	P value
Age (years)	38.48 \pm 13.26	37.20 \pm 13.85	0.52
Sex (M:F) (n)	31:19	25:25	0.23
Weight (Kg)	55.65 \pm 10.26	56.70 \pm 11.13	0.54
ASA I:II (n)	36:14	35:15	0.90
Duration of Surgery (min)	78.00 \pm 31.64	77.70 \pm 29.80	0.96

Data represented as Mean \pm SD or otherwise specified, n- number of patients

In both the groups, in more than three-fourth subjects the T6 level of sensory blockade was achieved showing no significant difference between two groups ($p=1$) (Table 2). The time taken to achieve T10, T8 and T6 level of sensory block was significantly more in Group II as compared to Group I ($p<0.05$) (Figure 1) but the sensory block level achieved was comparable ($p=0.981$) (Table 2). All of the patients achieved maximum grade of motor blockade showing no significant difference between two groups ($p=1$) (Table 2). As compared to Group I, the time taken to achieve maximum grade of motor blockade was significantly higher in Group II ($p<0.001$) (Table 2). Mean time taken to achieve maximum grade of motor blockade was 3 ± 1.29 min in g Group I as compared to 4.06 ± 1.62 min in Group II ($p<0.001$) (Table 2). The sensory block regression to S2 was faster in Group II as compared to Group I ($p=0.025$). The motor recovery was comparable in the two groups ($p=0.264$). The duration of analgesia was prolonged in Group I as compared to Group II ($p=0.027$) (Table 2).



$P < 0.05$

Figure 1: Mean time taken to achieve T10, T8 and T6 levels of sensory blockade in the two groups

Table 2: Study parameters in the two groups

Parameters	Group I (n-50)	Group II (n-50)	P value
Sensory block level (T4:T6:T8:T10) (n)	1:38:6:5	0:39:10:1	0.981
Sensory block level (median)	T6	T6	1
Time taken to achieve Sensory Blockade T10 (min)	2.10±1.11	2.56±1.15	0.044
Time for maximum Motor blockade of Modified Bromage scale 3 (min)	3.00±1.29	4.06±1.62	<0.001
Time for Sensory Regression to S2 (min)	212.90±40.50	198.50±19.07	0.025
Time for Motor recovery to Modified Bromage scale 0 (min)	180.20±41.66	173.00±17.76	0.264
Duration of Analgesia (min)	241.80±42.10	227.00±19.85	0.027

Data represented as Mean±SD or otherwise specified, n- number of patients

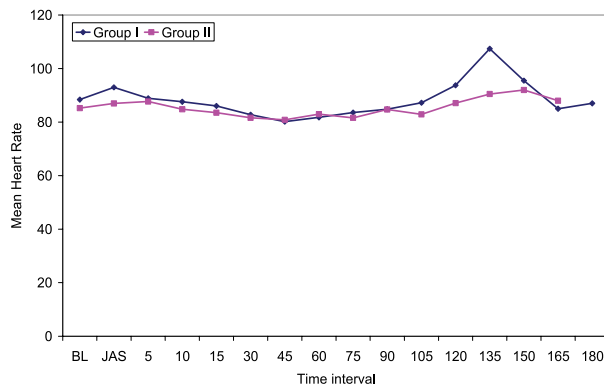


Figure 2: Mean heart rate in two groups at different time intervals (P<0.05)

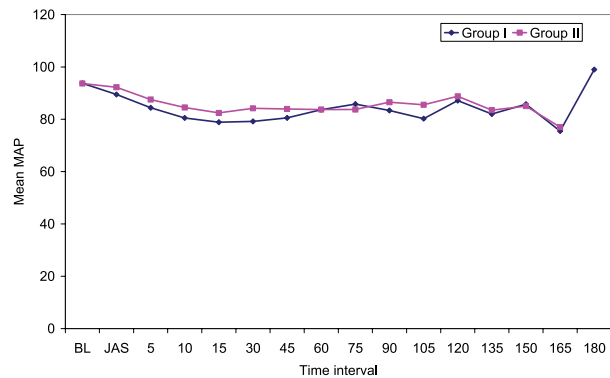


Figure 3: Mean MAP in two groups at different time intervals (P<0.05)

The baseline haemodynamic parameters were comparable in the two groups ($p > 0.05$). The mean pulse rate was comparable in the two groups during the study period ($p > 0.05$) (Figure 2). The mean arterial blood pressure (MAP) during the study period in both the groups was comparable ($p > 0.05$) except between 10 min to 30 min intervals where MAP was relatively lower in Group I ($p < 0.05$) (Figure 3).

Hypotension and bradycardia were the only side effects encountered among the study subjects. The incidence of hypotension was more common as compared to bradycardia in both the groups while the incidence of both the side effects was higher in Group I as compared to Group II. However, the difference between two groups was significant only for hypotension ($p = 0.001$). 35 patient developed hypotension in Group I, compared to 19 patients in Group II ($p = 0.001$).

At all time intervals, the mean oxygen saturation in both the groups remained $\geq 99\%$ and was comparable ($p > 0.05$). At baseline the mean respiratory rate in Group I was 16.3 ± 1.6 per min while the same was observed to be 15.9 ± 1.9 per min in Group II, showing no significant difference between two groups. Throughout the follow up no significant difference was

observed in the respiratory rate between two groups ($p > 0.05$).

There was no incidence of respiratory depression, pruritis, sedation, nausea and/or vomiting in any of the patients in either group.

DISCUSSION

We have observed during our study that spinal anaesthesia with ropivacaine-fentanyl has faster onset of sensory block but the onset of motor block is delayed as compared with bupivacaine-fentanyl. In group ropivacaine-fentanyl, the regression of sensory block was faster but motor block regression was comparable as compared to bupivacaine-fentanyl group. The duration of analgesia was prolonged in bupivacaine-fentanyl as compared to ropivacaine-fentanyl group.

In our study, T_{10} level was achieved in all of the patients in both groups. The time taken to achieve T_{10} , T_8 and T_6 level of sensory block was significantly longer in Group II as compared to Group I ($p < 0.05$). Gunaydin et al, in their study, used 10 mg of isobaric bupivacaine and 15 mg isobaric ropivacaine with $20 \mu\text{g}$ fentanyl for elective caesarean sections.¹² They concluded that both the drug solutions achieved T_6 dermatome level but time

to achieve sensory block till T_6 level was significantly longer (7.5 ± 5.5 min) in ropivacaine group; which is comparable to our study. Although, we used equal doses of intrathecal drugs in our study as compared to different doses by them. Koltka et al, using 19.5 mg isobaric ropivacaine and 13 mg isobaric bupivacaine with 20 μ g fentanyl for lower abdomen surgery,¹³ showed that all patients achieved T_{10} level or higher, but level of sensory block was higher in bupivacaine group (in contrast to our study) and was achieved faster in bupivacaine group as compared to ropivacaine group (comparable to our study). Lee et al used 10 mg isobaric bupivacaine and 10 mg isobaric ropivacaine with 15 μ g fentanyl for urological surgery.¹⁴ They observed that all patients achieved sensory block upto T_{10} dermatome or higher after 15 min of intrathecal injection and cephalad spread of sensory block was higher in bupivacaine group than ropivacaine group which is in contrast to our study though these authors used same intrathecal drug dose in both the groups. Ogun et al compared the combinations of intrathecal isobaric bupivacaine-morphine with isobaric ropivacaine-morphine (15 mg and 150 μ g respectively in both groups) for caesarean sections.¹⁵ They observed that mean time to achieve T_5 sensory block was 4.9 ± 2.0 min in bupivacaine-morphine group and 6.1 ± 2.5 min in ropivacaine-morphine group with no statistical difference.

As compared to Group I, the time taken to achieve maximum grade of motor block (Bromage scale=3) was significantly prolonged in Group II ($p < 0.001$) similar to that of Ogun et al, where the mean time to achieve complete motor block was 4.0 ± 2.0 min in bupivacaine group and 5.9 ± 3.3 min in ropivacaine group; but are in contrast to observations by Koltka et al of significant difference in onset of motor block between two group.^{13,15}

In our study, the mean time of sensory regression to S_2 level occurred earlier in Group II than Group I, which is similar to studies mentioned earlier.¹³⁻¹⁵ Though motor regression to Bromage Scale 0 was faster in Group II as compared to Group I but was statistically insignificant. These results are in contrast to earlier studies. Gunaydin et al¹² concluded that duration of motor block was shorter in ropivacaine group 121.6 ± 33.7 min vs bupivacaine group 149.7 ± 46.0 min i.e. early motor recovery in ropivacaine group. Koltka et al¹³ observed that duration of motor block 136 min (median time) in bupivacaine group and 90 min (median time) in ropivacaine group and time to mobilise 300 min in bupivacaine group and 255 min in ropivacaine group. Lee et al¹⁴ concluded that motor block was shorter in ropivacaine group (median 126, interquartile range 93-162 min) as compared to bupivacaine group

(median 189, interquartile range 157-234 min). Duration of complete recovery of motor block was shorter in ropivacaine group. Ogun et al¹⁵ concluded that mean time to complete recovery was 220.0 ± 32.4 and 200.2 ± 34.9 in bupivacaine and ropivacaine groups respectively, which was statistically significant.

The mean time for complete analgesia was found to be maximum in Group I than Group II, showing a statistically significant intergroup difference ($p = 0.027$). Koltka et al¹³ used equipotent doses of isobaric ropivacaine and isobaric bupivacaine with fentanyl and they concluded that addition of fentanyl increases the level and duration of sensory block without altering motor block. In contrast, Ogun et al¹⁵ studied that addition of opioid prolonged the analgesia in both of the groups and they concluded that the mean time of complete analgesia was comparable statistically in both groups.

The pulse rate was comparable in the two groups throughout the study period, which is similar to the study by Ogun et al.¹⁵ The MAP was statistically lower in Group I during 10 min to 30 min intervals of intrathecal administration of the study drugs. This is in contrast to study by Ogun et al,¹⁵ which showed no significant difference between two groups. Hypotension episodes were statistically higher in Group I as compared to Group II which is similar to their study but in contrast to the study by Koltka et al.¹³

Since hyperbaric solution of ropivacaine is not available, so we preferred to use plain ropivacaine in our study. Also, previous studies have used different doses of ropivacaine and bupivacaine as compared to same doses in our study. In our opinion, ropivacaine-fentanyl combination produces analgesia for a shorter time interval than bupivacaine-fentanyl combination and there is early recovery from sensory block in the earlier group. Hence, ropivacaine-fentanyl is a better choice in spinal anesthesia than bupivacaine-fentanyl for short procedures with minimum hemodynamic disturbances and side effects. If intensity of motor block is required for longer duration then bupivacaine-fentanyl is a better choice. Blood pressure fall was observed in more patients in bupivacaine group as compared to ropivacaine group. No other side effect was observed between two groups except hypotension and bradycardia. Haemodynamic stability was more in ropivacaine-fentanyl group.

Our study is limited by the fact that the analgesic requirement may be different in the orthopedic lower limb surgery and lower abdominal surgery.

CONCLUSION

We conclude that intrathecal administration of ropivacaine-fentanyl has faster onset and faster regression of sensory block, delayed onset but comparable regression of motor block and shorter duration of analgesia as compared to intrathecal bupivacaine-fentanyl. The bupivacaine-fentanyl group

is associated with increased episodes of hypotension as compared to ropivacaine-fentanyl combination administered intrathecally.

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Conflict of Interest: None

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