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COMPARATIVE EVALUATION OF HYPERBARIC BUPIVACAINE VERSUS ISOBARIC ROPIVACAINE IN SPINAL ANAESTHESIA IN LOWER ABDOMEN AND LOWER LIMB SURGERY

Dharam S. Nanavati, Urmi Mittal Dave, Deepa Gondalia, Vandana Parmar, Vrajesh Chhaya and Ujjaval Gupta

Department of Anaesthesiology, P.D.U. Medical College, Rajkot, Gujarat, India

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Correspondence to Author:
Dr. Vandana Parmar

MBBS, DA, MD [Anaesthesia], Professor and H.O.D, Department of Anaesthesiology, PDU Government Medical College, Civil Hospital Campus, Rajkot-360001, Gujarat, India.

E-mail: drvandanapithadia@yahoo.com

ABSTRACT: Aim of this study was to compare bupivacaine heavy (0.5%) 3ml with isobaric ropivacaine (0.75%) 3ml, intrathecally in patients posted for lower abdominal and lower limb surgery for sensory and motor effects and hemodynamic stability. 100 patients aged 12 years or older (ASA grade I, II, III) scheduled for various lower abdominal and lower limb surgeries were randomly distributed in two groups. In group B (n= 50) 15 mg of hyperbaric bupivacaine (0.5%, 3ml) and in group R (n=50) 21.5 mg of isobaric ropivacaine (0.75%, 3ml) was given intrathecally. All observations were recorded and analyzed statistically by using unpaired t-test and P- value < 0.05 was considered significant. No statistically significant difference in onset of sensory blockade up to T_{10}, onset of motor block (grade "I"), mean duration of analgesia and side effects was observed between both groups. Statistically significant difference in onset of motor blockade at grade "III" was observed between group B and R. Statistically significant mean duration of sensory and motor blockage was found in group B. Administration of 0.75% isobaric ropivacaine intrathecally was found to have shorter duration of motor blockade and similar duration of analgesia as compared to bupivacaine with hemodynamic stability and without significant side effects.

INTRODUCTION: Local anaesthetics are compound that provides reversible regional loss of sensation and thus allowing patient to undergo surgical procedures with reduced pain and distress. Bupivacaine was introduced in the market in 1965 and was followed by reports of CNS and CVS toxicity. Identification of treatment resistant CVS toxicity leads to restrictions of its use.

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Ropivacaine is new amide local anaesthetic, optically active and pure S-enantiomer [1], nearly identical in onset, quality and duration of sensory block to equipotent doses of bupivacaine but producing less motor blockade [2]. Differential sensory and motor block is apparent only at low concentration. The primary benefit of ropivacaine is its lower cardiotoxicity as compared to Bupivacaine. Higher therapeutic index leads to improved safety profile as compared with bupivacaine. Two major advantages of ropivacaine over bupivacaine are:

1. It provides more differential block when given epidurally, allowing for better separation between sensory and motor

block. This makes it excellent in obstetrics and in postoperative epidural pain relief [3].

2. Lower systemic toxicity than both bupivacaine and levobupivacaine. Purpose of study is to do comparison of effects of intrathecal injection bupivacaine heavy (0.5%) 3ml and injection ropivacaine isobaric (0.75%) 3ml, in spinal anaesthesia in patients posted for lower abdominal and lower limb surgery, with particular emphasis given on onset of sensory and motor blockade, duration of analgesia, motor block, hemodynamic stability and need of vasopressors, side effects and incidence of complications.

MATERIALS AND METHODS:

100 patients aged 12 years or older of ASA grade I, II, III scheduled for various lower abdominal and lower limb surgery under spinal anesthesia were evaluated in prospective manner after approval from Institutional Ethics Committee, P D U Medical College, Rajkot (Registration number-PDUMCR/IEC/15/2010).

Patients excluded from study were patients with CNS, CVS disorders, allergy to local anaesthetics, patient refusal, infection/ injury/abrasion at site of injection, patient on anticoagulant drugs or having blood dyscrasia with altered coagulation profile. Detailed pre-anaesthetic assessment of each case was done and required investigations were carried out. ASA physical status, associated pathologies, adequacy of treatment and drugs consumed were recorded. Bronchodilator, antihypertensive drugs and coronary vasodilator dose given with sip of water. Morning dose of inj. Insulin omitted. All patients were premedicated with inj. Glycopyrrolate (0.004mg/kg), inj. Ondansetron (.08-0.1mg./kg.) and inj. Ranitidine (1.0mg./kg.) intravenously.

In operating room pulse rate, blood pressure, respiratory rate, SpO_2 were recorded before giving spinal anesthesia and patients given infusion of 15ml/kg of Ringer lactate solution over period of 20 - 30 minutes. Under all aseptic and antiseptic precautions lumber puncture was performed with 23gauge Quincke spinal needle in L_3-L_4 space in sitting position. Patients were randomly distributed in two groups.

Group B - n= 50: 15 mg of Hyperbaric Bupivacaine (0.5%, 3ml)

Group R- n=50: 21.5 mg of Isobaric Ropivacaine (0.75%, 3ml)

After noting time of injection, patient was immediately placed in supine position. No tilt of O.T. table was given for first 30 minutes. Following parameters were evaluated.

Onset of sensory blockade is the time between induction and loss of pin prick sensation up to T_{10} level, checked by every 30 second after injection.

Motor blockage was assessed with modified bromage scale. [5]

Grade	Criteria	Degree of Block
0	Free movement of leg and feet, with ability to raise extended leg.	None
1	Inability to raise extended leg and knee flexion is decreased. But full flexion of feet and ankles is present.	Partial (33%)
2	Inability to raise leg or flex knee, flexion of ankle and feet present	Partial (66%)
3	Inability to raise leg, flexes knee or ankle, or move toes.	Complete paralysis

Onset of motor blockade is the time required to produce inability to raise extended leg, measured at every 30 seconds up to onset period. Surgery was followed to start after establishment of sensory blockade up to T_{10} level and this time was noted.
Intra operative monitoring includes pulse rate, blood pressure, and SPO_2 and ECG monitoring recorded by multipara monitor every 10 minutes. Supplementary oxygen was given during surgery.

Intra operative complications and side-effects like:

I. Bradycardia (pulse < 60/min). Treated by – atropine sulphate (0.6 mg)

II. Hypotension (>20% decrease in systolic BP from baseline BP). Treated by i.v. fluid, injection mephentermine 5mg i.v. bolus.

III. Nausea, vomiting, respiratory distress (RR < 10 min, SpO_2 < 90 %), irregular rhythm,

shivering, pruritus, urinary retention etc. were noted and treated accordingly.

Time of completion of surgery and duration of sensory and motor block were noted. Post-operatively duration of sensory blockade (regression up to L_1 dermatome) was noted. Duration of motor blockade was taken from onset of Grade-I block to recovery that is ability to raise extended leg.

Highest level of sensory blockade noted in each patient. Surgeons were informed not to give analgesic or sedative postoperatively until patient complains of pain. In postoperative period Pulse, BP, Respiration, SpO_2, Cardiac monitoring (ECG) were observed half an hour interval for two hours following surgery, then hourly for next six hours, then four hourly for next 24 hours after surgery.

Post-operative complication and side effects like nausea, vomiting, dryness of mouth, sedation, respiratory rate, desaturation, hypotension, bradycardia, neurological deficit, headache, etc. were noted and treated accordingly. All the observations were recorded, analyzed statistically and compared with unpaired two-sample t-test except for sex (χ2-test) and p- value < 0.05 was considered significant. Data are presented as Mean ± SD.

RESULTS:

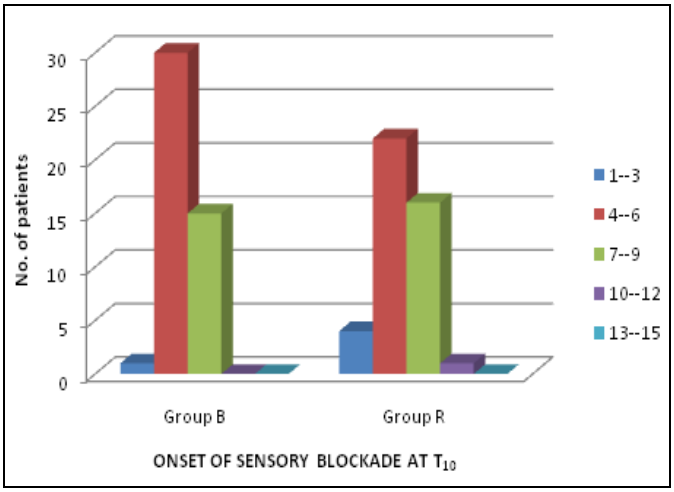
Table 1 shows demographic data. Both groups were comparable and there was no statistically significant difference in their age, weight, height distribution. (P-value> 0.05) Mean duration of surgery in group B was 83.66 ± 16.28 and in group R was 84.16 ± 16.1 minutes. P-value is 0.4384, which is statistically non-significant.

TABLE 1: SHOWING THE DEMOGRAPHIC DATA

	Group-B	Group-R	p-Value
Age (years)	40.76 ± 11.63	40.12 ± 16.7	0.411
Weight (Approx in Kg)	59.02 ± 4.96	58.98 ± 6.63	0.3669
Height (cm)	161.74 ± 6.01	162.96 ± 5.25	0.1404
Sex (M : F)	33 : 17	46 : 4	

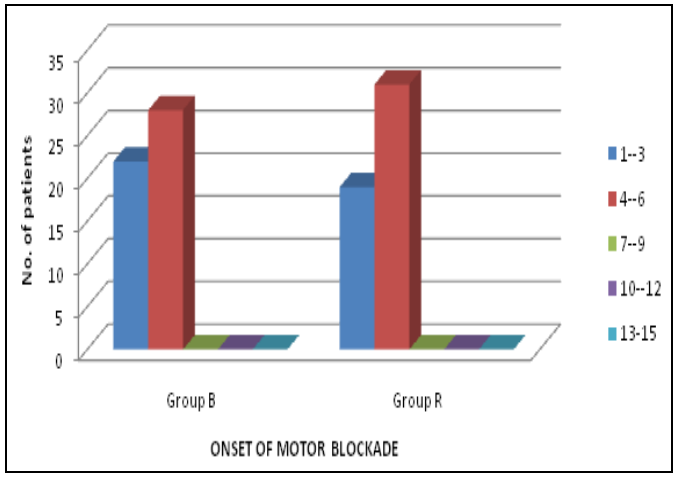
P-Value – 0.026, Z-Value - -0.7524, statistically non-significant

No statistically significant difference was observed in mean pulse rate, mean blood pressure before and after spinal anaesthesia and in post operative period between both groups. Mean time of onset of sensory blockade up to T_{10} in group B and group R was 5.73 ± 1.3 and 6.12 ± 1.75 minutes respectively. The Z-value is -1.2568 and p-value is 0.1045 (> 0.05). (As shown in **graph 1**), which is statistically non-significant.



GRAPH 1: ONSET OF SENSORY BLOCKADE AT T_{10} IN MIN

The mean time of onset of motor blockade at grade "I" in group B and group R was 3.8 ± 0.948 and 3.94 ± 0.913 minutes respectively. The Z-value is -0.7524 and p-value is 0.226 (> 0.05(As shown in **graph 2**), which is statistically non-significant.



GRAPH 2: ONSET OF MOTOR BLOCKAD AT GRADE "I" IN MIN

Table 2 shows that mean time of onset of maximum sensory blockade in group B and group R was 8.58 ± 1.46 and 8.84 ± 1.77 minutes

respectively. The Z-value is -0.7998 and p-value is 0.2148(>0.05), statistically non-significant.

TABLE 2: ONSET OF MAXIMUM SENSORY LEVEL AS JUDGED BY LOSS OF PINPRICK SENSATIONS.

Time in minutes	Group B	Group R
4-6	04	04
7-9	29	25
10-12	17	19
13-15	00	01
15-17	00	00
Minimum time	06	04
Maximum time	12	13
Mean time	8.58	8.84
S.D.	± 1.46	± 1.77

P-Value - 0.0069, Z-Value - 2.4639, Statistically highly-significant

Table 3 shows that mean time of onset of maximum motor blockade at grade "III" in group B and group R was 6.66 ± 1.6856 and 7.44 ± 1.473 minutes respectively. The Z-value is -2.4639 and p-value is 0.0069 (< 0.05), statistically highly significant.

TABLE 3: ONSET OF MAXIMUM MOTOR BLOCKAD (GRADE "III") ACCORDING TO MODIFIED BROMAGE SCALE

Time in minutes	Group B	Group R
1-3	00	00
4-6	23	11
7-9	23	35
10-12	04	04
13-15	00	00
Minimum time	04	05
Maximum time	10	12
Mean time	6.66	7.44
S.D.	1.6856	1.473

P-Value – 0.2148, Z-Value – - 0.7998, statistically non-significant

Table 4 shows that mean duration of sensory blockade in group B is 282.5 (±41.927) minutes and in group R is 266.96(±37.821) minutes, Z value is 1.94605 and p value is 0.026, which is statistically significant.

TABLE 4: DURATION OF SENSORY BLOCAGE IN MINUTES

Time in minutes	Group B	Group R
151-200	02	04
201 – 250	09	12
251 – 300	25	26
301 – 350	11	08
351 – 400	03	00
401 – 450	00	00
Minimum time	193	185
Maximum time	375	332
Mean time	282.5	266.96
S.D.	± 41.927	± 37.821

P-Value – 0.026, Z – 1.9460, Statistically significan

Table 5 shows that mean duration of motor blockade in group B is 244.72 (±25.416) minutes and in group R is 225.72(±36.443) minutes, Z value is 3.02385 and p value is 0.0013, statistically highly significant.

Table 6 shows that mean duration of analgesia in group B is 238 (±30.756) minutes and in group R is 237.123(±26.6) minutes, Z value is 0.1555 and p value is 0.5596, which is statistically non-significant.

TABLE 5: DURATION OF MOTOR BLOCKADE IN MINUTES

Time in minutes	Group B	Group R
101-150	00	02
151-200	03	10
201 – 250	23	27
251 – 300	24	11
301 – 350	00	00
351 – 400	00	00
Minimum time	172	157
Maximum time	290	300
Mean time	244.72	225.72
S.D.	± 25.416	± 36.443

P-Value – 0.0013, Z-Value – 3.02385, Statistically highly significant

TABLE 6: DURATION OF POSTOPERATIVE ANALGESIA IN MINUTES

Time in minutes	Group B	Group R
101-150	00	01
151-200	02	04
201 – 250	32	39
251 – 300	16	06
301-350	00	00
Minimum time	165	120
Maximum time	300	275
Mean time	238	237.12
S.D.	± 30.756	± 25.6

P-Value – 0.5596, Z-Value – 0.5596, statistically non-significant

Graph 3 shows perioperative side effects in both groups. Main side effect observed in both groups was hypotension, in control group 7 patients and in study group 8 patients had hypotension. Nausea and vomiting and shivering were other side effects observed. None of the patients reported bradycardia. The observed side effects are not statistically different in both groups.

DISCUSSION: As practice of medicine focuses increasingly on outpatient care, spinal anaesthetics should provide short-acting and adequate anaesthesia without compromising early ambulation and discharge from the day surgery unit. Ropivacaine could have potential in this area.

Present study was undertaken to evaluate ropivacaine as mean of providing less motor block, early ambulation and less toxicity as compared to bupivacaine. This study shows that intrathecal administration of either 21.5mg (0.75%, 3ml) ropivacaine or 15mg (0.5%, 3ml) bupivacaine was well tolerated and adequate block for lower limb and lower abdominal surgery was achieved in all patients. In humans, ropivacaine has been shown to be effective in providing intrathecal anaesthesia for patients undergoing THR [6], TURP [7] and lower abdominal and lower limb surgery [8, 9]. The efficacy and safety of two solutions, ropivacaine and bupivacaine were assessed.

The pKa of bupivacaine and ropivacaine are identical but ropivacaine is less lipid soluble, envisaging that ropivacaine will block a fibers more slowly than bupivacaine. Thus ropivacaine would cause less motor block than bupivacaine, [10] which is confirmed in this study. This evidence suggests that there is greater degree of sensory – motor separation when using ropivacaine.

In present study, most of patients have pre-operative pulse rate between 70 and 90 per minute. During intra–operative and post-operative period, pulse rate change was mostly between 0-10/min in both groups. Mean arterial blood pressure change from pre-operative value was same in both groups. There was initial fall in arterial pressure in majority of patients. Mehta, V. Gupta, R. Wakhloo, et al [11] compared intrathecal administration of isobaric bupivacaine 15 mg and ropivacaine 15 mg undergoing lower limb surgery. They found that, there was slight decrease in mean heart rate and

arterial blood pressure over 30 minutes after anaesthesia which was statistically non-significant. Mean time of onset of sensory block up to T_{10} is less in group B than group R, but statistically non-significant. Mac Namee, McClelland, S. Scott et al [12] studied isobaric ropivacaine 5mg/ml (3.5ml) and isobaric bupivacaine 5 mg/ml (3.5 ml) for major orthopaedic surgery.

No statistically significant difference found in median time of onset of sensory block which was 2 minutes (range2-5 min) in ropivacaine group and 2 min (range 2-9 min) in bupivacaine group. As compared to our study, this difference could be due to different volume and concentration of drug used. Helena Kallio, Eljas-Veli T, et al [13] used intrathecal isobaric solution (2ml) containing Ropivacaine 20 mg (1%) or 15 mg (0.75%) versus Bupivacaine 10mg (0.5%). Median onset of analgesia to T_{10} was 10 minutes in all groups. Difference could be due to difference in concentration.

Onset of motor blockade at grade "I" in group B and group R was 3.8 ± 0.948 and 3.94 ± 0.913 minutes respectively, which is statistically non-significant. Mac Namee, McClelland, S. Scott et al [12] found that there was rapid onset in both groups with median time of onset 2 min to achieve a bromage score of 1 for both groups. This difference was not statistically significant. Difference could be due to different concentration and volume of drug used. M. Mantouvalou, S. Rally, H. Arnaoutoglou el al [14] found that onset of motor blockade at grade "I" was 2 ± 1 min in group A, 3 ± 1 min in group B, and 2 ± 1 min in group C. These differences were not significant. This slight difference could be due to different concentration of drug used.

Onset of maximum motor blockade (Grade III) in minutes in group B and group R was 6.66 ± 1.6856 and 7.44 ± 1.473 respectively, which is statistically highly significant. Onset of maximum motor blockade is achieved up to grade 'III' in all patients, except two patients in bupivacaine group achieved up to grade II, and one patient in ropivacaine group achieved up to grade II. J.B. Whiteside, D Burke, J.A.W. Wildsmith et al [9] found that onset of complete motor block at grade "III" was 10 min (2-15) in bupivacaine group and 15 min (10-25) in ropivacaine group which is statistically significant ($p<0.0001$). The longer onset time than our study could be due to lower concentration and baricity of drug used. PE Gautier, De Kock M, Van Steenberge A, et al [15] found that time to maximum motor blockade in minute in group '1'-15 ± 9, group '2'-20 ± 11, group '3'-20 ± 11, group '4'-20 ± 11, and group '5'-19 ± 13. In our study longer time taken for onset of maximum motor blockade could be due to low concentration of drugs used.

Mean duration of sensory block was high in group B than in group R, which is statistically significant. Mac Namee, McClelland, S. Scott et al [12] found that median duration of sensory block at T_{10} dermatome was significantly longer in the bupivacaine group: 3.5 hr (range 2.7-5.2 hr) compared with 3.0 hr (range 1.5-4.6 hr) in the ropivacaine group ($p<0.0001$).

The mean duration of motor blockade in group B is 244.72 (±25.416) minutes and in group R is 225.72 (±36.443) minutes, statistically highly significant. Mac Namee, McClelland, S. Scott et al [12] shows that median duration of complete motor block (modified bromage scale 3) was significantly shorter in ropivacaine group compared with bupivacaine group (2.1 v/s 3.9 hr, $P<0.001$).

Difference could be due to difference in volume and concentration of drug used. A. Mehta, V. Gupta, R. Wakhloo, et al [11] shows duration of motor block was statistically comparable in group A and C but longer in group B. Helena Kallio, Eljas-Veli T, et al [13] found that median duration of complete motor block was 100, 40, and 100 min, respectively and full recovery occurred in 210, 150, and 210 min, respectively. This study confirms that ropivacaine is approximately 50% less potent than bupivacaine. Smaller dose of ropivacaine (15mg), proved beneficial because recovery from the motor block was faster. Difference could be due to difference in volume and concentration of drug used.

Mean duration of analgesia in group B is 238 (±30.756) minutes and in group R is 237.12(±25.6) minutes. There was no statistically significant difference ($p>0.05$) in mean duration of analgesia

between two groups. Mac Namee, McClelland, S. Scott et al [12] found that no patients required supplemental analgesia intra-operatively, except for one patient in ropivacaine group. Median time to first analgesic request was significantly shorter in ropivacaine group than in bupivacaine group (3.4 v/s 4.9 hr, $p<0.001$). Duration of analgesia was shorter in the ropivacaine group which could be due to low concentration of drug used.

In conclusion, there was no significant difference between onsets of sensory blockade at T_{10} level, onset of motor blockade at grade "I", onsets of maximum sensory blockade, intraoperative and post-operative side effects in both groups. Onset time for maximum motor blockade is significantly delayed in group R. Duration of sensory and motor blockade is significantly more in bupivacaine group. Duration of analgesia is not significantly different in both groups.

So, administration of 0.75% isobaric ropivacaine in spinal anesthesia is found to have shorter duration of motor blockade and similar duration of analgesia with hemodynamic stability and without significant side effects and complications as compared to bupivacaine. So, ropivacaine can be useful as choice of spinal anesthetic in ambulatory surgery because of shorter motor duration while similar duration of analgesia.

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