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Research Article

A PROSPECTIVE RANDOMIZED INTERVENTIONAL STUDY TO DETERMINE THE INFLUENCE OF SPINAL FLEXION VERSUS EXTENSION IN THE LATERAL DECUBITUS POSITION ON THE UNILATERALITY OF SPINAL ANESTHESIA USING HYPERBARIC BUPIVACAINE FOR ELECTIVE UNILATERAL LOWER LIMB SURGERIES

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ABSTRACT

Objective: A restricted sympathetic block during spinal anesthesia may minimize hemodynamic changes and advantageous in view of maintaining stable cardiovascular profile through intraoperative period.

Methods: This prospective randomized interventional study was conducted **o**n a total of 150 patients of either sex aged 20-50 years of American Society of Anesthesiologists grades 1 and 2 were randomly allocated in two groups (75 in each group).Using a 25-gauge Quincke spinal needle, 7.5 mg of 0.5% hyperbaric bupivacaine was injected over a period of 80s at L3-L4 interspace in both groups. Patients were kept in flexion or extension according to belonging groups: Group A (flexion) or Group B (extension) after drug administration for15 min of lateral decubitus position, then patients were turned to supine position.

Results: Strict unilateral sensory and motor block at 15 min was noted in Group A 45 patients (60%) and 25 patients (33.33%) in Group B (p=0.002*). At 60 min, there was no significant sensory unilaterality between the groups (p=0.987). At 60 min, 30 patients (40%) in Group A and 14 patients (18.66%) in Group B had strict unilateral motor block (p=0.007*). Highest achieved sensory level on nondependent side was T10 in Group A and T8 in Group B, whereas it was T6 in Group A and T5 in Group B on dependent side.

Conclusion: For unilateral spinal anesthesia, spinal flexion position provided better strict unilaterality and restricted sympathetic blockade than spinal extension position.

Keywords: Lateral decubitus position, Cauda equina, Unilaterality.

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INTRODUCTION

Spinal anesthesia is most common choice for infraumbilical or lower limb surgeries nowadays in comparison with general anesthesia because of its simplicity, reliability, low cost effective, low time–consuming, and minimal intra- and post-operative complications.

The conventional bilateral spinal anesthesia has its own complications just like hypotension, bradycardia, respiratory depression, nausea, vomiting, postoperative urinary retention, postdural puncture headache, and transient or permanent neurological symptoms. Unilateral block is effective in restricting the extend of sympathetic block hence shows minimal hemodynamic changes as compared to bilateral block [1]. The term unilateral spinal anesthesiais defined as when there is block of only operative side with the absence of block of non-operative side [2]. The fewer hemodynamic changes make unilateral spinal anesthesia suitable for patients with cardiovascular risk factors, for example, aortic valve stenosis or coronary artery disease [3].

The unilaterality of spinal anesthesia depends on various factors such as type of spinal needle, direction of bevel end of needle, speed of injection, drug baricity, volume and concentration of drug, and position of patient during spinal anesthesia. Direction of the subarachnoid distribution of hyperbaric bupivacaine can be controlled by the posture of patient at the time administration of drug [4]. Takiguchi *et al.* [5] have shown that cauda equina sinks to the dependent lower limb side due to the gravity of cerebrospinal fluid (CSF) during lateral decubitus position with both the lower limb extended. It has also been observed that in flexed lateral decubitus position there is tightening or straightening of cauda equina thus tightened cauda equina moves to the nondependent side and remains in the central part of intrathecal sac [6]. Primary aim of our study was to compare the quality of sensory and motor blockade in dependent side in spine flexion versus extension position.

METHODS

After getting approval from the Institutional Ethics committee (IEC No MC/EC/2022/354) and informed and written consent from patients, this prospective, randomized, interventional study was conducted on total 150 adult patients of either sex 20–50 years, belonging to the American Society of Anesthesiologists (ASA) Grade 1 and 2 scheduled for elective unilateral lower limb surgeries not lasting more than 2 h. Patients with morbid obesity (body mass index [BMI] >30 Kg/m^2), with a history of hypertension, diabetes mellitus, respiratory, cardiac, hepatic, or renal disease (necessitating classification in ASA Class III or above), patients with contraindications for spinal anesthesia, history of convulsion, allergy to the drug used, bleeding disorder, severe neurological deficit, and pregnant patients were excluded from the study. Expecting 60% in flexion group and 36.6% in extension group strict unilateral sensory block within 15 min using 8 mg of 0.5% hyperbaric bupivacaine at a study power of 80% and alpha error=0.05 as per seed article; the sample size was defined 68 for each group, it was further enhanced to 75 patients for each group as final sample size expecting 10% attrition.

After pre-anesthetic checkup and obtained informed and written consent and fasting status checked, patients were taken to the operation theater. All monitors were connected to the patient and baseline vitals such as non-invasive blood pressure, pulse rate, respiratory rate, and oxygen saturation were recorded. Intravenous (IV) line was secured by 18 gauge IV cannula with strict aseptic precautions at the forearm level, and lactated Ringer's solution was started at the rate of 2 ml/kg/h. Randomized allocation of patients was done in 2 groups, in Group A and Group B, 75 patients in each group, total 150 patients by opaque sealed envelope technique.

Spinal anesthesia was performed in lateral decubitus position (with flexed hips and legs) with all aseptic precautions using 25G Quincke needle at L3-L4/L4-L5 interspinous space at midline approach. At the time of local anesthetic administration, spinal needle bevel end was kept facing downward. Free flow of CSF was verified before injection of 0.5% hyperbaric bupivacaine 1.5 ml volume, which was administered over 80 s @0.2 ml/10 s. Patients belonged to Group A were maintained with spine flexion position (with hips and knees flexed) for 15 min in the lateral decubitus position after administration drug then gently turned to supine position. Patients belonged to Group B were immediately be turned into spine extension position (with hips and knees extended) in the lateral decubitus position for 15 min after administration of drug and then gently turned to supine position.

Intra-operative vitals, sensory blockade and motor blockade assessed after every minute for initial 5 min, followed by every 5 min interval for next 15 min followed by every 10 interval for next 40 min followed by every 15 min interval till complete recovery. Sensory blockade was assessed with pin-prick sensation method and motor blockade using modified Bromage scale.

Onset time of sensory block, time to achieve highest level of sensory block, highest achieved dermatomal level of sensory block, highest achieved modified Bromage grade of motor block, time to achieve highest motor grade, time to regression (2 segment regression time) of sensory block, and total duration of sensory and motor block were assessed on both dependent and nondependent side. Strict unilateral sensory and motor block at 15th min and at 60th minute was also assessed.

Hypotension was defined as declined mean arterial pressure below 65 mm of hg or fall in mean arterial pressure by 30 percentage of base line value, treated by incremental doses of mephentermine 6 mg IV and IV fluid as required. Respiratory depression was defined as a respiratory rate <8 breaths/min and/or oxygen saturation <90% in room air. Nausea and vomiting were treated with injection ondansetron 4 mg IV and pruritis with antihistaminics.

Strict unilateral sensory block was defined as analgesia of only dependent side, whereas nondependent side with maintaining complete somatic sensibility to superficial pain to pin prick. Time of onset of sensory block - Time from administration of drug to till patient has a loss of sensation to pin prick at L1 dematomal level. Duration of sensory block - Time from administration of drug to patient gains sensation at S2 dermatomal level. Strict unilateral motor blockade- Motor block of dependent side with Grade 4 in the absence of motor block on nondependent side. Bradycardia was defined as fall in heart rate below 55 beats per minute and will be treated with incremental doses of atropine 0.3–0.6 mg IV. Sensory block was assessed by pin-prick sensation method (0 - Sharp pain, 1 - Touch sensation only, 2 - Not

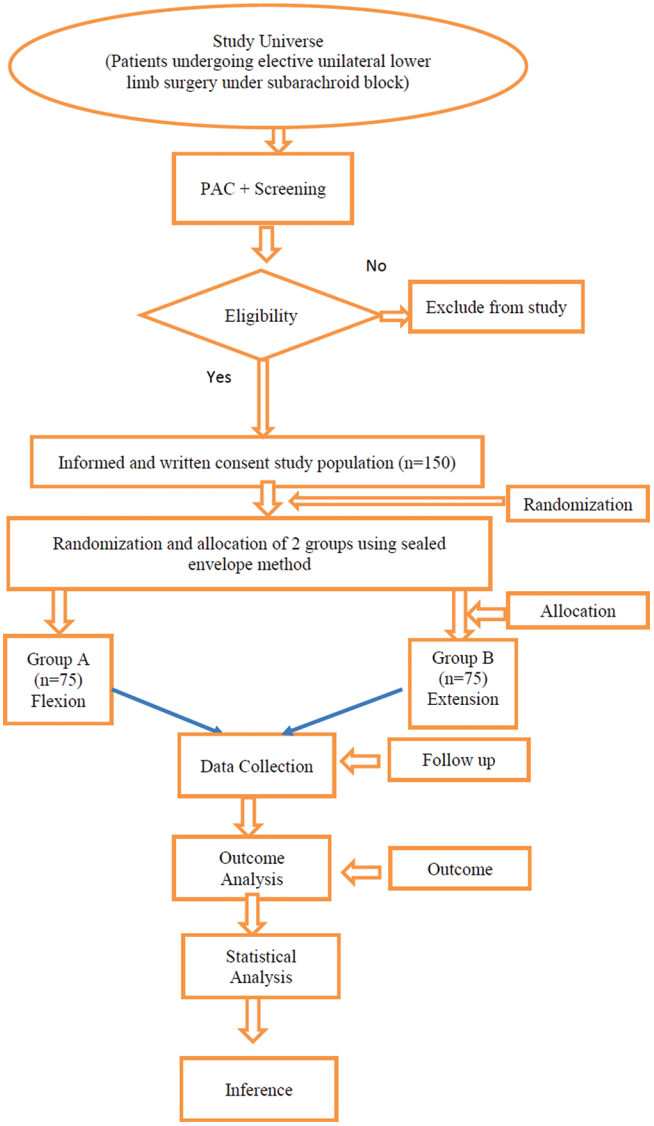

Fig. 1: Study procedure

Table 1: Demographic data of the patients in both the group

Demographic variable	Group A (n=75)	Group B (n=75)	p value
Age in years[a]	30.68±9.35	31.57±9.79	0.568
Sex[b]			
Male	78.66%	82.66%	0.679
Female	21.33%	17.34%	
Weight[a] in KGs	53.8±4.73	54.87±3.64	0.123
Height[a] in cms	159.61±4.89	160.28±4.56	0.389
BMI[a] in kg/m^2	21.17±1.26	21.48±1.14	0.121
ASA[b]			
Grade 1	74.66%	85.33%	0.153
Grade 2	25.33%	14.66%	
Duration of surgery[a] (in min)	54.19±4.83	55.14±3.79	0.186

[a]Student t-test used, [b]Chi-square test used.

even touch sensation) and motor block was assessed by modified Bromage score (Grade 0 - No paralysis, Grade 1 - Inability to raise the extended leg, Grade 2 - Inability to flex knee, Grade 3 - inability to do dorsiflexion of foot but can wiggle toes, and Grade 4 - Inability to move at all (complete paralysis).

Statistical analysis

It was performed with SPSS, version 21 for windows statistical software package (SPSS inc. Chicago, IL, USA). Qualitative data were expressed as percentage and analyzed by the Chi-Square test, whereas quantitative data were expressed as mean±SD, analyzed by Student t-test. Probability (p-value) ≤0.05 was considered statistically significant(s) and >0.05 as non-significant (NS).

RESULTS

A total of 150 patients were taken up for the study and randomly allocated into two groups (n=75) as shown in above consort chart (Fig. 1). There were statistically no significant differences between the groups in terms of the demographic profile including age, gender, weight, height, BMI, and physical status (Table 1). There were statistically significant differences (p≤0.05) in between study groups in terms of mean onset time of sensory and motor block for non-dependent side, highest achieved modified Bromage grade on nondependent side, strict unilateral sensory and motor block at 15 min, and strict unilateral motor block at 60 min. There was no significant difference in hemodynamic variables in both groups. Total four patients complained of nausea (1 in Group A and 3 in Group B). None of the patients of Group A experienced hypotension, bradycardia, and vomiting. However, in Group B, hypotension was occurred in only one patient and vomiting in two patients (Tables 1 and 2, Figures 2-4).

DISCUSSION

Since the spinal roots of the cauda equina will float in the CSF with a small amount of blood, it is well known that it is practically difficult to achieve a strict unilateral spinal anesthesia due to the distance between the right and left spinal roots, any medicine administered intrathecally will always block both sides. Takiguchi *et al.* [5] showed that the entire cauda equina dips to the dependent side in the lateral extended position due to gravity and moves to the middle of the subarachnoid space in the lateral flexed position due to the tightness of nerves. During lateral decubitous position with both the lower limbs extended, cauda equina sinks to the dependent side due to gravity in the CSF. It has also been observed that in flexed lateral position, the tightened cauda equina moved to the nondependent side and remain in the central part of the intrathecal sac [6]. Unilateral spinal anesthesia aims to limit the distribution of spinal block only to operative side and less umber of segments blockade in non-dependent side with minimal hemodynamic changes.

However, many of the studies have suggested that, using small volumes of hyperbaric drugs and keeping patients in lateral position for 15–20 min and injecting drug in subarachnoid space may be distributed preferentially to the dependent lower limb when administered slowly with pencil-point needles [7]. Al Malyan *et al*. [8] found that lateral posture during the induction of spinal anesthesia is pivotal for a higher success of unilateral block. Atef *et al*. [9] evaluated that 7.5 mg, 0.5% hyperbaric bupivacaine was the optimal dose for adequate unilateral spinal anesthesia. Kim *et al.* [10] and Kulkarni *et al.* [11] used Quinke needle to inject hyperbaric bupivacaine 8 mg in the lateral position, maintaining the patients in either a flexed or extended position for 15 min before transferring them to a supine position. We studied influence

Table 2: Characteristics of spinal anesthesia

Subarachnoid block characteristics	Group A(n=75)	Group B (n=75)	p value
Mean onset time of sensory block (in min) [a]			
Dependent side	2.73±0.84	3.63±0.71	0.304
Nondependent side	13.92±9.10	9.40±5.82	0.045*
Mean onset time of motor block (in min) [a]			
Dependent side	3.47±0.66	4.47±0.92	0.899
Nondependent side	16.51±6.69	12.64±6.70	0.002*
Mean time required for two segment regression of sensory block (in min) [a]			
Dependent side	44.20±5.32	45.03±5.05	0.330
Nondependent side	36.57±12.09	37.28±7.43	0.698
Mean of total duration of sensory block (in min) [a]			
Dependent side	134.20±16.44	135.20±17.45	0.718
Nondependent side	121.69±15.05	122.08±23.69	0.914
Mean of total duration of motor block (in min) [a]			
Dependent side	125.12±10.64	124.99±9.39	0.935
Nondependent side	79.26±11.29	80.07±10.38	0.651
Highest achieved level of sensory block[b]			
Dependent side	T6 (T12-T6)	T5 (T12-T5)	0.087
Nondependent side	T10 (L4-T10)	T8 (L4-T8)	0.115
Highest achieved modified Bromage grade[b]			
Dependent side	0/1/2/3/4:0/0/0/1/74	1/2/3/4:0/0/4/71	0.363
Nondependent side	0/1/2/3:33/31/10/1	0/1/2/3:14/61/0/0	<0.001*
Mean time required to achieve highest level of sensory block (in min) [a]			
Dependent side	7.04±4.19	8.55±2.07	0.149
Nondependent side	17.70±6.68	16.50±6.08	0.165
Mean time required to achieve highest Bromage grade[a]			
Dependent side	10.60±3.60	11.32±4.90	0.170
Nondependent side	17.25±6.07	16.65±7.58	0.185
Strict unilateral sensory block[b]			
At 15 min	45 (60%)	25 (33.33%)	0.002*
At 60 min	17 (22.67%)	14 (18.67%)	0.987
Strict unilateral motor block[b]			
At 15 min	45 (60%)	25 (33.33%)	0.002*
At 60 min	30 (40%)	14 (18.67%)	0.007*

[a]Student t-test used, [b]Chi-square test used

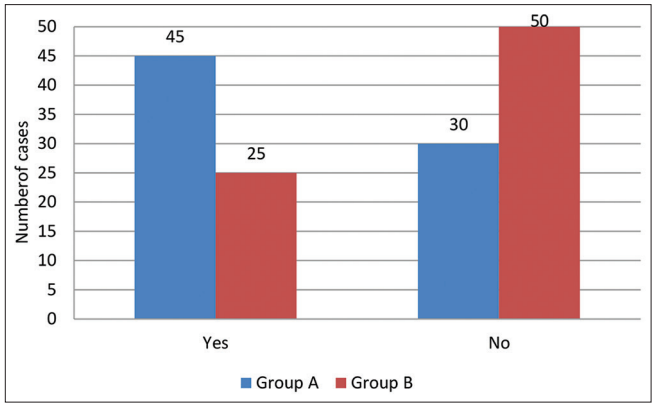

Fig. 2: Comparison of strict unilateral sensory and motor block at 15 min in both study groups

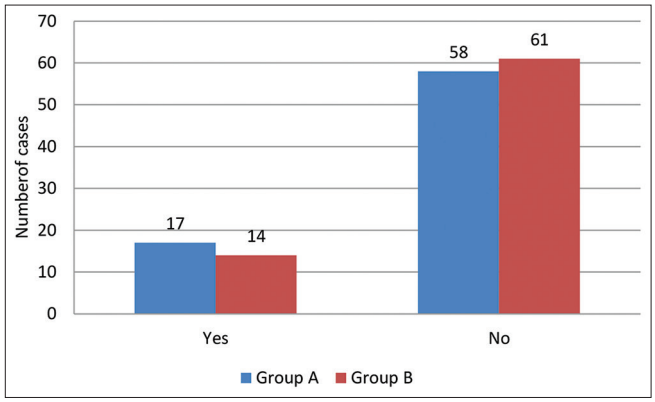

Fig. 3: Comparison of strict unilateral sensory block at 60 min in both study groups

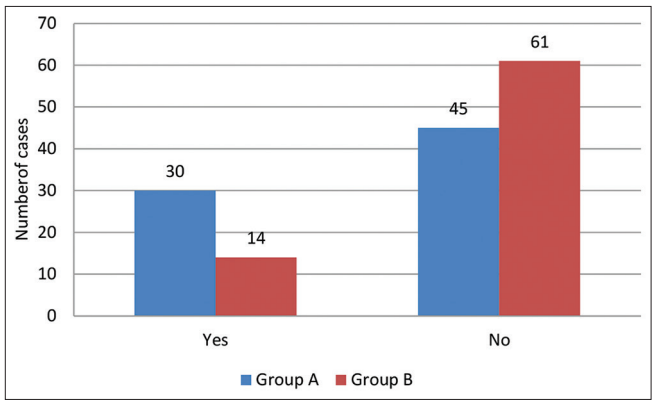

Fig. 4: Comparison of strict unilateral motor block at 60 min in both study groups

of spinal flexion versus extension in the lateral decubitus position on the unilaterality of spinal anesthesia using hyberbaric bupivacaine (0.5%, in dose of 7.5 mg) by Quincke needle over 80 s. Demographic data (age, gender, weight, height, BMI, physical status, and duration of surgery) between the study groups were comparable and the difference observed was statistically non-significant in both groups. Our results were coincided with Kim *et al.* [10] and Kulkarni *et al.* [11] in terms of delayed onset time of sensory block on nondependent side in flexion position than extension position; however, in our study, onset time of motor block was also statistically significant different in both groups on nondependent side while non-significant difference on dependent side. Our findings were similar to Kim *et al.* [10] and Kulkarni *et al.* [11] regarding to lower sensory levels and slighter motor grading (1/2) in nondependent side than dependent side in both groups (p>0.05) Our study findings concerning to the level of sensory block achieved in nondependent side were lower than dependent side, but sensory levels were similar in dependent side in both study groups; these findings were comparable to Kim *et al.* [10] study results. In our study observed that mean time to achieve highest motor and sensory block was lesser in dependent side than nondependent side in both study groups, but no difference in Group A and Group B. Kim *et al.* [10] also observed that time to achieve highest level of sensory block was lesser in dependent side than non-dependent side. Our study results were similar to Kulkarni *et al.* [11] concerned to strict unilaterality of sensory block at 15 min statistically significant difference but non-significant at 60 min, whereas strict motor unilaterality was found statistically significant difference at 15 and 60 min in both study groups. Kim *et al.* [10] also found that flexed position provided more unilaterality of sensory block at 15 min as compared to extended position but not maintained till 50 min; however, they did not find any difference in strict unilateral motor blockade at 15 and 50 min after spinal anesthesia in flexion and extension group. Meyer *et al.* [12] injected 8 mg of hyperbaric 0.5% bupivacaine through a 29-gauge Quincke needle with a pump controlled injection flow of 1 mL/min into patients kept in lateral position for 20 min, the incidence of sympathetic,motor and sensory unilateral block was 69%, 77%, and 28%, respectively. In our study, total four patients complained of nausea (1 in Group A and 3 in Group B). None of the patients of Group A experienced hypotension, bradycardia, and vomiting. However, in Group B, hypotension was occurred in only one patient and vomiting in two patients. There was statistically no significant difference in both study groups in terms of incidence of side effects. Our results were similar to Kim *et al.* [10] and Kulkarni *et al.* [11] found statistically non-significant difference in hemodynamic status and side effects in both groups. The only drawback of our study was delay in preoperative period.

CONCLUSION

For unilateral spinal anesthesia, spinal flexion position provided better strict unilaterality and restricted sympathetic blockade than spinal extension position.

COMPETING INTERESTS

None.

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Nil.

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