

Effect of spinal flexion and extension in the lateral decubitus position on the unilaterality of spinal anesthesia using hyperbaric bupivacaine

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Abstract

Background and Aims: Many unilateral lower limb orthopedic surgeries are conducted under unilateral spinal anesthesia with full flexion of spine and immediate extension after local anesthetic administration into the subarachnoid space. Studies have shown that extension of the spine in lateral decubitus position makes cauda equina to sink to the dependent side due to gravity. Continuous flexion of the spine causes sunken cauda equina to be suspended in the middle of the subarachnoid space increasing the possibility of unilateralization of the block. Hence, this study was carried out to assess the effect of flexion and extension in lateral decubitus position in unilateral spinal anesthesia.

Material and Methods: Sixty patients posted for elective unilateral lower limb below knee orthopedic surgeries were randomly allocated into two groups—group F (flexion of spine) and group E (extension of spine). Using a 25-gauge Quincke spinal needle, 8 mg of 0.5% hyperbaric bupivacaine was injected over a period of 80 s at L3–L4 interspace. Patients were kept in flexion or extension according to the group they belong to after drug administration. After 15 min of lateral position in either group, patients were turned to supine position. Sensory blockade was assessed by loss of pinprick sensation and motor blockade by modified Bromage scale.

Results: Strict unilateral sensory block at 15th min was in 18 patients in flexion group compared with 11 patients in extension group which is statistically significant ($p=0.03$). At 60th min, there was no significant sensory unilaterality between the groups ($p=0.06$). A strict unilateral motor blockade at 15th min was also in 18 patients in group F and 11 patients in group E which was also statistically significant ($p=0.04$). At 60th min, seven patients in group F and three patients in group E had strict unilateral motor blockade which was also statistically significant ($p=0.03$). The maximum sensory level on the nondependent side was T10 in group F and T8 in group E, whereas it was T6 in both the groups on the dependent side. There was no difference in the two-segment regression of the sensory block, duration of sensory and motor blockade, the maximum level of the block, and hemodynamic status between the groups.

Conclusion: Maintaining flexion of the spinal column for 15 min increases the likelihood of unilateral spinal block compared with extension of the spinal column during lateral decubitus positioning.

Keywords: Cauda equina, lateral decubitus position, unilateral spinal anesthesia

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Introduction

Spinal anesthesia is a choice for surgeries below umbilicus because of its simplicity, reliability, and popularity with little sophistication. However, it has its own complications such

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as hypotension, bradycardia, urinary retention, postdural puncture headache, and transient or permanent neurological symptoms.^[1] A few of these complications can be minimized by selectively distributing anesthesia to the operating side especially in unilateral lower limb surgeries. This technique is often called as selective or unilateral spinal anesthesia. Obtaining a unilateral spinal anesthesia in a patient undergoing unilateral lower limb orthopedic surgery would be clinically advantageous, since theoretically, with the same dosage of local anesthetic, one could provide a more profound and longer anesthetic with less sympathetic block.^[2] Hence, there can be many benefits of unilateral spinal anesthesia such as hemodynamic stability, early mobilization, and decreased incidence of urinary retention in the postoperative period which helps in ambulatory setting.^[3-5] Takiguchi *et al.* have shown that cauda equina sinks to the dependent side due to gravity in the cerebrospinal fluid (CSF) during lateral decubitus position with both the lower limbs extended.^[6] 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.^[7] Thus, we hypothesized that unilateral spinal blockade in lateral position can be more selective to the dependent side using hyperbaric local anesthetic if the patient is maintained in lateral flexed position rather than lateral position with lower limbs extended after administration of local anesthetic. The primary aim of our study was to compare the selectivity of sensory and motor blockade to the dependent lower limb in flexed and extended spine position.

Material and Methods

After obtaining hospital ethical committee approval, 60 patients between 20 and 50 years of age of both gender belonging to American Society of Anesthesiologists physical status I to II, scheduled for elective unilateral lower limb below knee orthopedic surgeries lasting not more than 2 h, were selected and written informed consent was obtained. Patients with body mass index of more than 30 kg/m², pregnant patients, patients with spinal deformities, patients with height less than 150 cm and more than 170 cm, and patients with absolute contraindications for spinal anesthesia were excluded from the study. Concealment of allocation was done using opaque sealed envelopes after randomization using computer generated random number list. Group F: Patients were kept in spinal flexion for 15 min before placing in supine posture after spinal anesthesia in lateral posture and Group E: patients were kept in spinal extension for 15 min before placing in supine posture after spinal anesthesia in lateral posture. With 6 h of nil per oral for solids and 2 h for clear fluids, patients were shifted to operation theater and were connected

to standard monitors of electrocardiogram, noninvasive blood pressure, and pulse oxymetry. All patients were started with intravenous Ringer's lactate solution at a rate of 2 mL/kg/h.

The patients were placed in lateral decubitus position with operating side (limb) dependent on the operating table, with both hip and knee joints flexed. The lumbar area was prepared aseptically and draped. The intervertebral space of L3–L4 was identified and spinal anesthesia performed with 25-gauge Quincke needle with midline approach and bevel facing downward. When intrathecal placement of the needle was confirmed with free flow of CSF, 1.6 mL (8 mg) of 0.5% hyperbaric bupivacaine was injected using 2-mL syringe over a period of 80 s (0.2 mL/10 s). The patients allocated to group F were maintained in lateral decubitus position with hips and knees flexed for 15 min, whereas those patients belonging to group E were made to extend their hips and knees immediately and maintained in lateral decubitus position for 15 min. At the end of 15 min, patients in both the groups were gently turned to supine position.

The sensory level was assessed using pinprick bilaterally, at every 1 min for 5 min followed by every 5 min after administration of the drug. Motor blockade was assessed bilaterally using modified Bromage scale (0 = no paralysis, 1 = inability to raise extended leg, 2 = inability to flex knee, 3 = inability to do dorsiflexion of foot but can wiggle toes, 4 = inability to move at all) at 15th minute in the lateral position after spinal anesthesia. Sensory and motor blockade were evaluated every 5 min for 20 min after placing the patient in supine posture and at 10-min interval for 60 min and then every 15 min till complete recovery. Hemodynamic variables such as blood pressure and heart rate (HR) were monitored before spinal anesthesia, just after spinal anesthesia, and every 5-min interval till the end of surgery. After the patients were turned into supine position, an anesthesiologist who was blinded to patient groups recorded the spread of sensory and motor block. A strict unilateral sensory block was defined as analgesia of only the dependent side, whereas the nondependent side maintained complete somatic sensibility to superficial pain to pinprick.^[8] A strict unilateral motor block was defined as a motor block of grade 4 on the dependent side in the absence of motor block on nondependent side.^[8] Time of onset, time to maximal level, and time to two-segment regression of sensory blockade, total duration of sensory, and motor blockade were recorded in both dependent and nondependent limbs. Time of onset of sensory block was defined as the time from completion of administration of the drug till patient has loss of sensation to pinprick at L1 dermatome. The duration of sensory block was defined from the completion of administration of drug till the patient regains sensation at S2 dermatomal level. Postdural puncture headache, low back pain, and other complications

were also noted for 2 postoperative days. Hypotension was defined as the decrease in systolic blood pressure (SBP) by more than 30% of baseline or if it was less than 90 mm Hg and was treated by inj. ephedrine 6 mg in incremental doses to a maximum of 30 mg. Bradycardia was defined as HR less than 60 beats/min and was treated with 0.5–1 mg of intravenous atropine.

The calculation of the required sample size was based on our pilot study and a previous study^[8] wherein the mean and standard deviation (SD) of time required for complete regression of pinprick sensation in nondependent side was considered. The SD of our pilot study was approximately 30 min and was similar to a previous study.^[1] Sixteen patients per group were required to detect a 30-min difference in time for complete regression of spinal blockade in nondependent legs with an expected effect size to SD ratio of 1.0, and a α error of 0.05 and a β error of 0.2. Keeping in view about the number of drop-outs, 30 patients in each group were selected for the study [Figure 1]. Statistical analysis was performed using SPSS version 19 (SPSS Inc.). Data were analyzed using χ^2 test, Fisher's exact test, Student's *t*-test, or Mann–Whitney *U*-test as appropriate. A *P* value <0.05 was considered significant.

Results

No difference between age (34 ± 11 vs 37 ± 9), weight (66 ± 6 vs 69 ± 6), and height (160 ± 4 vs 161 ± 5) was observed between groups F and E [Table 1]. The onset of

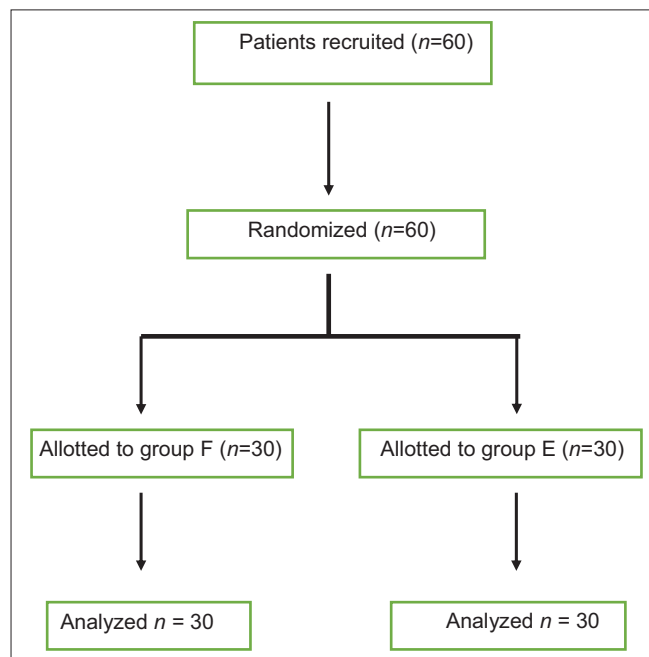


Figure 1: Consolidated standards of reporting trials (CONSORT) diagram

sensory block on nondependent side was longer in group F (14 ± 9) min when compared with group E (8 ± 6) min ($P = 0.04$). Sensory block levels on the nondependent side were lower than those on the dependent side in both the groups throughout the study. A strict unilaterality of sensory block was higher in group F (60%) than group E (36.6%) at 15th min ($P = 0.03$). The strict unilaterality was similarly low, 60 min after intrathecal injection, in group E (16.7%) than in group F (23.3%). The maximum sensory level on the nondependent side was T10 in group F and T8 in group E, whereas it was T6 in both the groups on the dependent side. Therefore, sensory levels on the dependent side were similar between groups over time, whereas lower on the nondependent side, more so with group F. All patients had complete motor block on the dependent side in both the groups. The nondependent side was not blocked in 18 patients (60%) in group F and 11 patients (36.6%) in group E in lateral decubitus position at 15th min ($P = 0.03$), whereas 7 patients (23.3%) in group F and 3 patients (10%) in group E had strict unilateral motor blockade over time ($P = 0.05$). Complete resolution of pinprick sensation in the nondependent side of group F and group E was 121 ± 58 and 124 ± 41 min, respectively ($P = 0.18$). Complete resolution of pinprick sensation in the dependent side of group F and group E was 155 ± 35 and 161 ± 26 min, respectively ($P = 0.17$) [Table 2]. No difference in mean arterial pressure and HR was found. Two patients in each group were found to have SBP <30% of baseline value and were treated with inj. ephedrine 6 mg. None of the patients required treatment for bradycardia. There was no postdural puncture headache, low back pain, and dysesthesia in legs for the first 2 postoperative days.

Discussion

It is a well-known fact that it is almost impossible theoretically to produce a strict unilateral spinal anesthesia as the spinal roots of cauda equina will be floating in CSF with a small distance between the right and the left spinal roots, and hence the drug introduced intrathecally will invariably block both the sides. 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

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

	Flexion	Extension
Age in years	34 ± 11	$37 \pm 9^*$
Sex - Male	25 (83.3%)	24 (80%)*
Female	5 (16.7%)	6 (20%)*
Weight in KGs	66 ± 6	$69 \pm 6^*$
Height in cms	160 ± 4	$160 \pm 5^*$

**P* value > 0.05

Table 2: Characteristics of spinal anesthesia

	Flexion	Extension	P
Strict unilateral sensory block			
At 15 th min	18 (60%)	11 (36.6%)	0.03
At 60 th min	7 (23.3%)	5 (16.7%)	0.06
Strict unilateral motor block			
At 15 th min	18 (60%)	11 (36.6%)	0.03
At 60 th min	7 (23.3%)	3 (10%)	0.04
2 Segmental regression time in minutes			
Dependent	49±13	53±10	0.18
Nondependent	39±22	48±18	0.06
Duration of motor block in minutes - dependent	150±30	145±23	0.18
Duration of motor block in minutes - nondependent	108±64	121±44	0.07
Complete regression of sensory level in minutes - Nondependent	121±58	124±41	0.18
Complete regression of sensory level in minutes - Dependent	155±35	161±26	0.17
Maximum pin prick sensory level - Dependent	T6	T6	
Nondependent	T10	T8	

slowly through pencil-point needles may result in preferential distribution of spinal anesthesia to dependent lower limb.^[9] Hence, when patients are administered spinal anesthesia using hyperbaric local anesthetics in the lateral posture and kept in the same position for at least a period of 15 min and then turned to supine posture, the number of segments blocked on the nondependent side may be less compared with the dependent side. Since there will also be a difference in the number of sympathetic segments blocked on the dependent and nondependent sides, the number in the nondependent side being less, hemodynamic changes after unilateral spinal anesthesia will also be minimal.^[8] This will be useful in many of the patients who have a compromised cardiovascular system who otherwise can develop refractory hypotension with higher segmental blockade with regular spinal anesthesia.

Various factors influence the selectivity of the local anesthetic (LA) agents to dependent segments of the spinal cord which include using hyperbaric LAs, slow injection of the drug, maintaining lateral decubitus position for a sufficient period of time for the LA to get fixed to the spinal nerves, using smaller volume of drug, and using pencil-point needles.^[9] In our study, we have used 1.6 mL of hyperbaric 0.5% bupivacaine for spinal anesthesia which was administered over 80 s and the patients were kept in lateral position for 15 min after injection to produce unilateral spinal anesthesia. Takiguchi *et al.* using magnetic resonance imaging have found out that the whole of cauda equina sinks to the dependent side in the lateral extended position due to gravity and the lateral flexed position repositioned the same to the middle of the subarachnoid space due to the tightening of nerves.^[6,7] With this finding, Kim *et al.* administered hyperbaric bupivacaine in the lateral position using Quincke's needle and keeping the patients in either flexed or extended position for 15 min

before turning them in to supine posture.^[8] They found out that flexed position produced more unilaterality of sensory block compared with extended position during the first 15 min and no difference after turning the patients to supine position. However, they did not find any difference in motor block as strict unilateral motor block 15 and 50 min after spinal injection were similar between flexion and extension groups. The explanation given was the relationship between the local anesthetic concentration in the CSF and the characteristics of motor nerve. The concentration of the upper layer of bupivacaine may be less dense so as to achieve nondependent side motor block. In our study, we did not find any such differences regarding motor block. Our study proved that flexed position increased the number of patients having selectivity for both sensory and motor blockade to dependent position during the first 15 min. This selectivity persisted even at 60th minute although the percentage of patients had reduced. Valanne *et al.* using 4 and 6 mg of hyperbaric bupivacaine found out that 4 mg produced more selectivity than 6 mg in patients posed for knee arthroscopy, although the authors found increased failure rate with 4 mg dose.^[3] Esmoğlu *et al.* found out that 1.5 mL (7.5 mg) of 0.5% hyperbaric bupivacaine is ideal for operations below knee, and keeping patients for 10 min in lateral decubitus position was appropriate to get a unilateral spinal anesthesia.^[10] In another study by Tekye and Alipour, with 1.5 mL of hyperbaric bupivacaine keeping patients for 20 min in lateral decubitus position produced a success rate of 94.45% of unilateral spinal anesthesia.^[11] When Meyer *et al.* 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 blockade was 69%, 77%, and 28%, respectively.^[12] The rate of injection

in our study was also slow, 1.2 mL/min, although we did not use any pump control for injection. Pencil-point needles may be more appropriate to get a selective spinal blockade as these needles produce nonturbulent flow and can also control a unidirectional flow of LA, and hence may minimize mixing of the drug in the CSF.^[4] Although we used a Quincke needle because of availability in our institution, a directional spinal needle such as a Whitacre needle would have produced more unilaterality compared with Quincke needle. Many of the previous studies have not given any consideration to flexion or extension of the spine in lateral posture for getting a more selective unilateral spinal anesthesia. Our study has found out that maintaining a patient in flexion position can also be one of the factors contributing to unilaterality of spinal anesthesia. Since the total dose used in our study was 8 mg of hyperbaric bupivacaine, using further smaller doses such as 6 mg and using pencil-point needles probably would have produced better selectivity for a much longer period.

The only drawback of the technique of unilateral spinal anesthesia is the delay in preoperative time, but the benefits of stable hemodynamic status will definitely outweigh this delay. In clinical practice, where the comfort of the patient and the operating room schedule must be taken into consideration, it would seem realistic to consider 15 min as the upper limit during which the patient can be left in lateral decubitus position after injection.^[13]

Conclusion

In conclusion, clinically significant unilateral spinal sensory block was difficult to achieve when spinal anesthesia with 8 mg of hyperbaric bupivacaine was administered through a Quincke spinal needle at a slow rate and also keeping patients in lateral position for 15 min. However, maintaining flexion of the spinal column for 15 min increases the likelihood of unilateral spinal block compared with extension of the spinal column during lateral decubitus positioning.

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Conflicts of interest

There are no conflicts of interest.

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