COMPARATIVE EVALUATION OF PLAIN AND HYPERBARIC ROPIVACAINE IN PATIENTS UNDERGOING LOWER ABDOMINAL SURGERY UNDER SPINAL ANESTHESIA

Puneet Dwivedi*, Anu Kapur** and Sanjay Kumar Gupta***

Background: Preliminary work has shown that ropivacaine provides spinal anesthesia of shorter duration with greater sensory motor dissociation than bupivacaine, and may be of particular use in the day care surgery. Hypothetically, hyperbaric solution of ropivacaine could improve and shorten both sensory and motor block.

Material and Methods: This prospective, randomized, double blind study was conducted on 80 patients undergoing lower abdominal surgeries. Patients either received 20.25 mg of plain ropivacaine (group A) or 20.25 mg of hyperbaric ropivacaine in 5% dextrose (group B). The extent and duration of sensory and motor block, haemodynamics, time to home readiness, and the time to first rescue analgesia were recorded.

Results: All patients in group B achieved sensory block at or above T10 dermatome in comparison to only 87.5% patients of group A. Analgesia at T10 was reached in 4 min (4-6 min) in group B vs. 10 min (6-16 min) in group A ($p<0.001$). Patients in group B had a longer duration of analgesia at T10; 126 min (97-146 min) vs. 110 min (90-128 min) ($p=0.047$). Median duration of sensory block from injection of the anesthetic to complete recovery (regression to S_2 dermatome) was shorter in Group B than Group A, 273.5 min (258 - 289 min) vs. 300 min (290 - 312 min) ($p<0.001$), as was the time to 2 segment regression 80 min (63-90 min) vs. 102 min (82-124 min) ($p<0.001$). Duration of complete motor block (mean ± SD) was significantly less in group B, 93.06 ± 17.38 min compared to 139.89 ± 25.17 min ($p<0.001$) in group A, as was the total duration of motor block (181.83 ± 30.21 min in group B vs. 254.91 ± 25.34 min in Group A; $p<0.001$). Patients in Group B attained discharge criteria earlier as indicated by a shorter time to home readiness. Cardiovascular changes were unremarkable throughout, and similar in the two groups. There were no major sequelae.

Conclusion: Addition of dextrose 5% to ropivacaine increases the speed of onset, block reliability, duration of useful block for surgery and speed of recovery. Plain solutions are less reliable for surgery above a dermatomal level of T10.

Keywords: block characteristics; home readiness; lower abdominal surgery; ropivacaine; spinal anesthesia.

* Dr. Puneet Dwivedi, DA, DNB, Medical Officer, Department of Anaesthesiology and Critical Care, Deen Dayal Upadhyay Hospital, Hari Nagar, Delhi = 110064.

** Dr. Anu Kapur, MD, Senior Specialist, Department of Anaesthesiology, Critical Care and Perioperative Medicine, Hindu Rao Hospital, Malka Ganj, Delhi = 110007.

*** Dr. Sanjay Kumar Gupta, DNB, Chief Medical Officer, Department of Anaesthesiology, Critical Care and Perioperative Medicine, Hindu Rao Hospital, Malka Ganj, Delhi = 110007.

Corresponding author: Dr. Sanjay Kumar Gupta, Address: Flat No. D-14, MCD Medical Complex, Kalidas Marg, Gulabi bagh, Delhi, India, Pin Code-110007. Tel: +91 9810655949, Fax: +911123641676. E-mail: drskgupta4u@gmail.com.

Introduction

Spinal anesthesia is a safe, reliable and inexpensive technique with the advantage of providing surgical anesthesia and post-operative pain relief. It not only alleviates operative pain but also blunts autonomic, somatic and endocrine responses[1].

Ropivacaine, a pure S (-) enantiomer, is well tolerated after intrathecal use and has been found to have a shorter duration of action than bupivacaine, making it a possible alternative to lidocaine because of the low incidence of transient neurological symptoms[2]. Due to its property of sensory motor dissociation (ability to block sensory nerves to a greater degree than motor nerves), it allows a faster recovery of motor function that occurs after the use of bupivacaine[3].

Tradionally baricity of local anesthetics has been known to influence the spread of intrathecal local anesthetic solutions and characteristics of the subarachnoid block[4,5]. However, very few studies have compared the clinical efficacy of hyberbaric and plain solutions of ropivacaine. Much of the published work is focused on intrathecal anesthesia with plain ropivacaine in lower limb, obstetric, perineal, urological and anal procedures.

We hypothesized that, intrathecal anesthesia with hyperbaric ropivacaine may be useful for procedures where a sensory and motor block of adequate duration for the procedure and a fast regression of motor block is required, resulting in faster discharge time[6]. The aim of the current study is to compare the intraoperative characteristics and recovery profile of plain and hyberbaric solutions of ropivacaine in lower abdominal surgeries.

Methods

This randomized, double blind study was approved by the hospital ethical committee and written informed consent was obtained from each patient. Eighty patients (ASA 1 and 2) between 18-60 yrs of age, weighing between 45-80 kg, with height between 150 -180 cm, scheduled for elective lower abdominal surgery were randomly divided into two groups according to computer generated random numbers.

Group A: Plain group (n =40) received intrathecal injection of 20.25 mg of plain Ropivacaine (2.7 ml of 0.75% plain Ropivacaine + 0.3 ml normal saline).

Group B: Hyperbaric group (n = 40) received intrathecal injection of 20.25 mg of Ropivacaine with 5% glucose (2.7 ml of 0.75% plain Ropivacaine + 0.3 ml dextrose 50%).

Exclusion criteria included patients belonging to ASA class III, IV and V, unwilling patients, emergency surgeries, history of anaphylaxis to ropivacaine or any other aminoamide local anesthetic drug, pregnant and lactating females, patients with coagulation disorders or on anticoagulant therapy, local infection at the site of proposed puncture for spinal anesthesia, elective surgery more than 2 hours duration, surgeries requiring patient position other than supine, patient with medical complications like raised intracranial tension, anemia, heart disease, severe hypovolemia, shock, septicemia, and hypertension.

A detailed pre-anesthetic check up was done in all patients. Routine hematological, biochemical and radiological investigations were carried out in all patients. The special investigations were done as per the co-morbid condition of the patient.

All patients were asked to remain nil per oral intake for 6 hours before the planned surgical procedure and to be accompanied by an escort on the day of surgery. The anesthetic procedure was explained to the patient in detail. All patients were given tablet alprazolam 0.5 mg, the night before the surgery to have an adequate sound sleep. However, patient received no sedatives before arrival in the operating room.

In the operation theatre, baseline parameters were recorded (pulse rate, noninvasive blood pressure, heart rate). Intravenous access was secured with an 18G IV cannula and 10 ml/kg of ringer lactate was infused as a co-loading fluid. Patients were placed in the lateral decubitus position. Wide area of the back was cleaned and draped. L3-L4 intervertebral space was identified by palpation and infiltrated with 2% lidocaine. 26 G spinal needle (Quincke's) was inserted into the desired interspace in the midline with the bevel facing upwards. After confirming free flow of CSF, needle was rotated so that the bevel faces cephalad and the study drug was injected over 15-20 seconds without any barbotage. Study drug was prepared aseptically just before intrathecal injection by an anesthesiogist, who was not

involved in the study and had no clue about the group allocation. Therefore the investigator was blinded to the drug administered for intrathecal injection. Patient was placed supine immediately after the injection with the table maintained horizontally. Time of intrathecal injection was recorded. Vital parameters were monitored at 5 minute intervals till the end of surgery. Criteria for tachycardia, bradycardia and hypotension were more than 20% increase or decrease more than 20% from the baseline values, but treatment was given only if clinically indicated (systolic blood pressure <80 mmHg or heart rate <50 beats per minute). Injection of mephentermine 3 mg intravenous aliquots was given for hypotension and injection of atropine sulphate 0.6mg intravenous was given for bradycardia. Patients were given supplementary oxygen at 2-4 liters/min if saturation at room air was ≤ 92%.

Sensory block was assessed by loss of sensation to pin prick with a blunt 27 G needle bilaterally along the mid-axillary line every two minutes till two consecutive readings of sensory block remained the same (i.e. when highest cephalad spread of sensory block has occurred), after which it was assessed at ten minute intervals till the end of surgery.

Motor block was assessed by Modified Bromage Scale by Breen et al[7] (MBS 1-6 with MBS 1 = Complete motor block, 2 = Almost complete motor blockade: patient is able to move the feet, 3 = Partial motor blockade: patient is able to move the knees, 4 = Detectable weakness of hip flexion: patient is able to raise the leg but is unable to keep it raised, 5 = No detectable weakness of hip flexion: patient is able to keep the leg raised for at least 10 seconds, MBS 6 = no motor weakness; patient is able to perform partial knee bend while supine).

As in sensory block, motor block was assessed every two minutes till two consecutive readings remained the same, (highest level of motor block) after which it was assessed every ten minutes till the end of surgery.

If sensory block at T10 dermatome was not attained even at twenty minutes after intrathecal injection of the drug, patient was given general anesthesia. In patients undergoing surgery under spinal anesthesia, no analgesia was given during the surgery unless the patient complained of pain. Inj. fentanyl 2μg/kg intravenously was given as a rescue analgesic if patient complained of pain intraoperatively. If patient still complained of pain, then no more analgesics were given and patient was given general anesthesia.

All the patients were monitored in the operative room for at least 60 minutes after the subarachnoid block to a keep close watch on the hemodynamics and block characteristics, even if the surgery ended earlier. After completion of surgery, levels of sensory blocks and motor blocks were recorded with the patient still on the operating table. The patients were shifted to the Post Anesthesia Care Unit (PACU) and they were assessed every 30 minutes for motor block by Modified Bromage Scale till they attain complete motor recovery. Sensory block was also assessed every 30 minutes by the same technique which was used during the intra-operative period until regression of sensory block to S2 dermatome (total duration of sensory block). Patients were assessed half hourly by Post Anesthesia Discharge Scoring System[8] (PADSS) until a score of ≥ 9 was achieved, to check their readiness for discharge.

Time of request for the first analgesic was noted. Visual analogue scale (VAS) was used to assess postoperative pain at 0, 1, 2, 4 and 6 hour after completion of surgery. Inj. diclofenac sodium 75 mg by IV infusion was given for rescue analgesia once VAS score was ≥ 4 (0 = no pain, 10 = most severe pain). Bladder catheterization was performed when surgically indicated, but time to micturition was recorded in all other patients. On the day after the surgery patients were asked about any persistent symptoms like pain, nausea, vomiting, headache, backache, delayed voiding and neurologic symptoms such as tingling, numbness etc. and were treated accordingly. Follow up calls were made on telephone at 24 hrs and 3-7 days later to identify any sequelae.

Sample size

The primary outcome variable was complete recovery from motor block and results of Khaw et al[9] were used to estimate the sample size. When extrapolated from their study to our study with hyperbaric and plain solutions of ropivacaine, the mean time to complete motor recovery could be calculated

Table 1
Patient characteristics, duration and type of surgery performed. Data are mean ± SD or frequencies (n).

Variable	Group A (n=40) (Plain ropivacaine)	Group B (n=40)	P-value
Age (yr)	39.35 ± 2.20	40.35 ± 2.17	0.747
Weight(kg)	60.53 ± 1.48	62.13 ± 1.47	0.446
Height(cm)	165.83 ± 1.10	167.55 ± 1.00	0.251
Sex (M/F)	33/7	34/6	0.762
Duration of surgery (min)	53.17 ± 15.29	54.40 ± 13.16	0.702
ASA (I/II)	36/4	37/3	1.000
Type of Surgery			
Inguinal hernia	27	28	0.689
Incisional hernia	4	3	0.692
Femoral hernia	1	0	0.314
Interval appendectomy	4	4	1.000
Vesical calculus	3	3	1.000
Undescended testis	1	2	0.556

as 117.45 and 177.39 min. The difference between the means was 59.94 min and SD was estimated to be 42.5 min from their study. With an α risk 0.05, and a power (β risk ≤ 0.03) of more than 97%, we calculated the sample size to be 40 in each group.

Statistical analysis

Statistical analysis was performed using the SPSS version 17.0 program for Windows (SPSS Inc., Chicago, IL, USA). We conducted a Shaipro Wilk test to verify the distribution of the data. All data were summarized as the mean ± standard deviation, while those with a skewed distribution were described as a median with an interquartile range (IQR). The chi-square test was used to compare the differences in variables between the two groups. Student's t-test was used for continuous, normal variables. The Mann-Whitney test was used to test independent relationships between the variables that did not demonstrate normality. A two-sided P value less than 0.05 was considered statistically significant.

Results

Demographic profile

The two groups were comparable with respect to age, weight, height, sex, ASA status and duration of surgery (Table 1). Various types of lower abdominal surgical procedure were almost equally distributed amongst the two groups.

Hemodynamic parameters

The groups did not differ in hemodynamics in the operative and the recovery rooms (Table 2). In Group A (plain ropivacaine), only 4 out of 40 patients (10%) developed hypotension and 2 patients (5%) developed bradycardia. In Group B (hyperbaric ropivacaine), only 5 out of 40 patients (12.5%) patients developed hypotension and 3 patients (7.5%) developed bradycardia. Patients who developed bradycardia in the operative room were a subset of patients developing intraoperative hypotension. Patients in both groups were administered sympathomimetics or anticholinergics in the operating room as per protocol.

Table 2

Baseline Hemodynamics in the operating room and the recovery room of the hyperbaric ropivacaine (Group A) and the plain ropivacaine (Group B). Data are expressed in mean ±SD or numbers of patients and percentages

	Group A (n=40)	Group B (n=40)	P-value
Operating room			
Heart rate	70.17 ± 8.32	72.62 ± 12.21	0.298
Maximum heart rate	80.88 ± 11.93	78.35 ± 11.18	0.332
Minimum heart rate	60.33 ± 10.05	61.00 ± 8.55	0.935
Anticholinergic for bradycardia, *n* (%)	2	3	0.644
Systolic blood pressure	123.70 ± 12.23	127.25 ± 11.77	0.190
Maximum systolic blood pressure	128.10 ± 8.97	129.38 ± 7.31	0.488
Minimum systolic blood pressure	99.00 ± 9.80	96.93 ± 10.78	0.306
Sympathomimetics for hypotension, *n* (%)	4	5	0.724
Recovery room			
Maximum heart rate	77.91 ± 6.85	76.19 ± 9.90	0.839
Minimum heart rate	71.43 ± 9.02	70.58 ± 10.79	0.714
Anticholinergic for bradycardia, *n* (%)	0	0	1.000
Maximum systolic blood pressure	124.42 ± 7.07	126.55 ± 7.08	0.235
Minimum systolic blood pressure	97.11 ± 10.47	100.73 ± 11.65	0.214
Sympathomimetics for hypotension, *n* (%)	0	0	1.000

In the recovery room, 2 patients (5%) in both plain and hyperbaric ropivacaine groups developed hypotension but none of the patient in either group developed bradycardia. There was no need for sympathomimetics or anticholinergics in both groups in the recovery room.

Sensory block characteristics

Sensory block reached T10 dermatomal level or above in all patients of group B, but there were 5 patients (12.5%) in group A in whom block failed to reach T10 dermatomal level (Table 3). Out of these 5 patients, 3 patients (7.5%) achieved a maximum sensory level at T12 dermatome and 2 patients (5%) at L1 dermatome (Figure 1).

Fig. 1

Maximum upper level of sensory block in the two groups. Each point refers to one patient, and the horizontal line refers to the median. Patients with upper sensory level below T10 were given general anesthesia. Empty symbols indicate patients requiring intraoperative rescue analgesia to complete the surgery.

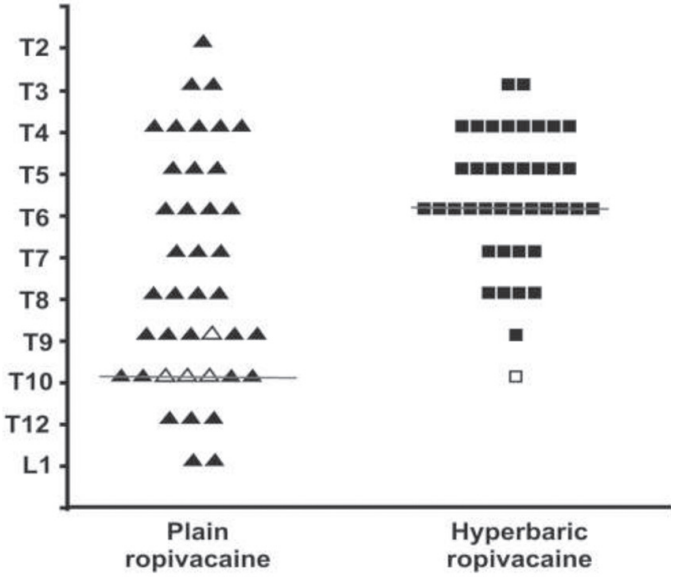

Table 3

Intraoperative Details. Data are represented as frequency (n) and percentage (%)

	Group A Plain ropivacaine (*n*=40)		**Group B Hyperbaric ropivacaine (*n*=40)**	
	Frequency	**%**	**Frequency**	**%**
Sensory block at or above T10 dermatome	35	87.5%	40	100%
Sensory block below T10 dermatome	5	12.5%	0	0%
Patients requiring general anesthesia	5	12.5%	0	0%
Intraoperative pain	4	10%	1	2.5%
Modified Bromage grade 1 (Complete motor block)	40	100%	33	82.5%
Modified Bromage grade 2	0	0%	1	2.5%
Modified Bromage grade 3	0	0%	2	5%
Modified Bromage grade 4	0	0%	2	5%
Modified Bromage grade 5	0	0%	2	5%

Table 4

Sensory block characteristics. Data are represented as median with interquartile range (IQR)

	Group A Plain ropivacaine (*n*=40)		Group B Hyperbaric ropivacaine (*n*=40)		P-value
	Median	IQR	Median	IQR	
Time to onset at T10 (min)	10[a]	6 - 16	4	4 - 6	<0.001
Total duration at T10 (min)	110[a]	90 - 128	126	97 - 146	0.047
Time to max. Cephalic Spread (min)	16	12 - 30	14	10 - 25	0.454
Time to 2 segment regression (min)	102[a]	82 - 124	80	63 - 90	<0.001
Total duration of sensory block (min)	300	290 - 312	273.5	258 - 289	<0.001

a: *n* = 35 as 5 patients in Group A did not achieve sensory block at T10 dermatome.

Table 5

Distribution of various grades of motor block (modified Bromage scale by Breen et al7). Data are represented as frequency (n).

Time to onset at modified Bromage score	Group A Plain ropivacaine		Group B Hyperbaric ropivacaine		P value
	Frequency (*n*)	Median time to onset (IQR)	Frequency (*n*)	Median time to onset (IQR)	
Grade 5	0		2		0.494
Grade 4	29	4 (2-7)	20	2 (2-4)	0.021
Grade 3	38	6 (2-9)	31	4 (2-4)	0.017
Grade 2	40	8 (4-12)	34	6 (4-8)	0.019
Grade 1 (complete motor block)	40	12 (10-16)	33	12 (8-16)	0.566
Total	40		40		

Table 6

Motor block characteristics. Data are represented as mean ± SD.

	Group A Plain ropivacaine (n = 40)		Group B Hyperbaric ropivacaine (n = 40)		P value
	Mean ± SD	Range (Min-Max)	Mean ± SD	Range (Min-Max)	
Duration of complete motor block (min)	139.89 ± 25.17 [a](n=35)	80 - 198	93.06 ± 17.38 [b](n=33)	70 - 158	<0.001
Total duration of motor block (min)	254.91 ± 25.34	208 - 310	181.83 ± 30.21	104 - 240	<0.001

a (n=35): (5 patients in Group A did not achieve sensory block at T10 dermatome and thus, these patients were given general anesthesia and therefore were not assessed for the duration of complete motor block).
b (n=33): (7 patients in Group B did not achieve complete motor block [grade 1]).

Table 7

Postoperative recovery. Data are represented as mean ± SD or median (range)

	Group A Plain ropivacaine (n=40)	Group B Hyperbaric ropivacaine (n=40)	Pvalue
Time to first micturition[a] (min)	377.68 ± 51.15	383.78 ± 61.93	0.649
Time to home readiness (min)	340.46 ± 35.53	285.95 ± 31.40	<0.001
Time to first Rescue Analgesia (min)	230 (20 – 337)	200 (15 – 270)	<0.001

a: (n = 37) in both the groups, as 3 patients in both the groups were operated for vesical calculus and therefore, urinary catheter was inserted intraoperatively in these patients and thus, time to first micturition in these patients could not be assessed.

Hyperbaric ropivacaine produced a more rapid onset of more extensive, but less variable sensory block, which regressed faster than in plain group (Table 4). The onset of analgesia to pinprick at T10 was faster (4 min vs. 10 min in plain group), and the maximum block height (median T6 vs T10) was greater (Figure. 1), but less variable. Median time to maximum sensory block height (14 min vs. 16 min in plain group) was slightly faster in the hyperbaric group; however the difference was not statistically significant. Median time to regression of sensory block to T10 dermatome was longer in the hyperbaric group (126 min vs 110 min in plain group), but median times 2 segment regression (102 min in plain vs 80 min in hyperbaric) and regression of sensory block to S2 dermatome (300 min in plain vs 273.5 min in hyperbaric)were longer in the plain group.

Motor block characteristics

The onset of motor block at grade 4, 3 and 2 was significantly faster in Group B than in Group A and the differences amongst the two groups were statistically significant (Table 5). However, the median time to onset of grade 1 motor block was comparable in the two groups with no statistically significant difference. The mean duration of complete motor block (Duration of motor block at modified Bromage 1) was significantly shorter in the hyperbaric ropivacaine group (93.06 ± 17.38 min vs 139.89 ± 25.17 min in plain group), as was the total duration of motor block (181.83 ± 30.21 min vs 254.91 ± 25.34 min in plain group) (Table 6).

Need for general anesthesia/ rescue analgesia

All the hyperbaric blocks were adequate for surgery while 5 patients in the plain group were given general anesthesia due to inadequate block height. These 5 patients in the plain group achieved complete motor block indicating that the inadequate block height was probably, a result of lesser cephalic spread of the drug and not a result of block failure. Also, the median time to reach complete recovery from sensory block (S2 dermatome) was approximately 300 min in these patients, which did not differ from the rest of the patients in Group A.

In Group A, 4 patients(10%) complained of intraoperative pain in comparison to only 1 patient(2.5%) in Group B (Table 3 and Figure 1). Majority of these patients experienced pain at the end of prolonged surgery and required supplemental analgesia with fentanyl 2μg/kg.

Postanesthesia care and discharge parameters

Patients in Group B complained of postoperative pain requiring rescue analgesic significantly earlier than patients in Group A (Table 7). None of the patients in the two groups experienced postoperative urinary retention and the time to first micturition was comparable in the two groups (table 7).

Patients in the hyperbaric ropivacaine group achieved criteria for home readiness (PADSS score ≥ 9) earlier than patients in the plain ropivacaine group (285.95 ± 31.40 min vs. 340.46 ± 35.53 min, respectively; $p<0.001$).

Two patients (5%) in both plain and hyperbaric ropivacaine group complained of mild backache at the puncture site, a day after the surgery, which was managed with non-steroidal anti-inflammatory drugs (NSAIDS). None of the patients in either group complained of persistence of these symptoms.

Discussion

This prospective, randomized, double blind comparative study conducted between plain and hyperbaric ropivacaine has shown that hyperbaric solution of ropivacaine produces a more consistent block with a greater success rate and less frequent incidence of intraoperative pain than a plain solution. Addition of glucose 50 mg/ml led to a more rapid spread to a higher median dermatomal level and with less variation in maximum height of sensory block.

We chose a dextrose concentration of 50mg/ml (5%) in the hyperbaric solution for two reasons. First, a previous study by Whiteside et al[10] has demonstrated the clinical efficacy of a solution of ropivacaine containing glucose 50 mg/ ml. In the absence of a commercially available glucose preparation, this solution can be easily prepared before spinal anesthesia using readily available solutions, and provides a solution that is sufficiently hyperbaric for its purpose. Second, previous works by Bannister et al[5] and Chambers et al[12] with bupivacaine have suggested that lower concentrations of glucose than are present in the commercially available hyperbaric solution (8.3%) may be sufficient to provide the previously stated benefits over plain solutions.

When a hyperbaric solution is injected in the left lateral position, the tendency for it would be to spread in the cephalad direction, gravity presumably encouraging spread of the bolus of drug down the slopes of the lumbar curve when the patient is placed supine after injection resulting in a more even distribution of the local anesthetic solution[13]. In contrast, a plain solution being marginally hypobaric would not have such gravity- assisted spread and thus would concentrate in the lower lumbar segments. This would explain the less reliability of the block for abdominal surgery but prolonged sensory and motor block in the lower limbs due to dense blockade of the lumbar and sacral segments. This would also explain the 12.5% failure rate to achieve analgesia at T10 in the plain ropivacaine group and also higher number of patients requiring intraoperative supplemental analgesia (4 patient in plain vs. 1 patient in the hyperbaric group).

In agreement with previous work, in our study, the sensory block with the plain solution of local anesthetic spread unpredictably; 5 patients (12.5%) in Group A did not reach sensory block at T10 dermatone and the highest extent of sensory block varied widely. This is also in accordance with the results of Khaw et al[9], who reported that all patients in the hyperbaric

group had sufficient analgesia for Caesarean section, but 25% of patients in Group plain needed rescue medication.

The cephalic spread of sensory block was significantly greater with hyperbaric ropivacaine T6than in group plain T10 and this trend, is similar to earlier study by Kallio et al[4], with (15mg) ropivacaine having a median cephalad spread of T4 and T9 in the hyperbaric and plain groups, respectively. Whiteside et al[6] studied hyperbaric ropivacaine 15 mg and reported a median maximum cephalic spread of sensory block at T7 dermatome, which is somewhat lower but comparable to our study with hyperbaric ropivacaine 20.25mg (T6).

In our study, the 126 min regression of the sensory block to the T10 level was comparable with that (115.8 min) inan earlier study by Chung et al[13] with a slightly lower dose of hyperbaric ropivacaine (18 mg). The median time to 2 segment regression of sensory block was faster with hyperbaric ropivacaine (80 min) in comparison to plain ropivacaine (102 min). These findings were in accordance with Kallio et al[4], who found median time to 2 segment regression of sensory block with 15mg ropivacaine to be 90 min and 60 min in the plain and hyperbaric ropivacaine group, respectively.

Faster recovery from both sensory and motor block with an increase in the useful duration of sensory block translated into faster mobilization in the patients of hyperbaric group. Similar findings were also seen in two previous studies by Kallio et al[4] and Essam et al[14], both of which stated that spinal anesthesia with hyperbaric ropivacaine was associated with early mobilization and faster discharge times.

In a recent Cochrane systematic review[15], authors have suggested that pain in the lower back is a very common complication after spinal anesthesia with any local anesthetic. Its etiology is unknown but no connection to neurologic pathology has been suggested in the literature. Data from previous studies[16,17,18] suggests that ropivacaine is not associated with an increased risk of neurologic symptoms. We also did not find any evidence of transient neurological symptoms in our study. However, the available data is not enough to make definitive conclusions.

Conclusion

In conclusion, hyperbaric ropivacaine produced a more predictable and reliable sensory and motor block, with faster onset and recovery than a plain solution. Not only the duration of useful block for surgery was increased, but also patients mobilized more quickly after spinal anesthesia with hyperbaric ropivacaine, something that may be particularly useful for ambulatory surgery and any procedure where prolonged immobilization is undesirable. However further studies are necessary to evaluate the role of hyperbaric ropivacaine in comparison to the plain solution for surgical procedures of short duration, particularly day care surgery.

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