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Unilateral spinal anesthesia with low dose bupivacaine and ropivacaine: hypobaric or hyperbaric solutions with fentanyl for one-day surgery?

LADA KALAGAC FABRIS
LIVIJA ŠAKIĆ
KATARINA ŠAKIĆ ZDRAVČEVIĆ

Department of Anesthesiology and Intensive Care, General Hospital Pula, Pula, Croatia

* Departement of anesthesia and ICU, Clinical Hospital "Sveti Duh"Zagreb, School of Medicine-University Zagreb, Croatia

Corresponding author:
Lada Kalagac Fabris, MD.
Departement of Anesthesiology and Intensive Care,
General Hospital Pula,
Pula – 52100, Croatia
E-mail: lada1966@gmail.com

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Summary

Background and Objectives: The purpose of this study was to compare the quality of unilateral spinal anesthesia with low dose bupivacaine and ropivacaine deluded in different baric solutions (hyperbaric / hypobaric). In our special interest was to define possibilities to use hypobaric solutions of local anesthetics if they prove to have any advantages. Methods : This prospective study was conduced over a 24-month period, enrolling eighty patients (ASA groups I, II, III) randomly divided into four groups. The study solution Š5mg of o.5% bupivacaine or 5 mg 1.0% ropivacaine with 25?g fentanyl, prepared in a different baric solution (hyperbaric / hypobaric)Ć were injected into the subarachnoidal interspaces at the level L2-L3/L3-L4. After the inducing spinal anesthesia, the patients in the hyperbaric groups kept the lateral decubitus position with the operated side facing down; while the patients in the hypobaric groups kept lateral decubitus position facing the operated side up. During the set time intervals we evaluated how rapid was the beginning and the regression of the unilateral block; the extension of the motor and the sensoric block, the haemodinamic changes and the home admition time. Results: All of the patients included in the study tolerated the procedure well. The median time for achieving the unilateral surgical anesthesia was the shortest in hyperbaric ropivacaine group (6.95 minutes). The maximal degree of the motor block (Bromage 3) was the highest in the hyperbaric bupivacaine group. The median recovery time to be able to walk and to the first urine pass was faster achieved in the hyperbaric and hypobaric ropivacaine groups (160 minutes vs.190 minutes), comparing to the hyperbaric and hypobaric bupivacaine groups (230 minutes vs.250 minutes). Side–effects were minor and infrequent in all groups.

Conclusions: According to this study the baricity of the anesthetic solution has no influence in achieving successful unilateral spinal block. Ropivacain will be chosen if we want to realize a faster readiness to surgery, and a faster recovery with few side-effects and complications; all particularly appreciable in an outpatient surgery.

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INTRODUCTION

Hyperbaric unilateral spinal anesthesia is frequently used in lower limb and lower abdominal surgery especially in an outpatient setting. Several advantages are claimed for this anesthesia technique, like limited cardiovascular effects, lower incidence of postoperative

urine retention, rapid recovery as well as good patient satisfaction. To achieve a successful unilateral anesthesia, several factors need to be considered, like the needle shape and bevel direction, site and speed of injection of anesthetics, amount, baricity and concentration of the anaethetic solution, as well as the patient posture during the performance of the spinal anesthesia and during the operation time.

In some orthopedic surgery (fracture of great trochanter, arthroplasty of the hip) as well as vascular surgery the limb which is going to be operated is usually kept on the upper side. In this situation the hyperbaric unilateral spinal block will be performed with the patients placed in the lateral position with the limb to be operated on facing downward. Only after the block is established the patient will be rotated on his health limb and the surgical procedure of the sick-upper limb can start.When giving hypobaric spinal block, rotation of the patient is not needed.

METHODS

The approval for this study was obtained from our Institutional Ethics Committee, as well as the written consent of 80 properly informed patients, who were enrolled into the study. The patients were ASA I-II-III, scheduled for an elective surgery of hernioplastic, endoscopic vein stripping, orthopedic surgery, and trauma surgery of a limb (fracture of the proximal part of a femur, fracture of an ankle). Patients with hyperthension, local skin infections, or those receiving anticoagulant therapies were excluded from the study. Patients fasted 8hrs preoperatively and received 500ml of lactated Ringer's solution (i.v.), and midazolam (7.5mg orally) for premedication.

The patients were randomly divided into 4 groups, with 20 patients in each group: *HyperB:* 1.0 ml 0.5% bupivacaine (5 mg) +25 μg fentanyl + 2.5 ml 10% glucosae, *HypoB:* 1.0 ml 0.5% bupivacaine (5 mg) +25 μg fentanyl + 2.5 ml aqua pro inject., *HyperR:* 0.5 ml 1% ropivacaine (5 mg) +25 μg fentanyl + 2.5 ml 10% glucosae, *HypoR:* 0.5 ml 1% ropivacaine (5 mg) +25 μg fentanyl + 2.5 ml aqua pro inject. All the patients were placed in a lateral decubitus position with attention to keep the position of the operated leg on a dependent position for the hyperbaric solutions, and with the operated leg on a non-dependent position for the hypobaric solutions. After the sterile preparation and draping, the spinal anesthesia was performed with a 25/26/27-G Whitacre needle at the L2-L3/L3-L4 interspaces via middle approach without the barbotage. The lateral decubitus position was maintained for a certain time, about 20 minutes before they were turned back supine.

Standard monitoring was used throughout the study as part of a routine evaluation of the side effects, including continuous ECG, heart rate, non-invasive arterial blood pressure measurement and continuous pulse oximetry. We were detecting early signs of the side effects: hypothension – reduction of systolic blood pressure >20% from baseline, and bradicardia as a decrease in heart rate to <50 beats/min.

A two-steps treatment was planned for hypothension: first a 200 mL bolus of crystalloid solution; second i.v. boluses of ephedrine 2 mg. Bradycardia was treated with atropine 0.5 mg. No sedative agents were administered in the course of spinal anesthesia.

We were using the standard qualitative and non-invasive tests like the Bromage motor score and the pin prick test in the set time intervals (0, 10, 20, 30, 60, 90 min of preforming the block). We evaluated the following:

1. The rapidity of beginning and regression of the unilateral block
2. The extension of the motor block by use of the Bromage motor-score
3. The extension of the sensor block by use of the pinprick test
4. Home readiness by the recovery test (Alderet, Chung).

After dismisson from the operating room, all the patients were allowed to eat, drink, and were instructed how and when to restart walking.

Statistical methods

Statistical analyses were performed using the SPSS 9.0 software (SPSS, Chicago, IL, USA). Mean, standard deviation and frequency of the variable distribution were calculated for all the groups. The One-way ANOVA analysis of variance with a post hoc analysis (Tukey test / Scheffe test) was performed to indicate trends and significant differences among the groups. General Linear Model--Repeated Measures-Multifactorial model (*Wilk's Lambda, Greenhouse-Geisse, Bonferroni)* with two factors were used for the analysis of the haemodinamic parameters.

A $p<0,05$, $p<0,01$, $p<0,001$ was regarded as a significant fact.

RESULTS

There was no difference in age, ASA physical status, gender distribution, and duration of surgical procedure between groups. (Table 1. and Table 2.)

After the spinal anesthesia was performed the patients were lying on one side for a certain time. When they reported feelings that the leg was blocked, they were positioned supine. The evaluations of the motor block degree by the Bromage motor score, and the extension of sensoric block by the pin-prick test (*time 1.*) were done. In all groups the block was unilateral. (Table 3.)

The baricity of the anesthetic solution didn't influence the quality of the ropivacaine unilateral spinal block. In the bupivacaine groups the hypobaric solutions were less effective; for the onset time of the unilateral block as well as for the quality of the Bromage motor score. Hyperbaric and hypobaric ropivacaine solutions express faster effects than bupivacaine ($p<0.05$). At "time 1" all of the groups have had effective anesthesia for the surgery, but

Table 1

Patient's characteristics and duration of surgery.

	Hyper B	Hypo B	Hyper R	Hypo R
Number of patients	20	20	20	20
Gender (M / F)	13 / 7	6 / 14	9 / 11	13 / 7
Age (year)*	50,35 (+/–17,79)	53,5 (+/–15,93)	44,4 (+/–17,17)	54,5 (+/–13,4)
Duration of anesthesia (min)*	76,47 (+/–24,41)	93 (+/–20,51)	72,15 (+/–13,73)	71,84 (+/–24,9)

*Values are mean +/– SD

Table 2

Type of surgery:

	Hyper B	Hypo B	Hyper R	Hypo R
One side herniorrhaphy	9	1	7	8
Endoscopic vein surgery	5		9	8
Knee arthroscopy	1			
Fracture of great trochanter		7		
Arthroplasty of the hip/fractured femur		6+1		
Fracture of ankle	2	2	2	2
Halux valgus	1	2		
Remove of bone screws	2	1	2	2

Table 3

Qualitative assesments of unilateral anesthesia.

	Median time to achieve motor block (min)	St.Dev.	Mean Bromage Score (0,1,2,3) at turning supine	St.dev.	Mean Bromage Score (0,1,2,3) at the **end** of surgery	St.dev.
Hyper B	13,55	1,90	2,9	0,30	0,95	0,94
Hypo B	18,10	3,19	2,5	0,68	1,5	1,05
Hyper R	6,95	1,90	2,6	0,59	0,15	0,48
Hypo R	7,15	1,34	2,7	0,47	0,45	0,88

the highest modified Bromage motor scores was achieved in the *Hyper B* group. Higher baricity makes bupivacaine not only faster in onset but produces higher modified Bromage motor score. (Figure 1.) (Figure 2.) (Figure 3.)

The resolution of the motor block was statistically significant between the hyperbaric and hypobaric solution; it was earlier achieved in the Hyper R >Hypo R >Hyper B >Hypo B ($p<0.05$). There was no statistical difference in the sensory block extension; the peak was reached within the 25 min of the performed spinal block. The sensoric resolution followed the motor block resolution, equally in all groups.

The effects of unilateral spinal anesthesia on the cardiovascular system were the result of the one side selective sympathetic denervation, realizated on the operated side. Consequently, the decrease in the mean blood pressure from baseline, registered during the side position of the body, spontaneously solve after the patients were turned supine (time interval 2–3). Statistically, there was no difference in pressure levels and the set time intervals between the groups. We can conclude that the degree of the sympathetic block is equal for the hyperbaric and the hyperbaric solutions.

The type of baricity solution didn't directly interfere with the heart beats. The isolated pulse analysis, particularly for the ropivacaine group, showed that the 2nd and the 3rd time intervals were critical. The patients who received ropivacaine expressed greater deceleration from the baseline HR (beats min^{-1} <50) than in bupivacaine group. This point is important because not every deceleration in the ropivacaine group needed the therapeutic approach with ephedrine (Figure 4.)

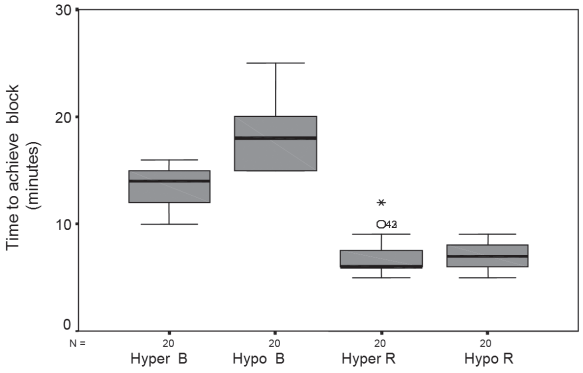


Figure 1. *Mean time spent in lateral position between the groups, needed to achieve motor block.*

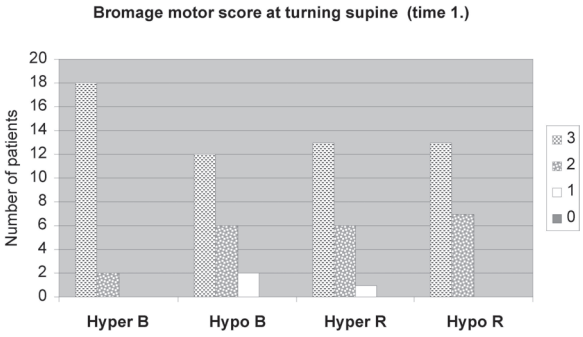


Figure 2. *Degree of motor block by Bromage motor score between the groups at time of returning supine from the initial lateral position.*

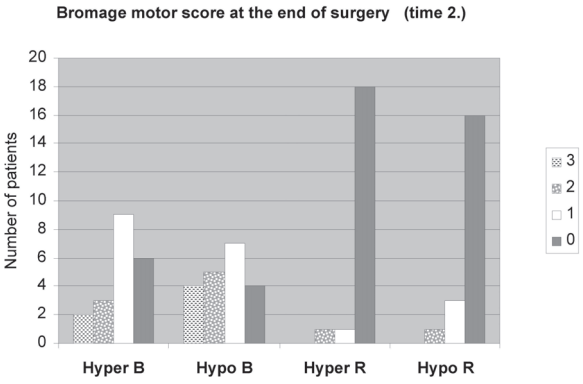
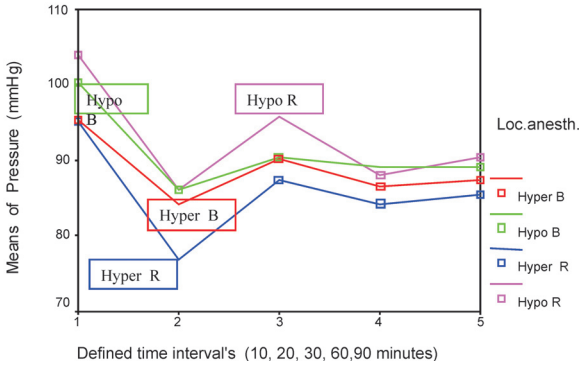


Figure 3. *Resolution of the motor block by Bromage motor score at the end of the surgery, before going out of the operating room.*

The recovery time from the subarachnoidal anesthesia was similar between the hyperbaric and the hypobaric solutions. The time for full anesthesia regression was faster achieved in the hyperbaric and hypobaric ropivacaine groups, with a statistical difference *(Post hoc test: Tukey test / Scheffe test)* ($p<0.05$) (Table 4.). The mean time to walk out and to first urine pass was similar in group Hyper R and Hypo R, but significantly longer in the bupivacaine groups ($p<0.05$) (Table 5.).



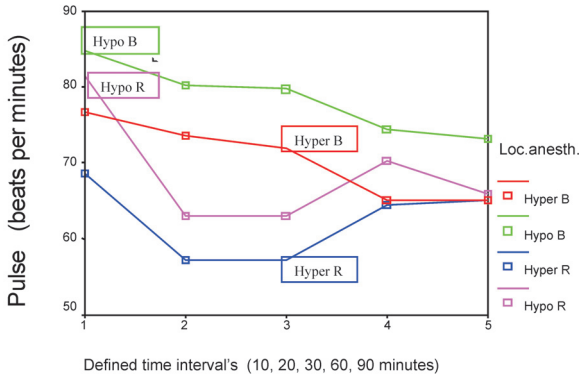


Figure 4. *Estimated marginal means of pressure and pulse in fixed time intervals between the groups.*

None of the patients complained about PONV or PPHD. In the ropivacaine groups some patients reported short time sensations of skin itching around the navel and in the gluteal region. (Hyper R=6 patients, Hypo R=3 patients). There was no need for treatment.

At the time of dismisson from the operating room, all the patients satisfied the criteria for the Fast-tracking, and were moved directly to the surgical ward. After the urine pass all the patients reached high Chung and Aldret scores required for their home-readiness (Table 6.).

DISCUSSION

Our results in this study show that there was no clinically significant difference between the hyperbaric and hypobaric groups regarding subarachnoid spread. Both baricity groups provided adequate surgical anesthesia in all of the patients. The degree of the motor block was the same in both groups but recovery was slightly prolonged in the hypobaric groups, as previously reported (14).

We believe that in one day surgery practice, in busy orthopedic ward, the hypobaric solutions can be as suitable as hyperbaric, or even more appropriate when we need to save some additional time and avoid secondary position change of the patient.

Fentanyl is a lipophilic opiod usually used as an adjunct to local anesthetics for enhancement of analgesia with-

Table 4

Number of therapeutical treatment's for keeping haemodinamic stability.

	Hyper B	Hypo B	Hyper R	Hypo R	Total USA
Hypothension (ephedrine)	4 (20%)	3 (15%)	2 (10%)		9 (11%)
Bradicardia (atropine)	3 (15%)	1 (5%)	7 (35%)	4 (20%)	15 (18%)

Table 5

Time to full regression of unilateral spinal anesthesia.

	Mean time to walk out (min)	St. Dev.	Mean time to first urine pass (min)	St. dev.
Hyper B	236,00	68,85	258,00	15,56
Hypo B	224,50	58,89	242,75	13,59
Hyper R	161,75	35,62	187,25	7,30
Hypo R	160,50	40,58	191,50	9,43

Table 6

Examination score for Fast-track and "home-readiness":

	Hyper B	*Hypo B*	*Hyper R*	*Hypo R*	
White & Song 14 points	70%	55%	95%	95%	FAST-track
Chung (PADSS) do 12 points	70%	55%	95%	95%	
Chung 1o points	100%	100%	100%	100%	Home-readiness
Aldret & Kroulik 10 points	100%	100%	100%	100%	

out intensifying motor and sympathetic block during spinal anesthesia.

In the final analysis, the two types of local anesthetics express some differences that have to be considered when we choose the ambulatory surgery pattern.

Our results suggest that ropivacaine can provide rapid onset (Hyper R=6.95 min) of surgical anesthesia (8), and shorter recovery time (Hypo R=160min) than bupivacaine (9).On the other side the degree of the motor block is less distinct in the ropivacaine group, but it is still sufficient to perform a surgical procedure.

The unilateral sympathetic block produced by the local anesthetics (injected into one side of the subarachnoid space) results in a low hypothension incidence (11) and in a decrease demand for intravenous vasopressor agents. This study confirms that even in the unilateral spinal anesthesia with two different local anesthetics, there exists a significant difference ($p<0.01$) of the ephedrine requirement (ropivacaine 5 % vs. bupivacaine 17.5 %). The atropin requirement for a bradicardia treatment was more visible in the ropivacaine group (27.5 %), in comparison to the bupivacaine (10 %). The Bonferroni correction defines that the reduction of the pulls rate was more evident with the appliance of ropivacaine.

McNamee et al. (9) reported that ropivacaine induced minimal cardiovascular changes (12 % hypothension) comparing to bupivacaine (26 % hypothension). They had no reports about bradicardia in the bupivacaine group, but they mentioned that 2 of 32 patients had to be treated with atropine in the ropivacaine group.

Gautier et al. (10) reported that for ambulatory knee arthroscopy 12 mg ropivacaine produced sensory and motor block almost comparable to 8 mg bupivacaine. Spinal 10 mg ropivacaine produced shorter sensory anesthesia and motor blockade than 8 mg bupivacaine. However, the quality of intra-operative analgesia was significantly lower in the 10 mg ropivacaine group ($p<0.05$). The authors concluded that spinal 12 mg ropivacaine was approximately equivalent to 8 mg bupivacaine.

Malinovsky et al. (8) reported that the motor block offset time for 15 mg hyperbaric ropivacaine was 165 minutes comparing to the 184 minutes for 10 mg hyperbaric bupivacaine. Cephalad sensory spread of anesthesia was higher in the bupivacaine group. They reported no statistical difference in the incidence of hypotension between the ropivacaine and the bupivacaine patients (44% vs. 38%). The authors concluded that ropivacaine was less potent than bupivacaine and inappropriate for endoscopic urology.

Whiteside et al. (12) studied spinal anesthesia with 15 mg ropivacaine in either 1% glucose or 5% glucose for different surgical procedures. The degree and the duration of sensory and motor block were the same in the two groups. There was no difference in the incidence of hypothension (15 – 20 %), treated with a single dose of ephedrine. The authors concluded that hyperbaric ropivacaine could produce predictable and reliable spinal anesthesia for a wide range of the surgical procedures.

The possibilities for by-passing the PACU and the time for home dismisson was almost equal for the criteria of baricity, but it was shorter in patients receiving ropivacaine for the spinal anesthesia.

In conclusion, this prospective and randomized study demonstrates that the unilateral spinal technique provides effective sensory and motor block. Furthermore; the baricity of the anesthetic solutions did not influence any of analyzed parameters. During the outpatient one day surgery procedures if we wish to avoid to change the position of the patient, hypobaric solutions could be advisable. Ropivacaine results in a rapid onset and shorter motor block than bupivacaine, and therefore represents the best choice for day-case surgery.

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