Original Research Article

Comparison of the Effects and Complications of Unilateral Spinal Anesthesia Versus Standard Spinal Anesthesia in Lower-Limb Orthopedic Surgery

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Abstract

Objective : The aim of this prospective, randomized, parallel group study was to evaluate vital parameters , sensory and motor block during unilateral subarachnoid block and to compare it with that produced by standard bilateral spinal anaesthesia. Side effects and complications were also noted and compared.**Methods:** 100 ASA I-II patients scheduled for one leg surgery. Dural puncture was performed by 25-G spinal needle with patients lying in the lateral position and the side to be operated on dependent. Patients then randomly received 8 mg of 0.5% hyperbaric bupivacaine injected over 80 sec with needle hole orientated towards the dependent side (Unilateral, n = 30), or 15 mg of the same solution injected over 6 sec with needle bevel cranially directed (Control, n = 30). Only patients of the Unilateral group remained in the lateral position for 15 min. Blood pressure, heart rate were measured before spinal block (baseline) and then at 5, 15, 30 and 45 min; while sensory and motor blocks were evaluated at 15, 30 and 45 min on both sides.**Results:**Patients characteristics in terms of age and weight were comparable in both the groups All blocks were fully effective. Mean blood pressure was significantly lower in the bilateral group. Heart and respiratory rates did not differ between the groups. There was no statistically significant difference in mean time for onset, peak of sensory block in two groups. But there was statistically significant difference in two segment and complete regression of sensory block. Regression of sensory block was prolonged in group A as compared to group B **(P<0.0001).**There was no statistically significant difference in onset of motor block in two groups. But there was statistically significant difference in regression of motor block. There was delayed regression of motor block in group A as compared to group B **(P<0.01).**There was significant prolongation of analgesia in Group **A** where first rescue analgesic was required after 9 hours of subarachnoid blockade. Patients in Group B required rescue analgesic at 7 hours after subarachnoid blockade. There was statistically significant difference in duration of analgesia in two groups. Postoperative analgesia was significantly prolonged in Group A as compared to Group B.The total number of side effects (hypotension, bradycardia, apnoea) requiring intervention was similar in both groups.**Conclusion:** The use of 8 mg of 0.5% hyperbaric bupivacaine slowly injected through a directional needle provided a spinal block relatively restricted to the operative side with minimal effects on cardiovascular homeostasis. Unilateral spinal anaesthesia is safe. The dose of bupivacaine is lower and haemodynamic stability is better. The technique is more time consuming, compared to standard spinal anaesthesia and the patient's cooperation is essential.

Keywords: Lateral Position ,0.5% Hyperbaric ,Blood Pressure, Heart Rate Sensory And Motor Block.

Introduction

Spinal anaesthesia is a simple and quick technique but it has risk of severe hypotension. Even though spinal anaesthesia provides intense and reliable block, it has risk of limited duration of action. Compared to conventional spinal anaesthesia, unilateral Spinal Anaesthesia (unilateral SA) provides more dense and longer lasting block with less hypotension and prolonged analgesia with faster onset of action and lower incidence of failure.Unilateral spinal anaesthesia is safe. The dose of bupivacaine is lower and haemodynamic stability is better. The technique is more time consuming, compared to standard spinal anaesthesia and the patient's cooperation is essential.Due to lack of proper studies on safety,efficacy and side effects and complications; the unilateral spinal anaesthesia was always quationable. Therefore a study was undertaken in our department to find some answers to above questions[1,2].

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Materials and Methods

This was single center, randomised, prospective comparative study, conducted between January 2019 – January 2020. The study was approved by the Local Institutional Ethical Committee and written, informed consent was obtained from all patients before surgery. With α error of 0.05 and power of study 80%, sample size came to 40 per group. We decided to study 100 patients to account for possible dropouts.

Consent

Written consent was obtained from the relatives of patients after explaining them the nature and purpose of the study. They were assured that confidentiality would be strictly maintained. The option to withdraw from the study was always open.

Methodology

In the operative room, routine noninvasive monitoring, electrocardiogram, Heart Rate (HR), SpO_2, Noninvasive Arterial Blood Pressure (NIBP) and nasal capnometer was used. All patients were premedicated with alprazolam 0.25 mg at night before the day of operation as routine protocol. All patients were preloaded with 500 ml of Ringer lactate solution before the start of surgery. Nature of intervention did not allow the blinding of investigator except for

noninvasive haemodynamic variables which was recorded by blinded investigator who was not a part of anaesthesia team.In unilateral SA group, patient were placed in lateral decubitus position with the limb to be operated in the dependent position. Under strict aseptic precautions subarachnoid block was given in L3- L4 space using 25 gaugeQuincke point spinal needle with midline approach. After noting free and clear flow of CSF, needle's bevel was turned towards dependent side and 2 cc (10 mg) of 0.5% hyperbaric bupivacaine was injected over two minutes without further aspiration of CSF. Patient was kept in this lateral position for 15 minutes and then made supine. Sensory block was assessed by pin prick method on operated limb side. Dermatome level tested every five minutes till thirty minutes, then every fifteen minutes until the point of regression of sensory level reached to L3 on the operated limb. At the end of 15 minutes if sensory block failed to reach T10 level or if patient had pain due to inadequate block, it was considered as failed block and general anaesthesia was given and these patient were excluded from further statistical analysis.We recorded various variable like anaesthesia readiness time as time from the end of injection of spinal drug to the time sensory block reached T10 level and patient anaesthesia wise ready to be handed over to surgeon for surgery, degree of motor block on operated limb was evaluated using a Modified Bromage scale when patient was anaesthesia wise ready for surgery (Bromage O: Free movement of limb at hip, knee and ankle joint. Bromage 1: Free movement of limb at knee and ankle joint. Bromage 2: Free movement limb at ankle joint. Bromage 3: No movement of limb at hip, knee and ankle joint). Duration of motor block noted as time from the onset of grade 3 motor block to complete resolution of motor block.Time to regression of sensory block to T12 noted as time from the onset of T10 sensory block to regression of sensory level to T12. If due to regression of spinal block and inability to maintain surgical anaesthesia during surgery in any group and if general anaesthesia was supplemented intraoperative then it was noted as supplementation of general anaesthesia. Initial and total dose bupivacaine required to establish and maintain block to T10 level also noted down.

Blinded observer noted down haemodynamic variables such as systolic arterial blood pressure and heart rate before administering anaesthesia and throughout intraoperative period. Clinically significant hypotension was defined as decrease in systolic arterial pressure by 30% or more from baseline values or <90 mm Hg. It was treated with IV ephedrine 5 mg incremental boluses dosages and the total amount of ephedrine required was noted. Clinically significant bradycardia was defined as a heart rate less than 50 beats per min and it was treated with IV atropine 0.5 mg boluses. Incidences of clinically significant hypotension and bradycardia were noted as incidence of haemodynamic adverse event[3].

Observation Chart

Observations and Results

Present study of 100 patients was carried out in the Department of Anaesthesiology, during period from January 2019 to December 2020 after fulfilling the inclusion and exclusion criteria. Following is an attempt to summarize the observations of the study.

Table 1:Showing Group Distribution

Groups(No. of Patients)	Study Drugs and Its Doses
Group A (n=50)	8 mg of 0.5% hyperbaric bupivacaine injected over 80 sec with needle hole orientated towards the dependent side (Unilateral)
Group B (n=50)	15 mg of the same solution injected over 6 sec with needle bevel cranially directed (Control).

Table 2:Demographic Profile of Patients

Variables	Group A	Group B	P value
Age (years)	47.18 ±09.72	47.28 ± 10.14	0.9600
weight (in kg)	64.32 ± 04.54	65.46 ± 12*42	0.3897

Patients characteristics in terms of age and weight were comparable in both the group s (P>0.05).

Table 3:Comparison of Sensory Characteristics of Subarachnoid Block Between Two Groups-

Variables		Group A Unilateral	Group B Bilateral	P Value
Highest sensory level achieved (range)		**T_6-T_8**	**T_6-T_8**	**0.1713**
Onset of sensory block (min)	At L_1 dermatome	01.4 ± 00.45	01.50 ± 00.40	0.2466
	At T_{10} dermatome	03.32 ± 01.17	03.59 ± 00.68	0.1703
	At highest sensory level	10.45 ± 01.91	10.99 ± 01.69	0.1364
Time to reach peak of sensory block (min)	L_1 dermatome	02.71 ± 00.84	02.9 ± 00.47	0.3591
	T_{10} dermatome	04.64 ± 01.36	04.81 ± 00.93	0.4555
	Highest sensory level	14.69 ± 01.36	16.26 ±0.72	0.1218
Time for regression of sensory block (min)	2 segment regression	147.04 ±32.09	120.9 ±\24.61	<0.0001
	Complete regression	325.76 ±38.49	264.8 ± 38.87	<0.0001

Table 4:Comparison of Motor Characteristics of Subarachnoid Block Between Two Groups

Variables	Group A (Mean ± Sd) Unilateral	Group B (Mean ± Sd) Bilateral	P Value
Time to achieve grade I motor block (min)	03.72 ±00.78	03.75 ±00.88	0.8582
Time to achieve grade II motor block (min)	05.95 ±01.13	05.92 ±01.15	0.8964
Time to achieve grade III motor block (min)	10.88 ±01.72	10.91 ±01.85	0.9335
Regression of motor block to previous grade	161.38 ± 24.05	147.18 ± 24.94	<0.0001
Time to complete regression of motor block	213.44 ± 22.27	194.72 ± 22.57	<0.0001

Table 5:Statistical Analysis of Pulse Rate (Per/Min)

Pulse rate per minute at different time points.	Group A (Mean ± SD)	Group B (Mean ± SD)	P value
Baseline	84.66 ± 07.03	83.80 ±07.40	0.54
Just after block	84.66 ± 06.85	85.12 ±06.88	0.73
5min after block	83.82 ± 06.65	84.22 ± 07.44	0.77
15 min after block	80.92 ± 06.43	82.82 ± 07.24	0.16
30min after block	80.02 ±05.72	81.78 ±06.84	0.16
45 min after bloik	75.42 ±05.73	77.26 ±05.49	0.10

Table 6:Statistical Analysis of Systolic Blood Pressure, Diastolic Blood Pressure And Mean Arterial Pressure (mm of Hg)

Blood Pressure at different time points	Systolic Blood Pressure			Diastolic Blood Pressure			Mean Arterial Pressure		
	Group A	Group B	P	Group A	Group B	P	Group Al	Group B	P
Baseline	125.0 ± 05.94	122.3 ± 07.83	0.05	77.82 ± 04.60	77.20 ± 04.60	0.51	93.50 ± 03.65	92.10 ± 04.40	0.08
Just after block	125.2 ± 07.84	122.7 ± 07.19	0.09	77.62 ± 04.28	76.32 ± 06.24	0.22	93.34 ± 04.57	94.98 ± 25.11	0.65
5 min	119.6 ± 05.87	118.4 ± 06.95	0.33	74.42 ± 05.76	74.42 ± 06.89	0.99	89.04 ± 05.36	89.04 ± 05.95	0.99
10 min	111.6 ± 06.11	111.9 ± 08.29	0.82	72.12 ± 04.85	71.94 ± 06.27	0.87	85.14 ± 04.40	85.32 ± 05.88	0.86
20 min	110.7 ± 06.11	111.1 ± 07.99	0.76	71.66 ± 05.17	71.32 ± 06.01	0.76	84.72 ± 04.52	84*.64 ^ 05.73	0.93
30 min	108.2 ± 04.98	109.3 ± 08.40	0.41	70.44 ± 04.17	69.68 ± 05.38	0.43	83.06 ± 03.84	82.82 ± 05.26	0.79
45 min	105.6 ± 05.94	108.1 ± 08.16	0.08	70.86 ± 07.03	68.60 ± 05.80	0.08	82.42 ± 05.85	81.72 ± 05.25	0.53
60 min	108.9 ± 05.59	110.3 ± 08.32	0.32	7L62 ± 03.90	69.82 ± 05.63	0.06	83.92 ± 03.39	83.26 ± 05.17	0.45

Table 8:Statistical Analysis of Visual Analogue Scale

Time	Group A (Mean ± SD)	Group B (Mean ± SD)	P Value
1 hr after block	0	0	-
3 hr after block	0	0	-
4 hr after block	0.38 ±0.83	3.5 ± 1.24	<0.0001
5 hr after block	1.96 ±0.325.26 ±0.12	05.46 ± 0.54 (rescue analgesic given)	<0.0001

Table 9:Statistical Comparison of Duration of Effective Analgesia

Variable	Group A (Mean ± SD)	Group B (Mean ± SD)	P value
Duration of effective analgesia (minutes)	526.4 ± 27.38	401 ± 34.71	<0.0001

Table 10:Complications in Two Groups

Complications	Group A No. of patients %unilateral	Group B No. of patients % bilateral
Hypotension	3.06%	3.06%
Bradycardia	1.02%	3.06%
Nausea-Vomiting	4.08%	6 .12%
Headache	0.00%	0.00%
Respiratory depression	0.00%	0.00%
Neurological complication	0.00%	0.00%

Results

Patients characteristics in terms of age and weight were comparable in both the groups (P>0.05).There was no statistically significant difference in mean time for onset, peak of sensory block in two groups. But there was statistically significant difference in two segment and complete regression of sensory block. Regression of sensory block was prolonged in group A as compared to group B **(P<0.0001).**There was no statistically significant difference in onset of motor block in two groups. But there was statistically significant difference in regression of motor block. There was delayed regression of motor block in group A as compared to group B **(P<0.01).**The changes observed in heart rate were comparable in both the groups throughout the study period. Heart rate remained stable and comparable at different time points in two groups. Except three patients in group B and one patient in group A, no other patient in either group developed bradycardia.Changes observed in systolic, diastolic and mean blood pressure were comparable in both the groups at different time points **(P>0.05).** Three patients in Group A and in Group B developed hypotension which responded to

intravenous fluid therapy.SpO_2 remained stable and comparable in both the groups throughout the study period, **(P>0.05).**

There was significant prolongation of analgesia in Group **A** where first rescue analgesic was required after 9 hours of subarachnoid blockade. Patients in Group B required rescue analgesic at 7 hours after subarachnoid blockade. There was statistically significant difference in duration of analgesia in two groups. Postoperative analgesia was significantly prolonged in Group A as compared to Group B.

Statistical Analysis: The results were expressed as mean±standard deviation for continuous variables while ordinal data as frequency and percentage. Continuous variables were analysed using unpaired two-tailed Student's t-test. Ordinal data were analysed using Chi-square test. The $p<0.05$ was considered as statistically significant. All statistical calculation were performed using SYSTAT package 7.0 (SPSS Inc. Chicago IL, USA) and Microsoft Excel were used for statistical analysis.

Discussion

Unilateral SA is given with aim to limit distribution of spinal block only to the operated side for operations involving only one lower limb. It is achieved by giving minimal required dose of intrathecal agent so that only nerve roots supplying specific area and only the modalities that require to be anaesthetized are affected. Unilateral SA has low rate of cardiovascular complication due to its low degree of sympathetic block than bilateral spinal anaesthesia . It has been suggested that a unilateral distribution of spinal anaesthesia can be attempted using the lateral decubitus position with small doses of not isobaric spinal anaesthetic solution, small gauge directional pencil point needles, injecting the drug slowly over long time and maintaining the lateral decubitus position for 15 to 20 minutes . An injection of 10 mg (2 ml) hyperbaric bupivacaine 0.5% is recommended to provide block of duration approximately two to three hours for operations above the knee . Thus, we used 10 mg of 0.5 % hyperbaric bupivacaine for unilateral SA for the block to last approximately two hour in our study.Casati A et al did a clinical comparison with bilateral spinal block.They studied block distribution and cardiovascular effects of unilateral spinal anaesthesia by 0.5% hyperbaric bupivacaine. They studied 30 ASA I-II patients scheduled for one leg surgery. Patients then randomly received 8 mg of 0.5% hyperbaric bupivacaine injected over 80 sec with needle hole orientated towards the dependent side (Unilateral, n = 15), or 15 mg of the same solution injected over 6 sec with needle bevel cranially directed (Control, n = 15). Only patients of the Unilateral group remained in the lateral position for 15 min. Noninvasive Arterial blood pressure, heart rate, stroke volume index and cardiac index were measured before spinal block (baseline) and then at 5, 15, 30 and 45 min; while sensory and motor blocks were evaluated at 15, 30 and 45 min on both sides.They concluded that **t**he use of 8 mg of 0.5% hyperbaric bupivacaine slowly injected through a directional needle provided a spinal block relatively restricted to the operative side with minimal effects on cardiovascular homeostasis.In a similar study,Akhtar MN et al did comparison of haemodynamic changes in patients undergoing unilateral and bilateral spinal anaesthesia. The results of different studies investigating the use of unilateral spinal anaesthesia are confusing and partly inconsistent. Some authors doubt whether it is possible to create a strictly unilateral block (i.e. motor, sensory and sympathetic) at all, while others claim that such a procedure is standard, especially for ambulatory anaesthesia. Enk D also studied unilateral spinal anaesthesia and their review considers those factors which are relevant, plausible and proven.The aim of the study by Esmaoĝlu A et al was to determine the ideal dosage of hyperbaric bupivacaine and the time required for the lateral decubitus position for a unilateral spinal block., The onset and regression of sensory and motor block were checked and compared between the dependent and non-dependent sides in each group.The rate of block progression of the non-dependent side was higher in the groups receiving 2.5 ml 0.5% hyperbaric bupivacaine solution than in the other groups; at the same time the level of block was higher and the duration of block was longer. The incidence of hypotension was 10–20% in these groups. In the 2 ml 0.5% hyperbaric bupivacaine solution groups, a satisfactory block level and duration of anaesthesia for surgery was obtained. The rate of block progression to non-dependent side in the groups receiving 1.5 ml of 0.5% hyperbaric bupivacaine solution was lower than the other groups, but the duration of block was shorter and the level of block was lower than the other groups.

They concluded that for unilateral spinal anaesthesia in lower extremity operations, 2ml 0.5% hyperbaric bupivacaine solution for operations above the knee and 1.5 ml 0.5% hyperbaric bupivacaine solution for operations below the knee and keeping the patients for 10 min in the lateral decubitus position were found to be appropriate.Karpel E et al did a study with a purpose to evaluate the effectiveness and safety of unilateral spinal anaesthesia and to compare this technique to the commonly used bilateral technique in a prospective, controlled, randomized study.Fifty-four ASA I-III adult patients, of both sexes, aged 18-75 years, and scheduled for elective unilateral surgery, were randomly allocated into two groups. The statistical analysis included haemodynamic parameters and side-effects. The t-test for independent trials, test for two structure indexes and chi2 test were used.All blocks were fully effective. Mean arterial blood pressure was significantly lower in the bilateral group. Heart and respiratory rates did not differ between the groups. The total number of side effects (hypotension, bradycardia, apnoea) requiring intervention was similar in both groups.It was concluded that the unilateral spinal anaesthesia is safe. The dose of bupivacaine is lower and haemodynamic stability is better. The technique is more time consuming, compared to standard spinal anaesthesia and the patient's cooperation is essential.Magar JS et al did comparison of efficacy and safety of unilateral spinal anaesthesia with sequential combined spinal epidural anaesthesia for lower limb orthopaedic surgery. A total of 60 patients randomly divided into two groups of 30 each, were studied. No patient in either group had failed block. Both groups were comparable with regard to age, height, gender ratio, ASA grade physical status and duration of surgery The main advantage of sequential CSEA that initial dose of spinal anaesthesia can be titrated as per patient's cardiovascular status but still required level of block for surgery can be achieved with titration of epidural top up. In unilateral SA haemodynamic stability can be improved by reducing dose of spinal drug but we should keep in mind that spinal drug dose decides the level and duration of spinal block needed.Unilateral SA is cost-effective as sequential CSEA requires extra cost of epidural set and extra drug. Possible limitation of study is that we did not do this study selectively in elderly high risk patients or selectively in major orthopaedic surgeries in elderly patients[4-6].

Conclusion

Unilateral spinal anaesthesia is safe. The dose of bupivacaine is lower and haemodynamic stability is better. The technique is more time consuming, compared to standard spinal anaesthesia and the patient's cooperation is essential.

What This Study Add to Existing Knowledge

Unilateral SA is given with aim to limit distribution of spinal block only to the operated side for operations involving only one lower limb. It is achieved by giving minimal required dose of intrathecal agent so that only nerve roots supplying specific area and only the modalities that require to be anaesthetized are affected. Hyperbaric bupivacaine slowly injected through a directional needle provided a spinal block relatively restricted to the operative side with minimal effects on cardiovascular homeostasis and low rate of cardiovascular complication due to its low degree of sympathetic block than bilateral spinal anaesthesia

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