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OUR EXPERIENCE USING DIFFERENT BARICITIES OF BUPIVACAINE FOR UNILATERAL SUBARACHNOID BLOCK ANESTHESIA IN DIFFERENT LOWER LIMB ORTHOPEDIC SURGICAL PROCEDURES

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ABSTRACT

Background: Unilateral subarachnoid block anesthesia uses decreased dosage, low speed of administration and lateral positioning to enhance unilateral drug distribution. **Aim**: To assess the effect of various baricities of bupivacaine solutions during unilateral subarachnoid block anesthesia in patients scheduled for various lower limb orthopedic surgical techniques. **Methods:** This prospective, double blind and randomized investigation included 122 patients, of both sexes, aged 33-71 yrs, classed II-III by the American society of Anesthesiologists and assigned for various lower limb orthopedic surgical techniques under unilateral subarachnoid block anesthesia at Prince Rashid military hospital, Irbid, JORDAN, during the year 2016.Patients were grouped in a random fashion into 2 groups. Group I patients were administered subarachnoid 10 mg of 0.5% isobaric bupivacaine solution (2 ml) (Group I, n=61)) or subarachnoid 10 mg of 0.5% hyperbaric bupivacaine solution (2 ml) (Group II, n=61), both in the L_3-$_4$ interspace with the patient in the lateral position and keeping such for 15 minutes. Sensory anesthesia was assessed by the pin prick test. Motor blockade was assessed by the Bromage score. Both blockades were compared with the contralateral side. Statistics: Mean age, height and length of the blockade were evaluated by Analysis of Variance, while the level of the sensory and motor blockades was evaluated by the Mood test for medians. The unilaterality of the anesthesia was evaluated by the Chi-square test. P-value less than 0.05 was considered statistically. **Results:** There was a significant discrepancy between the side of the surgery and the contralateral side in the two groups at 15 minutes, but the incidence of unilateral subarachnoid block anesthesia was more with the hyperbaric solution. Sensory and motor blockades were recorded in 18 patients (29.5%) in group I and in 48 patients (78.7%) in group II ($P<0.05$). **Conclusions:** Subarachnoid block anesthesia with hyperbaric bupivacaine solution has significantly more incidence of unilateral subarachnoid block anesthesia than isobaric bupivacaine solution after 15 minutes.

KEYWORDS: Bupivacaine; unilateral subarachnoid block anesthesia; lower limb orthopedic surgery; blockade: sensory, motor.

INTRODUCTION

The discrepancy in density between the cerebrospinal fluid and local anesthetics solutions is crucial for the distribution to the subarachnoid space. Keeping the patient in the sitting position for two minutes after the administration of the isobaric anesthetic causes a higher blockade than if the patient was positioned supine immediately after the administration.

Unilateral subarachnoid block anesthesia may be performed using an isobaric or hyperbaric solution in the subarachnoid space with the patient in the lateral position and the anesthetic makes a layer above (isobaric) or below (hyperbaric) the midline. During administration to one side, with the distribution of the solution relying on its specific gravity, there is no absence of anesthetic solution because of turbulence during rapid administration. The 1.2 ml (6 mg) of 0.5% hyperbaric bupivacaine has more frequency of unilateral subarachnoid block anesthesia than 1.2 ml (6 mg) of isobaric bupivacaine when administered slowly with the patient in the lateral position for 20 minutes.[1] The administration of 1% hyperbaric bupivacaine has no benefit over the 0.5% solution.[2] Patients administered 8 mg of 0.5% bupivacaine had more frequency of unilateral subarachnoid block anesthesia than who were administered 8 mg of the 1% solution.[2] Unilateral subarachnoid block anesthesia is a decreased dosage and decreased flow method, keeping the patient in the lateral position for 15 to 30 minutes.[3]

The aim of this investigation was to determine the incidence, efficiency and recovery of the unilateral subarachnoid block anesthesia using isobaric and

hyperbaric solutions for lower limb orthopedic surgical procedures.

METHODS

Our prospective, double blind and randomized investigation included 122 patients, of both sexes, aged 33-71 yrs, classed II-III by the American society of Anesthesiologists and assigned for various unilateral lower limb orthopedic surgical techniques under unilateral subarachnoid block anesthesia at Prince Rashid military hospital, Irbid, JORDAN, during the year 2016,after obtaining written informed consent from all patients and approval from our local ethical and research board review committee of the Royal medical services. Patients with previous neurological disorders, coagulopathies and infection at the subarachnoid puncture were ruled out.

Patients were grouped in a random fashion into 2 groups. Group I patients were administered subarachnoid 10 mg of 0.5% isobaric bupivacaine solution (2 ml) (Group I, n=61) or subarachnoid 10 mg of 0.5% hyperbaric bupivacaine solution (2 ml) (Group II, n=61), both in the L_{3}-$_{4}$ interspace with the patient in the lateral position and keeping such for 15 minutes. The patients in group I were positioned on the nonoperated side. The patients in group II were positioned on the operated side. The subarachnoid puncture was median, at the L_{3}-$_{4}$ interspace. Patients were kept in the same position for 15 minutes before supine repositioning for the surgery. Intravenous analgesics were administered if the patient had pain or discomfort. Failure of pain relief was labeled as pain or discomfort in the perineal area. The first dose of analgesic was administered at the end of the surgery. Sensory blockade was assessed by the pin prick test. Motor blockade was assessed by the Bromage score. Both blockades were compared with the contralateral side. The level of the sensory blockade, absence of pinprick feeling or the touch with the puncture needle, was checked bilaterally, while the motor blockade was assessed by the Bromage score[4]: 0 = mobilizing the lower limbs freely; 1 = unable to raise extended limbs; 2 = unable to bend the knees and 3 = unable to mobilize the ankles. Motor and sensory blockades were recorded on both lower operated limbs 15, 30 and 45 minutes after the anesthesia and at the end of the surgery, and with the nonoperated contralateral limb. Period of pain relief was defined by the time to regain sensation according to thesubarachnoid puncture. Time of recovery of sensory and motor blockades was recorded. The time to start movement was recorded by the surgeon .Patients were followed-up for three days after surgery.

Statistics: Mean age, height and length of the blockade were evaluated by Analysis of Variance, while the level of the sensory and motor blockades was evaluated by the Mood test for medians. The unilaterality of the anesthesia was evaluated by the Chi-square test. P-value less than 0.05 was considered statistically.

RESULTS

There were no discrepancies within the groups according to age and duration of the surgical procedure (Table 1).
During lateral position (15 minutes), the sensory blockade was unilateral in 39 patients in Group I (63.9%) and 52 patients in Group II (85.2%). After supine repositioning, the sensory blockade spread to the contralateral side. After 30 minutes, the blockade kept unilateral in 21 patients in Group I (34.4%) and 52 patients in Group II (85.2%) ($P < 0.05$). The highest sensitive blockade (at 15 minutes) did not demonstrate any discrepancies between the groups ($P > 0.05$).The level of the sensory blockade in the contralateral limb was higher in Group I, except at the end of surgery ($P < 0.05$); the level of the sensory blockade was higher in the operated limb in both groups constantly. The median period of the blockade was more in the Group I(3.6 hr) than in Group II (3.1 hr) ($P < 0.05$).Table 2.

At 15 minutes, 63.9% of the patients in Group I and 85.2% in group II experienced unilateral blockade. At 30 and 45 minutes, 29.5% of the patients in the group I and 78.7% in Group II kept with unilateral blockade. There was no need for general anesthesia secondary to failure of the subarachnoid block anesthesia.

During the lateral position, the motor blockade was unilateral in 40 patients in Group I(65.6%) and 54 patients in Group II(88.5%). After supine repositioning, the motor blockade spread to the contralateral side, and after 15 minutes in this position, it kept unilateral in 18 patients in GroupI (29.5%)and 48 patients in Group II(78.7%) ($P < 0.05$).

Table 1: Patients demographics.

parameter	GI	GII	P
N=	61	61	
Subarachnoid agent	Isobaric bupivacaine 0.5%,2 ml(10 mg)	Hyperbaric bupivacaine 0.5%,2 ml(10 mg)	
Sex M F	29 32	31 30	>
ASA II III	36 25	41 20	>
Age(yrs)median	47	49	>
Height (m)median	1.71	1.75	>
Period of operation (hr)median	1.4	1.3	>

Table 2: Subarachnoid blockade features.

	GI	GII	P
Unilaterality at 15 min	39(63.9%)	52(85.2%)	>0.05
Unilaterality at 30 min	18(29.5%)	48(78.7%)	<0.005
Period (hr)median	3.6	3.1	<0.005

DISCUSSION

In our investigation, 10 mg of hyperbaric bupivacaine caused optimum unilateral subarachnoid block anesthesia for different lower limbs orthopedic surgical interventions. More patients experienced unilateral blockade with hyperbaric (78.7%) bupivacaine than with the isobaric (29.5%) bupivacaine during supine position. The puncture location and the dose were constant, and every patient kept in the lateral position for 15 minutes.

The goals of the unilateral subarachnoid block anesthesia are: attaining unilateral motor blockade and enhancing patient comfort as lengthy bilateral motor blockade is not satisfactory. Patient position, the subarachnoid needle, the speed of administration, the volume of local anesthetic and the density of the anesthetic solution may affect poor outcome of unilateral subarachnoid block anesthesia.[5] Although the patient is maintained in the lateral position after administration, the isobaric and hyperbaric solutions may affect the distribution of the anesthetic. The period in the lateral position is affected by the dose of the local anesthetic. Bupivacaine 12 - 20 mg may cause migration of the blockade, even after 60 min in the lateral position[4], while bupivacaine 5 - 8 mg caused a limited blockade only after 10 - 15 minutes in the lateral position.[6] The optimum unilateral outcome was with hyperbaric bupivacaine, with the patient in the lateral position for 15 - 20 minutes.[7]

Bupivacaine is a long-acting agent. The density of the 0.5% isobaric bupivacaine at 37°C is 0.9993 g.m/l.[8] The hyperbaric solution of 0.5% bupivacaine with 8% glucose has a density at room temperature of 1.021 - 1.0247.[8] The position of the patient during and immediately after the administration of the local anesthetic affects the distribution of the agent in the leptomeningeal space. If a solution that is more or less dense than the CSF is used, it is possible, to control the distribution of the subarachnoid blockade, because the discrepancy of the specific gravity between the hyperbaric solution and the CSF is more than the differences between the hyperbaric and isobaric solutions. The administration of the hyperbaric solution has a more anticipated outcome.[7] Our investigation demonstrated that the Hyper group had (78.7%) sensory and motor blockades in every assessment, while the isobaric group had only 63.9% of patients with unilateral blockade at 15 minutes, which reduced to 29.5% when they were supine positioned.[7,9]

The dosage of the local anestheticis is the most important factor affecting the unilateral distribution of subarachnoid block anesthesia.[10] A diminution of the dosage is important to limit the blockade to one side.An excessive decrease might increase the failure of the subarachnoid block anesthesia. In our investigation, we used 10 mg of bupivacaine in both groups, with optimum outcome with the two solutions for the unilateral blockade. Increasing the dosage increases the recovery time of the blockade.

Large differences in volume and concentration of the local anesthetic have minimal effect in dispersion in the leptomeningeal channel, while the total volume of molecules administered in the subarachnoid canal is more important. In our investigation, using a fixed dose of 10 mg in both groups, the volume of isobaric and hyperbaric bupivacaine equalized 2 ml. The more volume caused more dispersion of the anesthesia.

Unilateral blockade was recorded with low doses of hyperbaric bupivacaine when patients kept in the lateral position for 15 - 30 minutes. The level of the blockade with low doses does not modify after the change in position. This was approved in our investigation using small doses of hyperbaric bupivacaine and with the patients in the lateral position for 15 minutes. When low dose of isobaric bupivacaine is used, the level of the unilaterality modifies when the position modifies, even 30 minutes after the administration as with increased doses of hyperbaric or isobaric bupivacaine. The outcome of 78.7% of unilateral subarachnoid anesthesia with the hyperbaric solution of bupivacaine is comparable to the 68% and 83%[7]; while the 29.5% frequency of unilateral subarachnoid block anesthesia using the isobaric solution is less than the 37%.[7] Baricity affected the distribution of local anesthetic solution in the CSF. It is the ratio of density (mass/volume) of local anesthesia solution's density in relation to CSF density in 37°C. Baricity affects local anesthetic spread and block level as gravity induces hyperbaric solutions to move downward in the CSF,while gravity has no influence on the distribution of isobaric solution.[11] Baricity influences how dense (heavy) the agent is in relation to CSF, affecting the agent distribution in the thecal space. Hyperbaric agebt is heavier than CSF. It goes with the curvatures of the spine and gravitates to the dependent areas of the vertebral column.[12] The lumbar lordosis splits the local anaesthetic solution with some moving down toward the sacrum and the rest moving up into the thoracic kyphosis.[13] Bimodal distribution of block with hyperbaric solution is one block in the low thoracic area and another block in the high thoracic region. Hyperbaric agent causes more spread. Isobaric agent has the same density as CSF,so gravity and spinal curvatures have less influence distribution. Isobaric agent stays close to the site of administration.[14]

In conclusion 10 mg of isobaric and hyperbaric bupivacaine induced proper anesthesia for orthopedic surgeries. The unilateral blockade was more common in the group who received hyperbaric (78.7%) bupivacaine. Contrary to the hyperbaric solutions, isobaric bupivacaine moves in the CSF even after 15 minutes,keeping the unilateral blockade in only 29.5% of the patients.

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