

# Plain versus Hyperbaric Solutions of 0.75% Ropivacaine in Spinal Anaesthesia in Elective Lower Abdominal and Lower Limb Surgeries: A Randomized Comparative Clinical Study

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**Aim:** This study was designed to compare the clinical efficacy of plain and hyperbaric solutions of 0.75% ropivacaine in spinal anaesthesia in elective lower abdominal and lower limb surgeries.

**Methods:** The present study was conducted in the Department of Anesthesiology, Jawaharlal Nehru Medical College & Hospital, Bhagalpur, Bihar, India for one year and Fifty ASA grade I–II patients who were to undergo elective lower abdominal and lower limb surgeries under spinal anaesthesia gave written informed consent to take part in the study, which was approved by the local research ethics committee.

**Results:** In the study, the mean specific gravity of the freshly prepared hyperbaric ropivacaine 0.75% solution (by the addition of 50 mg/mL dextrose) observed was 1.148 and plain ropivacaine 0.75% was 1.160. The two groups were comparable with regard to age, sex, height, weight, ASA status, and types of surgeries and the mean difference was statistically not significant. Hyperbaric ropivacaine produced a more rapid onset of more extensive, but less variable sensory block, which, nonetheless, ultimately regressed more quickly. The onset of analgesia to pinprick at T10 was more rapid, and the maximum block height (median T4 vs T8) was greater, but less variable. Median time to maximum block height was the same in both groups, but the range was considerably greater with the plain solution. The onset of lower limb motor block was slightly faster in the hyperbaric group, but the maximum degree obtained was the same in both groups.

**Conclusion:** Addition of glucose 50 mg /ml to ropivacaine 5 mg /ml increases the speed of onset, block reliability, duration of useful block for perineal surgery, and speed of recovery. Plain solutions are less reliable for surgery above a dermatomal level of L1.

**Keywords:** Hyperbaric Ropivacaine, Spinal Anesthesia, Abdominal, Lower Limb.

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## Introduction

Ropivacaine, a new long-acting amide local anesthetic, was introduced in clinical practice with the claim that it causes less motor block than bupivacaine, [1,2] and as an alternative to hyperbaric lignocaine

because of its higher incidence of transient neurologic symptoms and cauda equina syndrome. [3] The effect of ropivacaine has also been claimed to be less cardiotoxic than that of bupivacaine. [4]

Ropivacaine has been studied relatively little in intrathecal use. Early studies comparing two doses (15 vs 22.5 mg) of glucose-free (plain) ropivacaine found that intrathecal injection produced a sensory block of very variable extent, a proportion of the patients in both studies requiring general anaesthesia because of inadequate distribution of block, mainly, but not exclusively, in the patients receiving 15 mg. [5,6] Since then, other studies have shown that plain ropivacaine can produce satisfactory analgesia for surgery, [7-9] but doubt remains about its reliability, as is the case with other agents in plain solution. [10,11] However, two recent studies of hyperbaric ropivacaine (15 mg) have shown that it produces predictable and reliable anaesthesia for surgery, [12,13] and with a duration that is shorter than that of bupivacaine.

The preliminary studies evaluated the efficacy and safety of isobaric ropivacaine for neuraxial blockade.<sup>5,6</sup> Intrathecal ropivacaine was found to be safe, having shorter duration of action than bupivacaine and lesser incidence of transient neurological symptoms (TNS) as compared with intrathecal lignocaine. [3,14] Intrathecal use of hyperbaric LA agents have become more popular as they produce predictable block characteristics and reliable SA. [15,16]

This study was designed to compare the clinical efficacy of plain and hyperbaric solutions of 0.75% ropivacaine in spinal anaesthesia in elective lower abdominal and lower limb surgeries.

### Materials and Methods

The present study was conducted in the Department of Anesthesiology, Jawaharlal Nehru Medical College & Hospital, Bhagalpur, Bihar, India for one year and Fifty ASA grade I-II patients who were to undergo elective lower abdominal and lower limb surgeries under spinal anaesthesia

Patients were randomly divided into two groups of 25 each: plain and hyperbaric 0.75% ropivacaine. Patients were pre-medicated at the discretion of the responsible clinical anaesthetist and, in the anaesthetic room, monitoring with pulse oximetry, ECG, and non-invasive blood pressure was initiated, and venous access secured. Lumbar puncture was performed with a 25-G Quincke spinal needle using a midline approach at the second or third lumbar interspace with the patient in the left lateral position. The patients were randomized (shuffled, then numbered, opaque envelopes) to receive 3 ml ropivacaine 5 mg/ml (15 mg) injected over 10–15 s in either plain solution or with glucose 50 mg/ml. The solution was prepared aseptically by the anaesthetist administering the block, immediately before injection, by mixing ropivacaine 10 mg/ml with an equal volume of either glucose 50 mg/ml or sodium chloride 9 mg/ml to give solutions with densities (at 37°C) of 1.01949 and 0.99953 g ml<sup>-1</sup> respectively.<sup>17</sup> The patient was turned supine immediately at the end of injection, the time of which was defined as 'zero'.

Thereafter an investigator, blinded to the solution administered, assessed the upper and lower extent of sensory block (analgesia to pinprick with the short bevel end of a 27-G dental needle: caudal limit of sensory block assessment (S<sub>2</sub>), and the degree of motor block (modified Bromage scale: 0=full leg movement; 1=inability to raise extended leg, can bend knee; 2=inability to bend knee, can flex ankle; 3=no movement) and recorded the pulse rate and blood pressure 2, 5, 10, 15, 20, 25, and 30 min after injection. The patients were then transferred to the operating room and, if they wished, received sedation with a target-controlled infusion of propofol titrated to maintain verbal contact throughout. Because of this, and to avoid any interference, assessments were not made during surgery, but were continued at 30 min intervals thereafter

until the block had regressed completely. I.V. fluid was administered only to replace operative blood loss, hypotension (>30% decrease in systolic pressure from baseline) being treated with i.v. ephedrine 6 mg. Once sensory block had regressed fully, patients were encouraged to mobilize under supervision. Bladder catheterization was performed when surgically indicated, but time to micturition was recorded in all other patients. Patients were visited or telephoned 24 h and 3–7 days later to identify any sequelae.

### Statistical analysis

The sample size was chosen to show a difference in extent of sensory block of 2 dermatomes (SD 1 dermatome) between the groups, based on an a risk of 0.05 and a b risk of 0.10, using data from a previous study.<sup>8</sup> Data are presented as median [range], mean (SD) or frequencies as appropriate. Block characteristics were compared using the two-tailed Mann–Whitney U-test. A P value of <0.05 was considered statistically significant. Data were analysed using a standard computer-based statistics package

### Results

**Table 1: Patient characteristics and types of surgery performed. Data are median (range), mean (SD) or frequencies**

	Plain (n=25)	Hyperbaric (n=25)	P-value
Age (yr)	60 (50–73)	58 (30–75)	0.109
Height (cm)	167 (8)	165 (9)	0.712
Weight (kg)	71 (14)	70 (12)	0.989
Gender (M/F)	14/11	18/7	0.301
ASA I/II	20/5	14/11	0.300
<b>Type of surgery</b>			
Lower abdominal	12	12	0.818
Lower limb	13	13	

In the study, the mean specific gravity of the freshly prepared hyperbaric ropivacaine 0.75% solution (by the addition of 50 mg/mL dextrose) observed was 1.148 and plain ropivacaine 0.75% was 1.160. The two groups were comparable with regard to age, sex, height, weight, ASA status, and types of surgeries and the mean difference was statistically not significant.

**Table 2: Characteristics of spinal anesthesia**

	Plain (n=25)	Hyperbaric (n=25)	P-value
Onset of Sensory block to T10 (min)	10 [2–25]	5 [2–10]	<0.01
Median maximum block (dermatome)	T8 [T2–L2]	T4 [T2–T9]	<0.05
Time to maximum block (min)	25 [15–150]	25 [10–30]	0.847
Duration at T10 (min)	125 [0–208]	115 [50–178]	0.985
Sensory regression (min)	270 [150–390]	240 [180–270]	<0.05
Motor regression (min)	180 [90–270]	120 [30–150]	<0.001
Time to mobilize (min)	286 [101–403]	218 [183–347]	<0.01

Hyperbaric ropivacaine produced a more rapid onset of more extensive, but less variable sensory block, which, nonetheless, ultimately regressed more quickly. The onset of analgesia to pinprick at T10 was more rapid, and the maximum

block height (median T4 vs T8) was greater, but less variable. Median time to maximum block height was the same in both groups, but the range was considerably greater with the plain solution. The onset of lower limb motor

block was slightly faster in the hyperbaric group, but the maximum degree obtained was the same in both groups. Median time to regression of sensory block to T10 (an indicator of useful duration for surgery) was longer in the hyperbaric group, but median times to complete regression of both sensory and motor block were longer in the plain group. Patients therefore mobilized sooner in the hyperbaric group although the data for mobilization time were incomplete because of surgical constraints.

### Discussion

Early studies with isobaric ropivacaine reported to have variable or inadequate block patterns for surgery [5,6] and confirmed that the addition of glucose to the solution of ropivacaine has better effects as with other drugs used for SA. [15,16] It reduces the proportion of a limited block or more extensive block which has been previously reported from studies on both tetracaine [11] and bupivacaine. [19,20]

Addition of glucose led to a more rapid spread to a higher median level and with less variation in maximum sensory and motor block. However, the useful duration was longer and more consistent, but complete regression occurred sooner so that patients mobilized earlier. Similar observations on the effect of adding glucose have been made with other local anaesthetics. [11,18] The increase in density produced by the addition of glucose would appear to result in a more even distribution of the local anaesthetic, gravity presumably encouraging spread of the bolus of drug 'down' the slopes of the lumbar curve when the patient is placed supine after injection. [14] Usually, glucose-free solutions are marginally hypobaric, and have been found previously to be 'unpredictable', [10] perhaps because gravity does not encourage their spread in the supine position. Spread is likely to be more dependent on other factors such as the currents produced by injection and

simple diffusion. This may mean that more of the injected drug stays closer to the point of injection, making the block less useful for surgery, yet prolonging significantly sacral nerve block and so delaying recovery.

While the addition of glucose to a local anaesthetic solution improves predictability, all users of spinal anaesthesia must be aware that considerable variation in both total spread and duration of action still occurs. The average duration can be influenced by drug and dose choices, but the variability remains. This variability is even evident between studies. In a previous study the median duration of 15 mg ropivacaine 5 mg ml<sup>-1</sup> (with glucose 50 mg/ml) at T10 was 56 [range 28–145] min, whereas it was 115 [50–180] in our study.

Although this study was not performed in the day-case setting, the suitability of hyperbaric ropivacaine for ambulatory surgery should be considered. McDonald and colleagues, using sub-clinical doses of ropivacaine in volunteers, concluded that it was less potent than bupivacaine and offered no advantage for use in outpatient anaesthesia. However, what they found was that ropivacaine produced sensory block of similar onset and extent as bupivacaine, but that it was associated with less motor block and faster regression of both sensory and motor block, findings similar to those reported here. [20] Subsequently, clinically relevant doses of hyperbaric ropivacaine have been shown, as in this study, to provide predictable and reliable anaesthesia for elective surgery, albeit of a shorter duration than equal doses of bupivacaine. [13] The standard agent for short duration spinal anaesthesia has been lidocaine, but continuing concerns about the high incidence of transient neurological symptoms limit its use. [21,22,23]

### Conclusion

Hyperbaric ropivacaine produced more predictable and reliable sensory and motor block, with faster onset, than a plain solution. In addition, although the duration of useful block for surgery was increased, so was the speed of recovery from both sensory and motor block. Patients therefore mobilized more quickly after spinal anaesthesia with hyperbaric ropivacaine, something that may be particularly useful for ambulatory surgery and any operation when a long duration of block is unnecessary or undesirable, although it should be noted that the drug is unlicensed for this indication at present. Plain solutions of ropivacaine are associated with a less favourable pattern of block such that we advocate that they should not be used for surgery at or above the dermatomal level of the inguinal ligament that is L1.

## References

1. Brockway MS, Bannister J, McClure JH, McKeown D, Wildsmith JA. Comparison of extradural ropivacaine and bupivacaine. *British Journal of Anaesthesia*. 1991 Jan 1;66(1):31-7.
2. Zaric D, Nydahl PA, Philipson L, Samuelsson L, Heierson A, Axelsson K. The effect of continuous lumbar epidural infusion of ropivacaine (0.1%, 0.2%, and 0.3%) and 0.25% bupivacaine on sensory and motor block in volunteers: a double-blind study. *Regional Anesthesia and Pain Medicine*. 1996;21(1):14-25.
3. Zaric D, Christiansen C, Pace NL, Punjasawadwong Y. Transient neurologic symptoms after spinal anaesthesia with lidocaine versus other local anaesthetics: A systematic review of randomized, controlled trials. *Anesth Analg*. 2005; 100:1811-6.
4. Feldman HS, Arthur GR, Pitkanen M, Hurley R, Doucette AM, Covino BG. Treatment of acute systemic toxicity after the rapid intravenous injection of ropivacaine and bupivacaine in the conscious dog. *Anesthesia & Analgesia*. 1991 Oct 1;73(4):373-84.
5. Van Kleef JW, Veering BT, Burm AG. Spinal anaesthesia with ropivacaine: a double-blind study on the efficacy and safety of 0.5% and 0.75% solutions in patients undergoing minor lower limb surgery. *Anesthesia and Analgesia*. 1994 Jun 1;78(6):1125-30.
6. Wahedi W, Nolte H, Klein P. Ropivacain zur Spinalanästhesie Eine Dosisfindungsstudie. *Der Anaesthesist*. 1996 Aug;45(8):737-44.
7. Gautier PE, De Kock M, Van Steenberge A, Poth N, Lahaye-Goffart B, Fanard L, Hody JL. Intrathecal ropivacaine for ambulatory surgery: a comparison between intrathecal bupivacaine and intrathecal ropivacaine for knee arthroscopy. *The Journal of the American Society of Anesthesiologists*. 1999 Nov 1;91(5):1239-.
8. McNamee DA, Parks L, McClelland AM, Scott S, Milligan KR, Ahlén K, Gustafsson U. Intrathecal ropivacaine for total hip arthroplasty: double-blind comparative study with isobaric 7.5 mg ml<sup>-1</sup> and 10 mg ml<sup>-1</sup> solutions. *British journal of anaesthesia*. 2001 Nov 1;87(5):743-7.
9. McNamee DA, McClelland AM, Scott S, Milligan KR, Westman L, Gustafsson U. Spinal anaesthesia: comparison of plain ropivacaine 5 mg ml<sup>-1</sup> with bupivacaine 5 mg ml<sup>-1</sup> for major orthopaedic surgery. *British journal of anaesthesia*. 2002 Nov 1; 89(5):702-6.
10. Logan MR, McClure JH, Wildsmith JA. Plain bupivacaine: an unpredictable spinal anaesthetic agent. *British Journal of anaesthesia*. 1986 Mar 1;58(3):292-6.
11. Lee A, Ray D, Littlewood DG, Wildsmith JA. Effect of dextrose concentration on the intrathecal spread of amethocaine. *British journal of anaesthesia*. 1988 Aug 1;61(2):135-8.

12. Whiteside JB, Burke D, Wildsmith JA. Spinal anaesthesia with ropivacaine 5 mg ml<sup>-1</sup> in glucose 10 mg ml<sup>-1</sup> or 50 mg ml<sup>-1</sup>. *British journal of anaesthesia*. 2001 Feb 1;86(2):241-4.
13. Whiteside JB, Burke D, Wildsmith JA. Comparison of ropivacaine 0.5% (in glucose 5%) with bupivacaine 0.5% (in glucose 8%) for spinal anaesthesia for elective surgery. *British Journal of Anaesthesia*. 2003 Mar 1;90(3):304-8.
14. Hocking G, Wildsmith JA. Intrathecal drug spread. *British journal of anaesthesia*. 2004 Oct 1;93(4):568-78.
15. Fettes PD, Hocking G, Peterson MK, Luck JF, Wildsmith JA. Comparison of plain and hyperbaric solutions of ropivacaine for spinal anaesthesia. *British journal of anaesthesia*. 2005 Jan 1;94(1):107-11.
16. Kallio H, Snäll EV, Tuomas CA, Rosenberg PH. Comparison of hyperbaric and plain ropivacaine 15 mg in spinal anaesthesia for lower limb surgery. *British journal of anaesthesia*. 2004 Nov 1;93(5):664-9.
17. McLeod GA. Density of spinal anaesthetic solutions of bupivacaine, levobupivacaine, and ropivacaine with and without dextrose. *British Journal of Anaesthesia*. 2004 Apr 1;92(4):547-51.
18. Chambers WA, Edstrom HH, Scott DB. Effect of baricity on spinal anaesthesia with bupivacaine. *British journal of anaesthesia*. 1981 Mar 1;53(3):279-82.
19. Bannister J, McClure JH, Wildsmith JA. Effect of glucose concentration on the intrathecal spread of 0.5% bupivacaine. *British Journal of Anaesthesia*. 1990 Feb 1;64(2):232-4.
20. McDonald SB, Liu SS, Kopacz DJ, Stephenson CA. Hyperbaric spinal ropivacaine: a comparison to bupivacaine in volunteers. *The Journal of the American Society of Anesthesiologists*. 1999 Apr 1;90(4):971-7.
21. Breebaart MB, Vercauteren MP, Hoffmann VL, Adriaensen HA. Urinary bladder scanning after day-case arthroscopy under spinal anaesthesia: comparison between lidocaine, ropivacaine, and levobupivacaine. *British Journal of Anaesthesia*. 2003 Mar 1;90(3):309-13.
22. Schneider M, Ettlin T, Kaufmann M, Schumacher P, Urwyler A, Hampl K, von Hochstetter A. Transient neurologic toxicity after hyperbaric subarachnoid anesthesia with 5% lidocaine. *Anesthesia & Analgesia*. 1993 May 1;76(5):1154-7.
23. Obaid S. R. Viral pneumonia causative agents diagnosis by using Indirect Immune Fluorescent Assay. *Journal of Medical Research and Health Sciences*. 2022; 5(6): 2054-2058.