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ORIGINAL ARTICLE

Effect of Volume on Height of Sensory Blockade Keeping Dose Constant with Hyperbaric Bupivacaine in Patients Undergoing Orthopedic Procedure

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ABSTRACT

Objective: To evaluate the effects of different volumes (2ml-3ml) of hyperbaric bupivacaine as spinal anaesthesia in patients undergoing lower limb orthopaedic procedures.

Methodology: Randomized control trial was done at the Department of Anesthesiology and intensive care, PIMS, Islamabad. Two intravenous lines with 18G cannulas were maintained, and patients were preloaded with 1L of ringer-lactate solution. Patients were randomly divided into low volume and high-volume groups. The spinal injection was given in a sitting position with complete aseptic technique, using a 26G spinal needle and the L3-4 interspinous space. In the low volume group, 2 ml of hyperbaric bupivacaine 0.75% was administered, and in the high-volume group, 3 ml of 0.5% hyperbaric bupivacaine was injected in 20 seconds. After the spinal injection, the patient was put in a supine posture with a 5-degree head down. The level of block was assessed with a pin prick at 2 minutes, 10 minutes, and 15 minutes. Data was collected via a study proforma.

Results: The mean age of patients was 44.5±8.2 years in group I and 47.7 ± 9.6 years in group II. Males were predominant in both groups. The higher block level was compared among the study groups after 15 minutes. In group I (2 ml 0.75% hyperbaric bupivacaine), 1 (2.9%) had a higher block (above T4), while in group II (3 ml 0.50% hyperbaric bupivacaine), 7 (20.0%) patients were found to have a higher block (above T4) out of the total 35 cases in each group. This difference between the two study groups was statistically significant, as the higher block level was associated with a high volume of hyperbaric bupivacaine (p-0.02).

Conclusion: Larger volume of hyperbaric bupivacaine is associated with a higher level of blockade in subarachnoid block for orthopaedic surgical procedures.

Keywords: Spinal anesthesia, volume of drug, hyperbaric bupivacaine

INTRODUCTION

Regional block in terms of spinal anaesthesia has been a preferred choice in orthopaedic procedures nowadays.[1] One level of motor, sensory, and autonomic blockade is important for surgical anaesthesia, cardiovascular stability, and patient comfort during and after surgery. Spinal anaesthesia, also known as subarachnoid block, reduces the chances of deep vein thrombosis and pulmonary embolism.[2] It eliminates the risks associated with general anaesthesia, such as intubation complications, aspiration, post-operative nausea and vomiting, delirium, and cognitive impairment. It provides better post-operative analgesia as well. Regional techniques include epidural anaesthesia, subarachnoid blocks (spinal anaesthesia), and nerve blocks. Of these methods of regional block, spinal anaesthesia is preferred as it provides a rapid onset of anaesthesia and a more reliable and dense motor and sensory blockade.[3],[4] As lower limb surgeries involve mainly interventions due to orthopaedic issues, and due to the longer duration of procedures, an optimal level of sensory block till T10 is required.[5] Many spinal anaesthesia dosing regimens have been described for lower limb surgeries and caesarean section.[6] While some anesthetists favour a set dosage schedule, others alter the dose based on the participant's characteristics.[7] Adjusting the dosages is to attain the ideal height of block to avoid any significant hemodynamic changes and other complications. Many factors influence the spinal anaesthesia block height, among which the effect of the volume of local anaesthetic use is controversial. [8,9] This study has been done to compare the effects of different volumes (2ml and 3ml) of hyperbaric bupivacaine as spinal anaesthesia in patients undergoing lower limb orthopaedic surgeries in terms of the number of cases exposed to higher block (above T4).

MATERIAL AND METHODS

The study was conducted in the Department of Anesthesiology and intensive care, Pakistan Institute of Medical Science (PIMS), Islamabad for one year from April 2018 to March 2019. In this randomized control trial, 70 patients who were undergoing orthopaedic surgery of the lower limb were randomly assigned to receive either low volume (2 ml, hyperbaric bupivacaine 0.75%) or high volume (3 ml, hyperbaric bupivacaine 0.5%) in subarachnoid space. Two intravenous lines with 18G cannulas were maintained, and patients were preloaded with 1L of ringer-lactate solution. The spinal injection was given in a sitting position. A 26G spinal needle and L3-4 interspinous space were used. Both the regimens were injected in 20 seconds. After spinal injection, the patient was put in supine posture with a 5-degree head down. The level of block was assessed with a pin prick at 2 minutes, 10 minutes, and finally after 15 minutes of intervention. The hemodynamics were monitored and the level of block achieved by low volume (2 mL) and high volume (3 mL) hyperbaric bupivacaine was noted. All patients were oxygenated with variable devices at 41/min. The level of block was assessed by the trainee researcher not knowing which volume was used with a pin prick every two minutes up to 10 min. The final block level was assessed at 15 minutes and results were produced as such after analysis. Intravenous fluid was given as per the requirement of each patient after calculation. Complications like discomfort of patient were managed with midazolam and pethidine, whereas inadequate block was treated with general anaesthesia. Hypotension and bradycardia were treated with ephedrine and atropine, respectively. All the data was collected by the study proforma and SPSS version 26 was used for the data analysis.

RESULTS

A total of 70 cases were studied. The mean age of patients was 44.5±8.2 years in group I and 47.7 ± 9.6 years in group II. Males were predominant in both groups, particularly as 68.6% of males and 31.4% were females in group I, while 74.3% of males and 25.7% of females in group II. The indications for surgery were neck fracture of femur 28.5%, femur shaft fracture 20.0%, fracture shaft of tibia 8.7%, osteoarthritis of hip 8.7%, osteoarthritis of knee 5.7% in group I, while in group II the main indications were 8.6% fracture of the femur, 37.1% femur shaft fracture, 8.6% fracture shaft of tibia, osteoarthritis hip 11.6%, osteoarthritis knee 5.7%, osteoarthritis acetabulum 5.7% and osteoarthritis of femur 5.7%. Table.1

After 2 minutes of intervention, in group I, 7 (20.0%) patients had block at L1 compared to 6 (17.1%) in group II. The majority of patients in both groups had block levels between T6 and T12, whereas as an equal proportion, 2 (5.7%) of patients were seen at T4 level. When at 10 minutes after intervention, the height of the block was compared between the two groups, it was noted that in group I, the majority of cases (19, 54.3%) achieved level T8, whereas in group II, 7 (20.0%) were at this level. In group I, 7 (20.0%) had a level of analgesia at T10 compared to 2 (5.7%) in group II. Similarly, 4 (11.4%) patients were T6 level compared to 13 (37.1%) in group II. Those in both groups were at block level T12. In both groups, 1 (2.9%) patient each had block level L1. A few cases were at levels T5 and T7. At 10 minutes, none of the patients in group I reached T4 level, while 7 (20.0%) patients were already at T4 level in group II. After 15 minutes of intervention, the frequency of higher block, which was the main goal of the study, was measured. It was found that one patient in group I (2.9%), but nine patients in group II (25.7%), had achieved block of T4 level. Moreover, in group I, 1 (2.9%) patient had a block level at T3 compared to 5 (14.3%) in group II. There was no patient at block level T2 in group I, compared to 2 (5.7%) patients in group II. Table 2.

Overall, 1 (2.9%) patient in group I had a higher block (above T4) compared to 7 (20.0%) patients in group II and this difference was statistically significant between the two groups as higher block level was associated with high volume of hyperbaric bupivacaine (p-=0.02). Table 3

Table 1: Baseline characteristic of patient in the two study groups n=70

Variables		Group I n = 35	Group II n = 35
Age (years)		44.5 + 8.2	47.7+ 9.6
Gender	Males	24 (68.6%)	26 74.3%)
	Females	11 (31.4%)	9 (25.7%)

Group-I= (2 ml 0.75%), Group-II = (3ml 0.50%)

Table 2: Comparison of height of block between study group at 2,10 and 15 minutes after intervention n=70

Height of Block		Group-I n=35	Group-II n =35	p-value
At 2 minutes	L1	7(20.0 %)	6(17.1%)	0.001
	T12	8(22.9%)	3(8.6%)	
	T10	16(45.7 %)	5(14.3 %)	
	T8	3(8.6%)	12(34.3 %)	
	T6	0(0.0 %)	7(20.0%)	
	T4	1(2.9 %)	2(5.7 %)	
At 10 minutes	L1	1(2.9%)	1(2.9 %)	0.001
	T12	3(8.6 %)	2(5.7%)	
	T10	7(20.0%)	2(5.7 %)	
	T8	19(54.3 %)	7(20.0 %)	
	T7	1(2.9%)	2(5.7%)	
	T6	4(11.4%)	13(37.1 %)	
	T5	0(0.0%)	1(2.9%)	
	T4	0(0.0 %)	7(20.0 %)	
At 15 minutes	T12	1(2.9 %)	2(5.7 %)	0.001
	T10	7(20.0 %)	3(8.6%)	
	T8	18(51.4 %)	1(2.9 %)	
	T7	0(0.0 %)	3(8.6 %)	
	T6	7(20.0 %)	10(28.6%)	
	T4	1(2.9%)	9(25.7 %)	
	T3	1(2.9 %)	5(14.3 %)	
	T2	0(0.0 %)	2(5.7 %)	

Table 3: Comparison of higher block between the two study groups

	Group-I	Group-II	p-value
Higher block (Above T4)	1(2.9%)	7(20.0%)	0.023
Normal block (upto or below T4)	34(97.1%)	28(80.0%)	

DISCUSSION

Regional anesthesia, or spinal block, is the preferred choice for lower limb orthopaedic surgeries as it provides rapid onset and more reliable and dense motor and sensory blockade.[1-3] The optimal level of sensory block required in lower limb surgeries is T10 dermatome. Various factors influence the spread of the block, including patient position, spinal curvature, obesity, pregnancy, volume and dose, concentration and basicity of drug, and site of injection. Studies on direct comparison of volumes of anaesthetic drugs for spinal block are lacking. Our study has addressed specifically the effect of volume of hyperbaric local anaesthetic on the height of neuronal block, keeping other factors as mentioned above constant. Due to limited scientific evidence on drug volume, especially its effect on the height of the block, indirect evidence and sub parts of different reports have been reviewed to compare with the A study from Brazil using 50% enantiomeric excess hyperbaric bupivacaine (S75:R25) for infra-umbilical surgeries witnessed significant variation in the sensory block level between four volumes of hyperbaric bupivacaine (2.5ml, 3ml, 4ml, and 5ml).[10] Malinovsky JM studied the effects of volume and basicity of spinal bupivacaine on block onset, duration, height, and hemodynamics. They came to the conclusion that the volume of isobaric or hyperbaric bupivacaine had no effect on how it spread to the head or how long the sensory blockade lasted.[11] The effect of volume has been studied with hyperbaric tetracaine also by Hecker RB and Kingsley CP. A double-blind study was done to see if the volume of a fixed milligrams dosage of hyperbaric tetracaine hydrochloride to be used for subarachnoid block had an effect on the average maximum dermatomal spread of sensory anaesthesia, determined by pinprick testing. One hundred and twenty people were given spinal hyperbaric tetracaine in doses of 2 mL, 3 mL, or 4 mL, depending on their height. A Tukey HSD multiple comparisons test revealed a mean difference of more than one sensory dermatome between 2 mL and 4 mL quantities, that was clinically important but insignificant statistically.[12] A double-blind study employing hyperbaric bupivacaine solutions examined the effects of different bupivacaine concentrations and intrathecally given volumes. The 0.5 percent solution constantly caused effective nerve blockage, while increasing the volume administrated had no influence on the spread of sensory loss. However, the 0.75 percent solution resulted in a much larger cephalad spread when the volume administrated was increased.[13] In another trial conducted by C.J. Chung with 0.25% hyperbaric bupivacaine for SAB in caesarean. The impact of the volume of hyperbaric spinal anaesthetic solution administered is additive to the effect of gravity location and dose, according to the section. The distribution of the drug in the CSF and the final block in the clinical dosage range may be influenced by the high volume of 10–15 mg.[14].A local study by Sikander RI et al. compared 0.75% (1.6ml) Bupivacaine hyperbaric and 0.5% (2.4 ml) Bupivacaine hyperbaric in-patients undergoing elective caesarian section. They concluded that 2.4 ml of 0.5% hyperbaric bupivacaine experienced a higher level of block as compared to those who received 1.6 ml of 0.75% hyperbaric bupivacaine (P = 0.001).[15] Thus, the addition of 0.8cc in drug volume could affect the spread of intrathecal bupivacaine.[15]The current study revealed that high volume (3ml of hyperbaric bupivacaine, 0.5%) for spinal anaesthesia was significantly associated with higher block (above T4 dermatome) when compared with low volume (2ml of hyperbaric bupivacaine, 0.75%). Higher volumes achieved a rapid onset of anaesthetic block. Evidence supports the notion that volume does affect the physiology of SAB in terms of onset of block, duration of analgesia, and height of block.[14] Because of the diverse range of influences on the height of the spinal block, there is a significant element of bias. Another aspect is that if volume is changed by any means, it will affect the baricity of the drug also. These aspects make it difficult to assess the effect of volume on the height of a block. There are a few advantages to the current study, as this is one of the very few studies done to compare the volume of hyperbaric bupivacaine in spinal anesthesia. It is believed that the findings of this study would be helpful to anaesthetists nationally and internationally. We did not collect information regarding the hemodynamic changes and other related parameters in the current study. This could be one of the major limitations of the present study as this would have given a more detailed breakdown of data regarding drug volume in spinal anaesthesia for lower limb

orthopaedic surgeries. In this study, we concentrated on only the level of sensory block.

CONCLUSION

A larger volume of spinal anaesthesia (hyperbaric bupivacaine) is associated with a higher level (above T4 dermatome) of subarachnoid block in patients undergoing orthopaedic surgical procedures. Higher volume has been found to be related to a rapid onset of analgesia. As per results, the ideal level of spinal block can be achieved with a low volume (2 mL 0.75% hyperbaric bupivacaine). However, for the generalization of these findings, further large-scale randomized controlled trials with more rigorous and adequate research methods are recommended.

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