COMPARATIVE EVALUATION OF CLASSICAL SUBARACHNOID BLOCK, UNILATERAL SUBARACHNOID BLOCK AND LOW-DOSE SUBARACHNOID BLOCK IN HIGH-RISK PATIENTS UNDERGOING LOWER LIMB SURGERIES

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ABSTRACT

BACKGROUND

Subarachnoid block is a popular anaesthetic technique because of its rapid onset, safety and simplicity. A special technique of subarachnoid block named spinal hemi-block was described for one-limb surgeries, which was also known as spinal hemianalgesia or unilateral spinal anaesthesia. Addition of fentanyl to bupivacaine is an established technique to reduce the dose of anaesthetic and to maintain haemodynamic⁽¹⁾ stability.

FACTORS AFFECTING UNILATERAL SPINAL

Five main factors should be considered when trying to restrict spinal block ⁽²⁾ to the operative side. 1. The density of local anaesthetic solution compared with CSF.⁽³⁾ 2. Speed of intrathecal injection.⁽⁴⁾ 3. Patient position.⁽⁵⁾ 4. Dose, Concentration, volume of the local anaesthetic solution. 5. Design of spinal needles.

AIM

To compare the efficacy of classical subarachnoid block using 0.5% bupivacaine, unilateral subarachnoid block using 0.5% bupivacaine and low-dose subarachnoid block using 0.5% bupivacaine 1.5 mL with 0.5 mL of fentanyl⁽²⁾ (25 micrograms) in high-risk patients undergoing unilateral lower limb surgeries⁽⁶⁾ based on the following parameters. 1. Haemodynamic stability in the intraoperative period. 2. Onset and Quality of subarachnoid block.

MATERIALS AND METHODS

A total of 60 high-risk patients undergoing surgery on one lower limb were divided into three groups. Control Group-Received 2 mL of 0.5% Bupivacaine intrathecally and turned to supine position immediately. Study Group I: Received 1.5 mL of 0.5% Bupivacaine with 25 µg (0.5 mL) Fentanyl intrathecally and kept in lateral decubitus position for 10 minutes and then turned supine. Study Group II: Received 2 mL of 0.5% Bupivacaine intrathecally and kept in lateral decubitus position for 10 minutes and then turned supine. Heart rate, Systolic and Diastolic blood pressure were recorded before and after the spinal every five minutes for 60 minutes and in the recovery room and thereafter every 30 minutes till the time oral analgesic was given. Sensory blockade was assessed in the dependent as well as non-dependent limb separately. Using Modified Bromage scale, both the dependent as well as non-dependent limbs were assessed separately for the motor blockade at 0, 5, 10, 15 and every 5 minutes after surgical position. Side effects such as nausea, vomiting, and pruritus were recorded in the intraoperative and postoperative period.

RESULTS

The occurrence of hypotension requiring treatment was more in the control group (30%) versus Study Group I(15%) and Study Group II(15%) which is statistically significant($p<0.02$). The occurrence of bradycardia requiring treatment was more in the Control group (30%) versus Study Group I(15%) and Study Group II(15%) which is statistically significant ($p<0.02$). An analysis of motor blockade in the 3 groups showed that Study Group I and Study Group II produced lesser degree of motor blockade when compared to the Control Group. This difference was found to be statistically significant ($p<0.05$).

CONCLUSION

We conclude that in high-risk patients undergoing unilateral lower limb surgeries: 1. Unilateral low-dose subarachnoid block offers better haemodynamic stability during the intraoperative period. 2. The onset and quality of level of sensory block in unilateral subarachnoid and low-dose unilateral subarachnoid block is same as those produced by classical subarachnoid block. 3. There is sparing of motor block in the non-dependent limb in unilateral subarachnoid block and unilateral low-dose subarachnoid block.

KEYWORDS

Classical Subarachnoid Block; Unilateral Spinal, Low-dose spinal, Fentanyl.

HOW TO CITE THIS ARTICLE: Namasivayam SA, Gomathi M, Sudhakar R. Comparative evaluation of classical subarachnoid block, unilateral subarachnoid block and low-dose subarachnoid block in high-risk patients undergoing lower limb surgeries. J.Evolution Med. Dent. Sci. 2016;5(79):5919-5923, DOI: 10.14260/jemds/2016/1336

Financial or Other, Competing Interest: None.

Submission 26-08-2016, Peer Review 19-09-2016,

Acceptance 26-09-2016, Published 03-10-2016.

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DOI: 10.14260/jemds/2016/1336

INTRODUCTION

It was in the year 1899, August Bier, used subarachnoid block and he gave first deliberate spinal anaesthesia. Subarachnoid block continued to be most common anaesthetic technique because of its rapid onset, safety and simplicity. Even this relatively safe technique can have complication such as hypotension which a normal patient can tolerate but can be detrimental to patients with haemodynamic instability. The safety improves if the block can be localised to the area of surgery.

A special technique of subarachnoid block named spinal hemi-block was described for one limb surgeries, which was named as spinal hemianalgesia. This is also known as unilateral spinal anaesthesia. The distance between the left and right spinal roots is only 10–15 millimetre in the lumbar or lower thoracic level. Such a small distance should reasonably prevent from producing strictly unilateral block of the spinal nerve roots. However, various clinical reports suggested that using small doses of either hypo or hyperbaric anaesthetic solution injected at low speeds. (7)(8)(9)(10) through directional needles in patients lying in the lateral decubitus position for 10–15 minutes results in preferential distribution of subarachnoid block towards the operated side, providing intense surgical block on that side. Even though the term unilateral subarachnoid block has been in vogue for a long time most of the research on this is recent. Even though performing subarachnoid block is technically easier, the complications which are usually expected like hypotension and bradycardia can be detrimental to this high-risk group patients.

Addition of fentanyl to bupivacaine is an established technique to reduce the dose of anaesthetic and to maintain haemodynamic stability. However addition of fentanyl can change the baricity of the local anaesthetic and can alter the effect of intended unilateral spinal analgesia.

Factors Affecting Unilateral Spinal Anaesthesia

Five main factors should be considered when trying to restrict spinal block to the operative side.

1. The density of local anaesthetic solution compared with CSF.
2. Patient position.
3. Speed of intrathecal injection.⁽¹¹⁾
4. Dose, Concentration, volume of the local anaesthetic solution.⁽¹²⁾
5. Design of spinal needles.

This study was done to compare the efficacy of classical subarachnoid block, unilateral subarachnoid block, low-dose subarachnoid block in high-risk patients undergoing lower limb surgeries.

AIM

To compare the efficacy of classical subarachnoid block using, 0.5% bupivacaine,⁽¹¹⁾ unilateral subarachnoid block using 0.5% bupivacaine⁽¹²⁾ and low-dose subarachnoid block using 0.5% bupivacaine 1.5 mL with 0.5 mL of fentanyl (25 micrograms) in high-risk patients undergoing unilateral lower limb surgeries based on the following parameters.

1. Haemodynamic stability in the intraoperative period.
2. Onset and Quality of subarachnoid block.

MATERIALS AND METHODS

The effect of lateral position on maintaining unilaterality of subarachnoid block and the effect of adding fentanyl to hyperbaric bupivacaine in achieving unilateral subarachnoid block undergoing lower limb surgeries on one limb was studied in a total of 60 patients. The study was approved by the institutional research and ethics committee.

Inclusion Criteria

1. Patients between 18 to 80 years of age.
2. Patients belonging to ASA physical status II and III.
3. Undergoing unilateral lower limb surgery.

Exclusion Criteria

1. All contraindication for central neuraxial block.
2. Patients who are not cooperative to positioning for subarachnoid block.
3. Patients with anomalies of the spinal column.

Randomisation

The patients were allocated into three groups by simple randomisation using sealed envelope method. They were divided into three groups.

Control Group

Received 2 mL of 0.5% Bupivacaine intrathecally and turned to supine position immediately.

Study Group I

Received 1.5 mL of 0.5% Bupivacaine with 25 µg (0.5 mL) Fentanyl intrathecally and kept in lateral decubitus position for 10 minutes and then turned supine.

Study Group II

Received 2 mL of 0.5 % Bupivacaine intrathecally and kept in lateral decubitus position for 10 minutes and then turned supine.

Preoperative Preparation

The procedure was explained and the informed consent was obtained. When the patient reached the operating room, monitors were attached which included electrocardiogram, noninvasive blood pressure and pulse oximetry. A wide bore cannula was inserted and the patient was preloaded with 20 mL/kg of crystalloid solution. All baseline vital parameters were recorded.

The investigation was blinded to the drug as the study solution was prepared by an anaesthesiologist who was not involved with the administration of subarachnoid block and in the monitoring of the patients. The procedure was done by the investigator on all patients to maintain uniformity of technique. Using 23 gauge Quincke spinal needle with the patient in lateral position (The side to be operated on as the dependent side), the drug was given after assuring free flow of CSF. Patients were kept in the lateral position for 10 minutes after which the patient was positioned for surgery to proceed. The following variables were assessed and recorded in the operative period.

Heart rate, Systolic and Diastolic blood pressure was checked every three minutes and were recorded before the spinal and every five minutes for 60 minutes and in the recovery room and there after every 30 minutes till the time oral analgesic was given. Bradycardia was defined as heart rate less than 60/minute. If bradycardia is symptomatic 0.5 mg of atropine was given intravenously. Hypotension was defined as drop in systolic blood pressure less than or equal to 30% below baseline which was treated with rapid infusion of crystalloid in 200 mL Ringer lactate boluses and/or 6 mg of ephedrine was given intravenously and repeated if necessary.

Sensory blockade was assessed in the dependent as well as non-dependent limb separately. Sensation was assessed using pinprick by a blinded observer. This was recorded every 5 minutes after surgical position for 60 minutes. The sensory levels were checked in the postoperative period in the recovery room.

Motor blockade was assessed using Modified Bromage scale.

Modified Bromage Scale

0 – No Motor Block.

1 – Can flex knee, move foot, but cannot raise leg.

2 – Can move foot only.

3 – Cannot move foot or knee.

Both the dependent as well as non-dependent limbs were assessed separately for the motor blockade at 0, 5, 10, 15 and every 5 minutes for a total period of 60 minutes after surgical position.

Side effects such as nausea, vomiting, and pruritus were recorded in the intraoperative and postoperative period.

STATISTICAL METHOD

The data analysis was done using SPS SPC+Software. Comparison of the means between the groups was done by Student t-test or chi-square test.

P value<0.05 was considered significant.

RESULTS

Demographic Data

There were 60 patients in this study. Each group consisted of 20 patients. Patients characteristic for age, sex, height were comparable in all three groups. This is shown in Table I, Table II and Table III.

Age (Years)	Number of Patients		
	Control Group	Study Group I	Study Group II
17 – 26	n=3	n=1	n=1
26 – 36	n=3	n=1	n=1
37 – 46	n=7	n=2	n=4
47 – 56	n=3	n=5	n=4
57 – 66	n=4	n=11	n=10

Table I: The Distribution of Patients according to age were similar in all Three Groups

P-Values control group I and Group II=0.879 (Not Significant), P-Values control group I and Group II=0.486 (Not Significant)

Sex	No. of Patients			P value of control and Study Group I & Study Group II
	Control Group	Study Group I	Study Group II	
Female	n=8 (40%)	n=10 (50%)	n=7 (35%)	P value of control and Study Group II & Study Group II & Study Group II = 0.25(NS)*
Male	n=12 (60%)	n=10 (50%)	n=13 (65%)	

Table II: Depicts the Distribution of Males and Females in all Three Groups were Similar

*NS–Not Significant

Height	Control Group	Study Group I	Study Group II
151-165	n=1	n=1	n=2
156-160	n=3	n=8	n=3
161-165	n=9	n=8	n=6
166-170	n=5	n=1	n=9
171-175	n=2	n=2	n=0
Total	n=20	n=20	n=20

Table III: Distributions of Height in all Three Groups studied were Similar

The demographic data reveals that all 3 groups are comparable on height, weight and sex ratios. There is no statistically significant difference between the groups with regard to demographic data.

Haemodynamics (Heart Rate, Blood Pressure).

Heart Rate

Groups	Control Group	Study Group I	Study Group II
Total	n=20	n=20	n=20
Bradycardia Requiring Treatment	n=6	n=3	n=3
Percentage	30%	15%	15%

Table IV: Shows the Incidence of Symptomatic Bradycardia in the Three Groups

P=0.02 (Statistically significant).

Bradycardia–Heart rate <60 beats/min.

Heart rate comparison revealed that the occurrence of bradycardia requiring treatment was more in control group (30%) versus the Study Group I (15%) and Study Group II (15%). This difference was found to be statistically significant.

Blood Pressure

Groups	Control Group	Study Group I	Study Group II
Total	n=20	n=20	n=20
Hypotension Requiring Treatment	n=6	n=3	n=3
Percentage	30%	15%	15%

Table V: Shows the Incidence of Hypotension in the Three Groups

P=0.02 (Statistically significant).

Hypotension–Systolic drop of blood pressure more than 30% from the baseline.

Hypotension comparison revealed that the occurrence of hypotension requiring treatment was more in control group (30%) versus the Study Group I (15%) and Study Group II (15%). This difference was found to be statistically significant.

Motor Blockade

Motor Blockade		Dependent				Non-dependent			
At 15 Minutes	Bromage Scale	0	1	2	3	0	1	2	3
	Control Group	n=0	n=0	n=3	n=17	n=0	n=1	n=4	n=15
	Study Group I	n=1	n=0	n=7	n=12	n=6	n=7	n=2	n=5
	Study Group 2	n=2	n=0	n=7	n=11	n=8	n=2	n=4	n=6
At 30 Minutes	Control Group	n=0	n=0	n=3	n=17	n=0	n=1	n=4	n=15
	Study Group I	n=1	n=0	n=7	n=12	n=4	n=7	n=3	n=8
	Study Group 2	n=2	n=0	n=7	n=11	n=6	n=3	n=3	n=8
60 Minutes	Control Group	n=0	n=0	n=0	n=20	n=0	n=2	n=6	n=12
	Study Group I	n=0	n=0	n=8	n=12	n=4	n=5	n=3	n=8
	Study Group 2	n=0	n=0	n=8	n=12	n=6	n=2	n=4	n=8

Table VI: Shows Comparison of Motor Blockade in all Three Groups

Motor blockade in the 3 groups showed that in Study Group I and Study Group II there is lesser degree of motor blockade when compared to the Control group. This difference was found to be statistically significant.

Sensory Blockade

	Control group	Study Group I	Study Group II
Upper Level	T ₆ - L ₁	T ₉ - T ₁₂	T ₈ - T ₁₂

Table VII: Shows Comparison of Sensory Blockade in all Three Groups

There was no statistical difference in the upper level of sensory blockade.

The onset time for loss of pinprick sensation at T₁₀ in both the limbs in all the three study groups was similar between 5 to 7 minutes. We are not able to demonstrate any obvious difference in onset times.

DISCUSSION

This prospective randomised study was done in 60 high-risk patients of ASA II and III category with comorbid factors and potential for haemodynamic instability were drafted into the study. The practicality of producing a unilateral spinal block and ability to reduce haemodynamic instability was studied. The ability of a low-dose bupivacaine subarachnoid block in combination with fentanyl in maintaining a unilateral spinal block and its ability to decrease haemodynamic alteration was also studied.

Unilateral Spinal Anaesthesia

After performance of Subarachnoid block in the lateral position (Operated limb kept dependent), patients were maintained in the lateral position for 10 minutes before turning them supine.

In this study, the onset time for loss of pinprick sensation at T₁₀ in both the limbs in all the three study groups was similar between 5 to 7 minutes. In this study, we were not able to demonstrate any obvious difference in onset times.

In this study, the sensory block had a wide variation in the upper level of block between the dependent and non-dependent limb at 15 minutes. But with the passage of time this difference was narrowed or obliterated.

The median level of block was between T₉-T₁₀ in all 3 groups. The level of block in control group extended between T₆ to L₁. In the Study Group I, the block extended between T₉-T₁₂. In the Study Group II, the block extended between T₈ and T₁₂.

In our study, there was no statistical difference in level of sensory blockade between the dependent and non-dependent leg. The initial difference observed between the 2 limbs due to maintenance of lateral position is lost to a great extent on assumption of the supine position.

Motor Block

An analysis of motor blockade in the 3 groups showed that unilateral spinal block and low-dose spinal block introduced lesser degree of motor blockade when compared to the classical subarachnoid block group. This difference was found to be statistically significant.

Two Space Regression

In our study, we were unable to demonstrate any statistically significant difference in the two space regression of sensory block on the dependent limb when compared to the non-dependent limb in the three groups studied.

Haemodynamic Stability and Complications

In our study, haemodynamic stability as evidenced by systolic blood pressure, diastolic blood pressure and mean arterial blood pressure was comparable between Study Group I and II. Three patients had hypotension of more than 30% from baseline values that required treatment. Control group had higher incidence of both hypotension and bradycardia with 6 patients requiring treatment with vasopressors, and fluids (Crystalloid) for both these complications.

Study Group I and II had lesser incidence of haemodynamic problems. These difference was also found to be statistically significant.

Motor Blockade

Analysis of motor block was done using Modified Bromage Scale both in the dependent and non-dependent limb exclusively.

The control group had maximum degree of motor blockade with 17/20 patients having grade 3 motor blockade in both limbs. Study Group I had grade 3 motor blockade in 11/20 patients and the Study Group II had motor blockade of grade 3 in 12/20 patients. From this study, it was found that the unilateral spinal and low-dose subarachnoid block decreases the degree of motor blockade which was statistically significant. Analysis was done to see if there is any difference in the degree of motor blockade between the two limbs (Dependent vs. non-dependent, where applicable). Comparisons were made at 15, 30 and 60 minutes interval. Grade II and III of modified Bromage scale were considered as significant motor blockade of limb. Based on these parameters the following observations were made.

Control Group

This group showed no statistically significant difference in motor blockade between the limbs. Degree of motor blockade was recorded at 15 mins. and 60 mins. and also were compared between the two limbs.

Study Group I

This group showed a statistically significant difference in motor blockade between the two limbs at 15 mins. Significant motor blockade in dependent limb was 17/20 and in non-dependent limb was 10/20. At 60 mins., significant motor blockade in the dependent limb was 20/20 and in the non-dependent limb was 12/20.

Study Group II

This group showed statistically significant motor block on dependent limb 19/20 versus the non-dependent limb 7/20 at 15 minutes. This reflects that onset time is faster and denser in the dependent limbs. At 60 mins., the dependent limb had significant motor blockade of 20/20 while in the non-dependent limb motor blockade was 11/20. So as the time elapsed the differential blockade obtained between the two limbs seems to have reduced probably reflecting slow spread of local anaesthetics to the non-dependent limb also on assumption of supine position.

CONCLUSION

From this study, we conclude that in high-risk patients undergoing unilateral lower limb surgeries, unilateral low-dose subarachnoid block offers better haemodynamic stability during the intraoperative period.

The onset and quality of level of sensory block in unilateral subarachnoid and low-dose unilateral

subarachnoid block is same as those produced by classical subarachnoid block.

There is sparing of motor block in the non-dependent limb in unilateral subarachnoid block and unilateral low-dose subarachnoid block.

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