# Comparison of Efficacy and Safety of Intrathecal Ropivacaine-Fentanyl and Bupivacaine-Fentanyl in Lower Abdominal and Lower Limb Surgeries

*DS Prajwal, SS Kamath, AF Faiaz*

## Abstract

**Aim:** A prospective randomized clinical study was conducted to study the efficacy and safety of isobaric 0.5% ropivacaine-fentanyl with isobaric 0.5% bupivacaine-fentanyl intrathecally for lower abdominal and lower limb surgeries.

**Methods:** 100 patients aged between 18 to 65 years were randomized into two groups, n = 50 in each group. Group A received 3 ml of (0.5%) isobaric ropivacaine (15mg) with 25µg fentanyl and Group B 3 ml of (0.5%) isobaric bupivacaine (15 mg) with 25µg fentanyl. Spinal anesthesia procedure was standardized. Haemodynamic parameters, onset and duration of sensory and motor blockade, level achieved, regression and side effects were compared between the two groups.

**Results:** Onset of motor and sensory blockade was 15.6±3.4 min and 13.6±4.8min respectively in patients of group A as compared to 17.3±4.6min and 15.5±4.87min respectively in patients of Group B. The duration of sensory and motor blockade 132.08±16.3mins and 159.7±18.36min respectively in group A patients as compared to 175.7±15.7min and 205.9±29.8min respectively in patients of Group B ($p<0.05$).

**Conclusion:** Hence ropivacaine was safe and equally effective as bupivacaine in lower abdominal and lower limb surgeries with early motor recovery and providing early ambulation.

**Keywords: isobaric bupivacaine, ropivacaine, spinal anesthesia; fentanyl.**

**Authors' Addresses:** Department of Anaesthesiology, Kasturba Medical College, Mangalore, Manipal Academy of Higher Education, Karnataka-575001, India.
**Corresponding Author:** Dr S S Kamath; Department of Anaesthesiology, Kasturba Medical College, Mangalore, Manipal Academy of Higher Education, Karnataka-575001, India.
*Email:* shailakamath@ymail.com

## Introduction

Subarachnoid block is a commonly practiced anaesthetic technique in patients undergoing lower abdominal and lower limb surgeries [1]. It is a safe, inexpensive and easy to perform technique which also offers an advantage of post-surgical pain relief and avoid the various physiological and psychological phenomena which are vital for early mobilization and postoperative discharge [2] as pain can an unpleasant sensory and emotional, also considered as a vital signal of a life threatening problem [3]. Spinal anaesthesia has a quick onset and provides satisfactory sensory and motor blockade [4]. Administration of the appropriate choice and dose of local anaesthetic into the subarachnoid space results in rapid onset of deep surgical anaesthesia with a greater degree of success. The risks of general anaesthesia including complications due to airway management can be prevented like failed intubation, aspiration, venous thrombosis and pulmonary embolism [5].

Bupivacaine, levobupivacaine and ropivacaine have all been administered as intrathecal drugs [6]. Bupivacaine is the most commonly used local anaesthetic drug for subarachnoid block [7]. Bupivacaine has cardiotoxicity and central nervous system toxicity [8] apart from common complications like hypotension, bradycardia, urinary retention [9] which led to the identification of a better agents like ropivacaine.

Ropivacaine and bupivacaine are amino-amide local anaesthetics which structurally belong to the group of n-alkyl substituted pipecoloxylidide [10]. Ropivacaine has propyl group in comparison to butyl group of bupivacaine on the amine portion of pipecoloxylidide [11]. Apart from sharing various physicochemical properties with bupivacaine, onset time and duration of action of ropivacaine are also similar to the former but with less motor blockade when same volume and concentration are used [12]. This property is attributed to lower potency when compared to bupivacaine [13].

Ropivacaine is less lipophilic than bupivacaine and less likely to enter large myelinated motor fibres, which in turn produces relatively lower motor block and hence has a better motor sensory differentiation with hemodynamic stability [14].

The addition of adjuvants to ropivacaine has shown to improve the quality of intraoperative and postoperative pain relief without compromising its character such as early mobilization and voiding [15]. Fentanyl is the most common opioid which is used extensively as an adjuvant to local anaesthetics for enhancement of analgesia without increasing the depth of motor and sympathetic block [14, 15].

This study was conducted to study the efficacy and safety of isobaric 0.5% ropivacaine-fentanyl with isobaric 0.5% bupivacaine-fentanyl intrathecally for lower abdominal and lower limb surgeries.

## Methods

After approval of the Institutional Ethical Committee, a prospective observational study was conducted on 100 patients undergoing major lower limb orthopaedic surgeries and lower abdominal surgeries. Written informed consent was obtained from all patients.

Inclusion criteria include patients of American Society of ASA physical status I or II of either sex, aged between 18 and 65 years, presenting for lower limb orthopaedic and lower abdominal surgery.

Exclusion criteria were patients having contraindications to spinal anaesthesia, a resting heart rate of <60/min, allergy to amide local anaesthetic, a significant history of substance abuse and pregnant women. Visual analogue score (VAS) for pain was explained to the patients pre-operatively as a 10 point scale wherein '0' indicates no pain '3' & above indicates severe pain warranting additional analgesics.

The study was conducted in 100 patients over a period of 18 months. They were divided into two groups of 50 patients each by using open

label road method of randomisation. Patients were randomly allocated to receive either intrathecal 3.5 ml of 15 mg of 0.5% ropivacaine with 25 µg fentanyl (Group A) or 15 mg of 0.5% bupivacaine with 25 µg of fentanyl (Group B).

Following arrival into the operation theatre, intravenous access was established, multipara monitor (electrocardiogram, non-invasive blood pressure and pulse oximeter) was attached and baseline parameters were recorded. After ensuring sterile conditions, spinal anaesthesia was performed, and the patient received one of the two study drugs. The drug combinations were prepared by the first anaesthesiologist, however various observations was made by the second anaesthesiologist.

Heart rate, blood pressure, respiratory rate and oxygen saturation was monitored throughout the study. A decrease of more than 25% from the baseline in the systolic blood pressure (SBP) was considered hypotension and decrease in the heart rate below 50 beats/min was considered bradycardia and treated with intravenous ephedrine/ mephentermine and atropine respectively.

The level of sensory and motor block was evaluated at 5, 10, 20, 30 min, 60min and at the end of surgery. The sensory block level was evaluated with the pin prick test [16], and the motor block level was determined according to the Bromage Scale [17] (0-no motor block, 1-inability to raise extended leg, able to bend knee, 2-inability to bend the knee, can flex ankle; and 3- no movement). During the tracking of the sensory block in patients, maximum sensory block level, time to achieve maximum sensory block, and its regression to L1 dermatome will be recorded. While tracking the motor block, time to achieve maximum motor block and the duration were recorded.

In the post-operative period, the time to first analgesic demand was noted when VAS will be or more than 3 and rescue analgesia was administered. Patients were observed for any discomfort, nausea, vomiting, shivering, pruritus, bradycardia and any other side effects and the need for additional medications was recorded.

The sample size was calculated using the formula –

$$n = \frac{2(Z\alpha+Z\beta)^2 x\ \sigma^2}{d^2}$$

With 95% confidence level & 85 % power, the sample size is 50 in each group.

Z alpha = 1.96 at 95% confidence level

Z beta = 1 at 85% power

σ & d are the combined standard deviation and mean difference respectively.

Data analysis was done using the ANOVA F test and Fischer's exact test.

*p value of <0.05 was considered significant.

## Results

The mean onset time of sensory blockade (maximum sensory level in mins) was 13.64±4.82mins in group A as compared to 15.5±4.87mins in group B with significant statistical difference ($p<0.05$), whereas mean onset time of motor blockade was comparable between the two groups with 15.6±3.44mins in group A and 17.30±4.65mins in group B and the statistical analysis showed no significant difference as shown in Table 1.

The mean duration of sensory blockade (full sensory blockade recovery at T10) in group A was 132.08 ± 16.39min as compared to 175.70 ±15.9min in group B. The mean duration of motor recovery (bromage score back to zero) in group A was 159.70±18.36min and in group B was 205.9±29.87min, both of which had significant statistical difference ($p<0.05$), suggesting shorter duration of sensory and motor blockade in group A as shown in Table 2.

**Table 1** Comparison of mean onset time of sensory and motor block between Group A and Group B in minutes.

| Onset time | Group A | Group B | p | F |
|---|---|---|---|---|
| Sensory | 13.64±4.82 | 15.5±4.87 | 0.04 | 1.92 |
| Motor | 15.6±3.44 | 17.30±4.65 | 0.058 | 2.08 |

**Table 2** Comparison of mean duration of sensory and motor blockade between Group A and Group B in minutes.

| Duration of Blockade (mins) | Group A | Group B | p value |
|---|---|---|---|
| Sensory | 132.08±16.39 | 175.7±15.9 | <0.05 |
| Motor | 159.70±18.36 | 205.9±29.87 | <0.05 |

A level of T4 was achieved in 9 patients in Group A and 13 patients in Group B. T6 level was achieved in 28 patients in group A and 33 patients in Group B, whereas T8 level was achieved as a maximum sensory level in 12 patients in Group A and 4 patients in Group B. Most of the patients in Group A (56%) had a maximum sensory level of T6, which was comparable with Group B where the maximum number of patients (66%) achieved a level of T6, however there was no statistically significant difference between the two groups($p<0.081$) as shown in Table 3.

**Table 3** Maximal sensory level (MSL) achieved in Group A and Group B between dermatomal level T4, T6, T8 and T10. (n and %).

| MSL | Group A | Group B | Total |
|---|---|---|---|
| T4 | 9 (18%) | 13 (26%) | 22 (22%) |
| T6 | 28 (56%) | 33 (66%) | 61 (61%) |
| T8 | 12 (24%) | 4 (8%) | 16 (16%) |
| T10 | 1 (2%) | 0 (0%) | 1 (1%) |
| TOTAL | 50 (100%) | 50 (100%) | 100 (100%) |

We found no statistically significant difference between the groups in achieving the Bromage score of 1, whereas time taken to achieve the Bromage score of 2 & 3 was shorter in group A than in B with statistically significant difference ($P<0.05$) as shown in Table 4.

The comparison of quality of analgesia between the two groups depicts that 13.88% of the patients in group A and B had excellent pain relief (score 1). In both group A and B 8% of the patients had good pain relief. In group A, 2% patients had fair pain requiring additional analgesics as compared to 4%patients in group B. 2% patients in group A had severe pain requiring general anaesthesia as shown in Table 5.

The comparison of mean systolic blood pressure values between the two groups signifies that the differences are significant from 30min interval onwards (<0.05) with steadier blood pressure in group B as shown in Table 6.

Diastolic blood pressures were comparable between the groups with no statistically significant difference as shown in Table 7.

**Table 4** Comparison of mean time duration to achieve individual Bromage score between Group A and Group B in minutes.

| | | N | Mean | Std deviation | 95% Confidence Interval for mean | | t value | P |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower bound | Upper bound | | |
| BROM 1 | Group A | 50 | 6.90 | 2.452 | 6.20 | 7.60 | 1.448 | 0.151 |
| | Group B | 50 | 6.20 | 2.382 | 5.52 | 6.88 | | |
| BROM 2 | Group A | 50 | 10.30 | 3.436 | 9.32 | 11.28 | 2.312 | 0.023 |
| | Group B | 50 | 11.90 | 3.483 | 10.91 | 12.89 | | |
| BROM 3 | Group A | 50 | 14.90 | 3.710 | 13.85 | 15.95 | 2.540 | 0.013 |
| | Group B | 50 | 17.00 | 4.518 | 15.72 | 18.28 | | |

**Table 5** Comparison of analgesic score between Group A and Group B in terms of visual analogue scale score. (n, %).

| **Analgesic Score** | **Group** | | **Total** |
|---|---|---|---|
| | A | B | |
| Excellent | 44 (88.0%) | 44 (88.0%) | 88 (88.0%) |
| Good | 4 (8.0%) | 4 (8.0%) | 8 (8.0%) |
| Fair | 1 (2.0%) | 2 (4.0%) | 3 (3.0%) |
| Severe Pain | 1 (2.0%) | 0 (0.0%) | 1 (1.0%) |
| Total | 50 (50.0%) | 50 (50.0%) | 100 (100.0%) |

**Table 6** Systolic blood pressure between Group A and Group B at baseline, 5 minutes, 10 minutes, 20 minutes, 30 minutes and at one hour after start of surgery in mm Hg. (Mean + SD).

| | **Group A** | **Group B** | **t Value** | **p** |
|---|---|---|---|---|
| Baseline | 123.2 +11.9 | 124.8 +9.5 | 0.75 | 0.454 |
| 5 min | 111.9 +14.8 | 114.7 +15.5 | 0.90 | 0.368 |
| 10 min | 113.1 +11.3 | 117.6 +11.7 | 1.94 | 0.055 |
| 20 min | 115.6 +10.6 | 118.8 +11.4 | 1.43 | 0.156 |
| 30 min | 116.0 +9.9 | 120.7 +10.5 | 2.27 | 0.025 |
| AT END | 119.5 +9.7 | 125.4 +8.4 | 3.26 | 0.002 |
| 1 hr | 120.6 +9.3 | 126.9 +8.5 | 3.58 | 0.001 |

**Table 7** Diastolic blood pressure variation between Group A and Group B at baseline, 5 minutes, 10 minutes, 20 minutes, 30 minutes and at one hour after commencement of surgery in mm Hg. (Mean + SD).

| | **Group A** | **Group B** | **t Value** | **p** |
|---|---|---|---|---|
| Baseline | 73.74 + 7.5 | 74.0 + 6.3 | 0.22 | 0.830 |
| 5 min | 68.2 + 7.9 | 67.7 + 7.4 | 0.33 | 0.746 |
| 10 min | 68.9 + 5.9 | 69.8 + 5.1 | 0.80 | 0.426 |
| 20 min | 70.3 + 5.7 | 70.0 + 4.9 | 0.28 | 0.779 |
| 30 min | 70.3 + 6.1 | 69.6 + 10.4 | 0.37 | 0.709 |
| AT END | 71.5 + 5.1 | 71.4 + 4.5 | 0.10 | 0.917 |
| 1 hr | 71.5 + 6.7 | 72.3 + 4.2 | 0.65 | 0.519 |

# Discussion

Over the past many decades, subarachnoid block has been well established in modern day practice as a safe and effective anaesthetic technique [18]. There has been an upsurge of interest in recent times in newer agents that can be employed for subarachnoid block that may offer quicker recovery and early ambulation with fewer side effects.

The demographic features, mean duration of surgery and the ASA physical status were comparable between the groups. Baseline hemodynamic parameters were also comparable between the groups. The maximum sensory level achieved and the sensory block regression was tested in both the groups by using pin prick sensation.

A maximum sensory level of T6 was achieved in 56% of patients in the group A compared to 66% in group B, maximum level of T4 was achieved in 18% patients of group A compared to 26% in patients of group B. A maximum sensory level of only upto T8 was achieved in 24% of patients in group A as compared to 8% in group B. The upper level of sensory blockade was higher in patients of group B than compared to group A.

Malinovsky et al [19] compared intrathecal isobaric ropivacaine 15mg versus bupivacaine 15mg in patients who underwent TURP and found that cephalad spread of sensory block was higher with bupivacaine compared to ropivacaine, similar to our findings.

The mean onset of sensory blockade in our study in group A was 13.64±4.82min and 15.5 ±4.87min in the group B, which is statistically not significant. Similar findings were observed by Kallio et al[20] where they compared plain solutions of ropivacaine and bupivacaine 15mg each and found that time of onset of sensory block was comparable. Two segment regression time was significantly shorter with group A 65.30±10.89min compared to 80.80 ± 8.9min with group B; regression time to T10 segment was also shorter with group A [85±14.17min] compared to group B[111.04±10.4min]. Clearly, recovery from sensory block was more rapid with ropivacaine group compared to bupivacaine group.

The degree of motor blockade was assessed by using the modified Bromage score where a score of 3 indicates onset of motor blockade. The onset of motor blockade was rapid in both the groups with mean onset of 15.6 ± 3.4min in group A and 17.3 ± 4.6min in group B; these observations were comparable to previous studies by the McNamee et al [21] and Kallio et al [20]. The time required to achieve (individual Bromage score) was also similar in both groups with no statistically significant difference which is supported by a study conducted by Gudul Z et al [14] by comparing isobaric solutions of ropivacaine 7.5mg/ml and bupivacaine 5mg/ml.

In our study the duration of sensory blockade was assessed at the level of T10 and it is seen that the mean duration of sensory blockade

in group A was significantly shorter when compared with group B. Similar findings were noted by Mantouv et al [22] who studied plain ropivacaine versus plain bupivacaine for lower abdominal surgery.

Gudul et al [14] et al compared isobaric ropivacaine 15mg and isobaric bupivacaine 15mg in patients undergoing elective surgeries and concluded that duration of motor blockade with ropivacaine is shorter than bupivacaine which provides a better post-operative recovery. This study supports our findings where the mean duration of motor blockade in group A was 159.7±18.3min and in group B 205.9±29.8min indicating significantly lower duration of motor blockade in ropivacaine group.

Both the groups provided excellent analgesia with only one patient having mild discomfort, not requiring additional analgesics and another patient required additional analgesics due to inadequate pain relief in ropivacaine group.

We did not note any significant differences between the two groups regarding haemodynamic variables, heart rate and oxygen saturation. However, the fall in systolic and the diastolic blood pressure from the 5min interval was noticed more in the ropivacaine group, which was statistically not significant.

In group A, hypotension was noticed in 3 patients and in 3 other patients, hypotension was associated with bradycardia. In group B, 1 patient had an episode of hypotension and 3 other had hypotension and bradycardia. The above events were not statistically significant, thus concluding no significant hemodynamic instability in both the groups.

Hence based on our study, we conclude that use of ropivacaine for intrathecal anesthesia in the lower abdominal and lower limb surgeries provided an adequate level of block for the surgery with faster onset of sensory and motor blockade, lesser duration of motor blockade with good analgesia and stable hemodynamics.


### *Acknowldedgement*

We would like to thank Kasturba Medical College, Mangalore and Manipal Academy of Higher Education, Manipal, Karnataka, India for their help and support in performing this study.


## References


1. Valovski IT, Valovska A. Spinal anesthesia. In: Vacanti CA, Sikka PK, Urman RD, editors. ***Essential Clinical Anesthesia***. United States of America: Cambridge University Press, 2011; **57**: 340-46.
2. Venkatraman R, Sandhiya R. Evaluation of Efficacy of Epidural Butorphanol Tartrate for Postoperative Analgesia. ***International Journal of Pharmacy and Pharmaceutical Sciences*** 2014;**7(2)**:52-4.
3. Sheela D, Geetha RV, Krishna Mohan S, Vijayaraghavan R. A Concept on the development of Buprenorphine Autoinjector for self and emergency Administration. ***International Journal of Pharmacy and Pharmaceutical Sciences*** 2015;**7(8)**:253-7.
4. Mantouvalou M, Ralli S, Arnaoutoglou H, Tziris G, Papadopoulos G. Spinal anesthesia: comparison of plain ropivacaine, bupivacaine and levobupivacaine for lower abdominal surgery. ***Acta Anaesthesiologica Belgica*** 2008; **59(2)**:65-71
5. Butterworth JF, Mackey DC, Wasnick JD. Local Anesthetics. In: Butterworth JF, Mackey DC, Wasnick JD. ***Morgan & Mikhail's Clinical Anesthesiology***. 5th edition. USA: McGraw-Hill Companies; 2013: 16: 263-76.
6. Lee YY, Kee WDN, Fong SY, Liu JTC, Gin T. The median effective dose of bupivacaine, levobupivacaine, and ropivacaine after intrathecal injection in lower limb surgery. ***Anesthesia & Analgesia*** 2009;**109(4)**:1331-4.
7. Tariq, Bhutta IA. Single dose caudal tramadol versus bupivacaine for postoperative analgesia in perineal surgery. ***Journal of Pakistan Army Medical Corps*** 2009; **4(9)**:210-5.
8. Shaikh JM, Mughal SA, Shaikh SM, Siddiqui FG, Memon A. Caudal epidural for postoperative analgesia in male children. ***Journal of Liaquat University of Medical Health and Science*** 2006;**5(3)**:110-3.
9. Leone S, Di Cianni S, Casati A, Fanelli G. Pharmacology, toxicology, and clinical use of new long acting local anesthetics, ropivacaine and levobupivacaine. ***Acta Biomedica*** 2008;**79(2)**:92-105.
10. Akhtar MI, Saleem M, Zaheer J. Wound infiltration with Bupivacaine versus Ketorolac for postoperative pain relief in minor to moderate surgeries. ***Journal of Pakistan Medical Association*** 2009;**59(6)**:385-8.
11. Shaikh SI, Rohini K. Comparison of Epidural Bupivacaine 0.5% With Epidural Ropivacaine 0.75% for lower limb Orthopedic Procedures. ***Internet Journal of Anesthesiology*** 2012;**30(2)**:110-3.
12. Beilin Y, Halpern S. Focused review: ropivacaine versus bupivacaine for epidural labor analgesia. ***Anesthesia & Analgesia*** 2010;**111(2)**:482-7.
13. Korula S, George GM, Ipe S, Abraham SP. Epidural anesthesia and post-operative analgesia for bilateral inguinal mesh hernioplasty: Comparison of equipotent doses of ropivacaine and bupivacaine. ***Saudi Journal of Anaesthesia*** 2011;**5(3)**:277-81.
14. Gudul Z, Yumru C, Tokuc EC. A comparison of the effect of isobaric ropivacaine 7.5 mg/ml with isobaric bupivacaine 5 mg/ml for spinal anaesthesia for elective surgery. ***Regional Anesthesia and Pain Medicine*** 2003;2**8 (Suppl)**:27.
15. Coventry DM. Local anesthetic techniques. In: Aitkenhead AR, Smith G, Rowbotham DJ. ***Textbook of Anaesthesia***. 5th edition. London: Churchill Livingstone Elsevier, 2007; 17: 327-31.
16. Dhalwani N. Ropivacaine versus bupivacaine for spinal anesthesia in elective caesarean deliveries. ***Journal of Pioneering Medical Sciences*** 2012; **2(2)**:73-4.
17. Surjeet S, Singh VP, Jain M, et al. Intrathecal 0.75% Isobaric Ropivacaine Versus 0.5% Heavy Bupivacaine for Elective Cesarean Delivery: A Randomized Controlled Trial. ***Journal of Pakistan Medical Students*** 2012; **2(2)**:75-80.
18. Cousins & Bridenbaugh. Neural blockade in Clinical Anaesthesia and Pain ***Medicine*** 2012;**45**:256-7.
19. Malinovsky J-M, Charles F, Kick O, et al. Intrathecal Anaesthesia: Ropivacaine versus Bupivacaine, ***Anesthesia & Analgesia*** 2000;**91**:1457-60.
20. Kallio H, Snall EV, Kero MP, Rosenberg PH. A comparison of intrathecal plain solutions containing ropivacaine 20mg or 15 mg versus bupivacaine 10mg. ***Anesthesia & Analgesia*** 2004;**99**:713-7.
21. McNamee DA, McClelland AM, Scott S, et al. Comparison of plain ropivacaine 5mg/ml with Bupivacaine 5mg/ml for orthopaedic surgery. B***ritish Journal of Anaesthesia*** 2002;**89(5)**:702-6.
22. Mantouvalou M, Ralli S, Arnaoutoglou H,Tziris G, Papadopoulos G. Spinal anaesthesia: comparison of plain ropivacaine, bupivacaine and levobupivacaine for lower abdominal surgery. ***Acta Anaesthesiologica Belgica*** 2008;**59**:65-71.