ORIGINAL RESEARCH PAPER

Anaesthesiology

# A PROSPECTIVE RANDOMIZED STUDY OF QUALITY OF INTRATHECALLY INJECTED 0.5% HYPERBARIC BUPIVACAINE VERSUS 0.75% HYPERBARIC ROPIVACAINE IN LOWER ABDOMINAL SURGERIES

**KEY WORDS:** Hyperbaric, Ropivacaine, Bupivacaine, Spinal anaesthesia, Motor blockade

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**ABSTRACT**

**Background:** Ropivacaine is a pure S-enantiomer, long-acting regional anaesthetic structurally related to Bupivacaine, developed for purpose of reducing potential toxicity and improving relative sensory and motor block profiles. This prospective randomized study was aimed to evaluate and compare the efficacy and safety of intrathecally injected 0.75% hyperbaric ropivacaine and 0.5% hyperbaric bupivacaine in patients posted for lower abdominal surgeries. **Methods:** 90 patients belonging to ASA class I/II, posted for elective lower abdominal surgeries, under spinal anaesthesia were grouped in two groups of 45 each receiving 3ml (15mg) of 0.5% hyperbaric bupivacaine in Group B and 3ml (22.5mg) of 0.75% hyperbaric ropivacaine in Group R. Parameters observed were onset and duration of sensory and motor block, maximum sensory level achieved, duration of analgesia and haemodynamic changes. **Results:** The mean time for onset of sensory and motor block was not-significantly faster in group B as compared to group R. The mean duration of motor blockade was 166.88±14.11 min in group R and 208.91±14.62 min in group B. There was no significant difference between the groups regarding mean duration of analgesia and haemodynamic parameters. **Conclusions:** Intrathecal hyperbaric ropivacaine 0.75% is safe and effective with stable haemodynamics and similar duration of analgesia with a shorter duration of motor block compared to hyperbaric 0.5% bupivacaine. Hence, recommended for short duration surgeries where prolonged motor blockade is undesirable.

## INTRODUCTION:

Subarachnoid block is uniquely safe, economical, easy to perform and effective technique which provides rapid onset of action and reliable anaesthesia with muscle relaxation with less systemic and metabolic disturbances.[1,2,3] Also, awake patient, preservation of airway, decrease blood loss and ability to provide profound residual postoperative analgesia, avoidance of polypharmacy, early ambulation to allow early discharge makes this the preferred technique for various surgical procedures.[1,2,4,5]

Bupivacaine is an extensively used, well-established long-acting regional anaesthetic that produces an adequate sensory and motor blockade. It is a racemic (50:50) mixture of S and R enantiomers, and has selective cardiotoxic effects because of R enantiomer. Also, neurotoxicity and prolonged motor blockade are other concerns. This prompted the search for newer drugs with improved safety profiles and early recovery from motor block.[3,4,5]

Ropivacaine is a newer, pure "S" enantiomer, long-acting amide local anaesthetic with lower lipid solubility, easier reversibility after inadvertent intravascular injection, lesser motor block and greater differentiation of sensory and motor block. Increasing concentrations caused quicker onset, greater intensity, slower regression and longer duration of motor blockade. Being less lipophilic than bupivacaine, has selective action on the pain transmitting A and C nerves rather than A involved in motor function, resulting in a relatively reduced motor blockade. The reduced lipophilicity owing to the lower affinity of the S (-) isomer to the cardiac sodium channels contributes to the higher threshold for cardiotoxicity and CNS toxicity. Because of the sensorimotor dissociation, intrathecal ropivacaine relives the psychological distress of being immobile for a longer period of time after surgery compared to intrathecal bupivacaine, so it can be a favourable local anaesthetic for day-care surgeries, with greater margin of safety and associated with earlier postoperative mobilization.[1,2,6,7]

Based on this hypothesis, this study was aimed at evaluating and comparing the efficacy and safety of intrathecal hyperbaric ropivacaine and intrathecal hyperbaric bupivacaine in the patients posted for lower abdominal surgeries with primary objective of evaluating and comparing the duration of motor block and secondary objectives of comparing the time of onset and extent of sensory block, time of onset of motor block, duration of analgesia, any associated side effects (hypotension, bradycardia and arrhythmias) in the two study groups.

## METHODOLOGY:

This prospective randomized study was conducted on 90 ASA grade I–II patients, of either gender, between age group 18-65 years, undergoing elective lower abdominal (appendicectomy, hernia, hydrocoele), gynaecological (abdominal and vaginal hysterectomy) and urological (TURP, URSL) surgeries under subarachnoid block after obtaining institutional ethics committee permission and written informed consent. Using computer generated randomization patients were divided randomly in groups of 45 each. The anaesthesiologist, observers and patients were blinded to the groups. In Group B (bupivacaine group) patients were given 0.5% hyperbaric bupivacaine 3 ml intrathecally. In Group R (ropivacaine group) patients were given 0.75% hyperbaric ropivacaine 3 ml intrathecally.

A thorough preoperative evaluation was carried out and also proposed anaesthesia technique and VAS (visual analogue scale) for assessing pain in postoperative period (denoting 0 = no pain and 10 = worst imaginable pain) were explained to the patients. On arrival to the operating room, routine monitoring with ECG, non-invasive BP and pulse oximetry were commenced and baseline parameters recorded. Venous access secured and lactated ringer's solution started.

Under strict aseptic conditions, subarachnoid block was performed in sitting position through midline approach at the level of L3 –L4 intervertebral space using a 25-gauge Quincke Babcock spinal needle, study drug was injected over 20 – 30 seconds and patient was placed in supine position immediately without raising the extremities. A blinded investigator evaluated level of sensory block by loss of pinprick sensation (24-gauge hypodermic needle) and motor blockade using a modified Bromage scale (0 = no motor

block; 1 = hip blocked; 2 = hip and knee blocked; 3 = hip, knee and ankle blocked) every 30 seconds.

Parameters noted were
1. Onset of sensory block (time from deposition of study drug into subarachnoid space till the patient does not feel the pin prick at T10 level),
2. Time for achieving maximum sensory block (Time from deposition of study drug to the maximum sensory block attained),
3. Onset of motor blockade (time from deposition of study drug to Bromage grade 3),
4. Duration of motor block (time in from deposition of the study drug to the regression of motor block to Bromage grade 0).
5. Assessment of analgesia was done by VAS score (time from the deposition of study drug till injection of first rescue analgesic when VAS score was > = 4).

At the same observation times hemodynamic variables such as HR, MAP, RR were also recorded at 1,3,5,10,15 minutes and thereafter every 15 minutes till end of the surgery. In the perioperative period patients received IV fluids according to the blood loss during surgeries by using standard method of correction. Clinically relevant hypotension was defined as a decrease in systolic blood pressure by 30% or more from baseline, it was treated with a rapid IV infusion of 200 mL lactated Ringer's solution; and if proved ineffective, an IV bolus of ephedrine (6 mg) was given. Clinically relevant bradycardia was defined as heart rate less than 50 bpm and was treated with 0.6 mg IV atropine. Respiratory distress described as RR< 10 and $SpO_2$ < 90% was treated with oxygen supplementation with mask at 4 – 6 L/min.

In the post anaesthesia care unit also, thorough hemodynamic monitoring was maintained and patients were monitored for regression from motor block and requirement of first rescue analgesic (injection diclofenac sodium 75 mg IM).

**Statistical Analysis**:
The sample size of 45 samples per group was calculated with power and sample size calculation. Continuous variables are presented as Mean ± Standard Deviation, categorical data are presented as number(%). Quantitative data was analyzed by student's t-test and qualitative data was analyzed by Chi-square test. p <0.05 was considered statistically significant. The Statistical software namely SPSS 20.0 and GraphPad Prism 6.0 version were used for the analysis of the data.

## RESULTS:

The groups were comparable with respect demographic profile such as age, gender, weight, height, ASA physical status and mean duration of surgery and statistically non-significant. Table1

The mean time of onset of sensory block was not significantly faster in group B (4.07±0.86 minutes) as compared to group R (4.28±0.9 minutes). The mean time required to reach maximum sensory block was also statistically non-significant in group B was 7.8±1.03 minutes and in group R was 8.07±1.06 minutes. The mean time for the onset of motor blockade in group B was 6.70±0.99 minutes while in group R was 6.90±0.82 minutes. A significantly shorter duration of motor block was observed with group R (166.88±14.11mins) compared to group B (207.91±14.62mins). Thus, difference in the meantime of duration of motor block was clinically and statistically significant in both groups. Table2 The hemodynamic parameters including HR, MAP, RR were comparable between both groups and were statistically non-significant. (p>0.05). The difference between mean duration of analgesia in the groups was statistically not significant (222.58±11.36 minutes in group B and 218.18±8.63 minutes in group R). Table 2

The episode of hypotension and bradycardia in group B was seen in 4 (8.88%) patients, 2 (4.44%) patients and in group R 3 (6.67%) patients, 1 (2.22%) patient after drug administration respectively. There was no occurrence of cardiac arrhythmia, allergy and respiratory depression in our study. Hence, difference between the groups regarding the side effects was also non-significant.

**Table 1. Demographic Characteristics and Duration of Surgery**

| Parameters | Group B (n = 45) | Group R (n = 45) | p – Value |
|---|---|---|---|
| Age (Years) | 40.04±8.51 | 42.91±8.77 | 0.24* |
| Gender (Male/Female) | 22/23 | 24/21 | 0.53* |
| ASA grade (I/II) | 21/24 | 19/26 | 0.67* |
| Height (cms) | 163.6 0±8.46 | 164.02±5.78 | 0.78* |
| Weight (kgs) | 58.15±5.86 | 56.60±4.81 | 0.17* |
| Duration of Surgery | 88.43±12.58 | 85.66±12.69 | 0.30* |

NS – Non-significant

**Table 2. Comparison of Parameters between the Two Groups**

| Parameters (min) | Group B (n = 45) | Group R (n = 45) | p – Value |
|---|---|---|---|
| | Mean ± SD | Mean ± SD | |
| Onset of sensory block | 4.07±0.86 | 4.28±0.90 | <0.18 (NS) |
| Onset of peak sensory block | 7.80±1.03 | 8.07±1.06 | 0.61 (NS) |
| Onset of motor block | 6.70±0.99 | 6.90±0.82 | 0.76 (NS) |
| Duration of motor block | 207.91±14.62 | 166.88±14.11 | < 0.002 (S) |
| Duration of Analgesia | 222.58±11.36 | 218.18±8.63 | 0.21 (NS) |

S – Significant; NS – Non-significant

## DISCUSSION:

This prospective double-blind randomized study has shown that hyperbaric bupivacaine and ropivacaine both provide reliable and predictable spinal anaesthesia for various elective procedures. In this study, although the rate of onset and extent of the sensory block to pinprick showed no statistically significant difference between the two agents with respect to the onset time to T10, maximum extent of cephalad spread, and the time to maximum spread, the block produced by ropivacaine is of shorter duration.

As compared with plain solutions, use of hyperbaric local anaesthetic solutions results in more predictable cephalad spread, increases duration of clinically useful block and leads to a more rapid regression of sensory block and recovery from motor block.[7]

Comparative trials in patients undergoing elective Caesarean section receiving ropivacaine 12 mg, levobupivacaine 8 mg, or bupivacaine 8 mg, all with sufentanil 2.5 g showed similar times to onset of analgesia, but significantly shorter time to recovery from sensory and motor block was observed with ropivacaine and levobupivacaine as compared to bupivacaine.[8] The co-administration of opioids reduces the total dose of local anaesthetic required for anaesthesia and significantly prolongs duration of complete and effective analgesia without prolonging duration of motor block.[9] In a trial involving lower limb surgeries duration of sensory block with ropivacaine 15 mg was found to be similar with bupivacaine 10 mg, and the motor block was significantly shorter, it was also suggested that on a milligram for milligram

basis, potency of ropivacaine relative to bupivacaine is two-thirds with regard to sensory block and half with regard to motor block.[10]

Nema et al observed that no statistically significant difference was noted between two groups in terms of highest level of sensory block achieved.[11]

We observed a significantly shorter duration of motor block with group R as compared to group B. Kallio et al[10], Bhat et al[12], Surekha et al[13] and Malinovsky et al[14] also concluded that duration of motor block was significantly shorter with ropivacaine as compared to bupivacaine. The mean duration of analgesia was similar in both the groups similar to results in studies by Serap et al[15] and Chari et al.[16]

Scott et al reported that ropivacaine caused less cardiovascular symptoms and was at least 25% less toxic than bupivacaine, with regard to the dose tolerated and cardiac depression that appeared at lower dosage on lower plasma concentration with bupivacaine compared to ropivacaine.[17] Mantouvalou M et al in 2008 noted that hypotension and bradycardia was found to occur more often with Bupivacaine group than with ropivacaine group, requiring higher use of sympathomimetic and vasopressor drugs.[18]

Bozkirly et al, in their study comparing equieffective doses of bupivacaine and ropivacaine in patients undergoing TURP, also noted lower incidence of bradycardia in ropivacaine group as compared to bupivacaine group.[15] We found that although incidence of side effects was lesser in group R as compared to group B but the difference was statistically non-significant and comparable ($p > 0.05$). Nema at el[11] reported similar findings in their study where incidences of side effects (such as hypotension and bradycardia) were similar between the groups.

## CONCLUSION:

Ropivacaine is a well-tolerated regional anaesthetic, effective for surgical anaesthesia providing adequate level of sensory block, similar duration of analgesia with a shorter duration and less intense motor block compared to equivalent doses of hyperbaric bupivacaine. Also, its minimal peri-operative side effects and stable haemodynamics with reduced potential for CNS toxicity and cardiotoxicity, appears to be an important option for regional anaesthesia. Thus, Ropivacaine is particularly advantageous for short duration orthopaedic and lower abdominal surgeries where prolonged motor blockade is undesirable that is in day care surgeries.

## REFERENCES:


1. GuptaHB, AmilkanthwarSN. A prospective, comparative, observational study of quality of spinal anaesthesia with 0.5% and 0.75% plain isobaric ropivacaine in lower abdomen and lower limb surgeries.Int J Res Med Sci2016;4:3134-40.
2. Latwal BS, Singam A, Shrey S, et al. A comparative study of intrathecal 0.5% hyperbaric bupivacaine & intrathecal 0.75% isobaric ropivacaine in lower abdominal surgeries. J. Evolution Med. Dent. Sci. 2020;9(05):256-261, DOI: 10.14260/jemds/2020/58
3. Kuthiala G, Chaudhary G. Ropivacaine: A review of its pharmacology and clinical use. Indian J Anaesth. 2011 Mar-Apr; 55(2): 104–110.doi: 10.4103/0019-5049.79875
4. Barash PG, Collen BF. Handbook of Clinical Anesthesia. 5th edn. Lippincott Williams & Wilkins 2006: p. 700-6.
5. Hansen TG. Ropivacaine: A pharmacological review. Expert Rev Neurother. 2004;4:781–91.
6. Gianluca C, Giorgio A, Giorgio D, Chiara M, Massimiliano N, Gabriella I, Andrea C. Spinal Anesthesia with Hyperbaric Levobupivacaine and Ropivacaine for Outpatient Knee Arthroscopy: A Prospective, Randomized, Double-Blind Study. Anesthesia & Analgesia: July 2005 - Volume 101 - Issue 1 - p 77-82 doi: 10.1213/01.ANE.0000155265.79673.56
7. LuckJF, Fettes PDW, Wildsmith JAW. Spinal anaesthesia for elective surgery: a comparison of hyperbaric solutions of racemic bupivacaine, levobupivacaine, and ropivacaine. BJA: British Journal of Anaesthesia, Volume 101, Issue 5, November 2008, Pages 705–710, https://doi.org/10.1093/bja/aen299
8. Gautier P, De Kock M, Huberty L, Demir T, Izydorczic M, Vanderick B. Comparison of the effects of intrathecal ropivacaine, levobupivacaine, and bupivacaine for caesarean section. Br J Anaesth. 2003;91:684–9.
9. Chung CJ, Yun SH, Hwang GB, Park JS, Chin YJ. Intrathecal fentanyl added to hyperbaric ropivacaine for cesarean delivery. Reg Anesth Pain Med. 2002;27:600–3.
10. Kallio H, Snäll EV, Kero MP, Rosenberg PH. A comparison of intrathecal plain solutions containing ropivacaine 20 or 15 mg versus bupivacaine 10 mg. Anesth Analg. 2004;99:713–7.
11. Nema N, Sisodiya D, Raskaran S, et al. Comparison of 3.5 ml Bupivacaine heavy (17.5 mg) and 3.5 ml Ropivacaine plain (26.25 mg) for subarachnoid block. Journal of Evolution of Medical and Dental Sciences 2014;3(56):12746-54.
12. Bhat SN, Himaldev, Upadya M. Comparison of efficacy and safety of ropivacaine with bupivacaine for intrathecal anaesthesia for lower abdominal and lower limb surgeries. Anesth Essays Res 2013;7(3):381-5.
13. Surekha C, Radha MK, Kumar MS. A comparative study of intrathecal isobaric (0.75%) ropivacaine with isobaric (0.5%) bupivacaine for elective lower abdominal/limb surgeries – a clinical study. International Journal of Research in Health Sciences 2014;2(4):1172-9.
14. Malinovsky JM, Renaud G, Le Corre P, et al. Intrathecal bupivacaine in humans: influence of volume and baricity of solutions. Anesthes 1999;91(5):1260-6.
15. Atabeko lu S, Bozkırlı F. Comparison of the clinical effects of intrathecal ropivacaine and bupivacaine in geriatric patients undergoing transurethral resection. Gazi Medical Journal 2007;18(4):182-5.
16. Chari V, Goyal A, Sengar P, et al. Comparison between intrathecal isobaric ropivacaine 0.75% with hyperbaric bupivacaine 0.5%: a double blind randomized controlled study. Anaesthesia, Pain & Intensive Care 2013;17(3):261-6
17. Scott DB, Lee A, Fagan D, Bowler GM, Bloomfield P, Lundh R. Acute toxicity of ropivacaine compared with that of bupivacaine. Anesthesia and analgesia. 1989;69(5):563-9.
18. 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
19. Nanavati DS, Dave UM, Gondalia D, et al. Comparative evaluation of hyperbaric bupivacaine versus isobaric ropivacaine in spinal anaesthesia in lower abdomen and lower limb surgery. International Journal of Pharmaceutical Sciences and Research 2015;6(4):1602- 8.