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The Effect of Spinal Column Flexion on Block Quality in Spinal Anesthesia Applied in the Lateral Decubitus Position for Inguinal Hernia Surgery

Mehmet Sahap,[1] Esra Ozayar,[2] Munire Babayigit,[3] Eyup Horasanli[1]

[1]Department of Anesthesiology and Reanimation, Ankara Yıldırım Beyazıt University, Ankara Bilkent City Hospital, Ankara, Türkiye
[2]Department of Anesthesiology and Reanimation, University of Health Sciences, Ankara Bilkent City Hospital, Ankara, Türkiye
[3]Department of Anesthesiology and Reanimation, University of Health Sciences, Ankara Atatürk Sanatorium Training and Research Hospital, Ankara, Türkiye

ABSTRACT

Objective: Unilateral spinal anesthesia is often preferred to reduce the hemodynamic side effects of spinal anesthesia. This study aims to examine the impact of spinal column flexion on unilateral block development and hemodynamics.

Materials and Methods: Sixty patients, aged 18–65 years, were randomly allocated into three groups. Each of the three groups was administered 12.5 mg of heavy bupivacaine through intrathecal injection. In Group 1, spinal anesthesia was administered with the patient positioned laterally, the operative side facing downward, and the legs flexed, maintaining this position for 10 min. In Group 2, spinal anesthesia was administered while the patient was positioned laterally, and they were maintained in this position with their feet aligned for 10 min. In Group 3, spinal anesthesia was administered while the patient was seated, after which the patient was promptly repositioned to the lateral position and maintained in that orientation for 10 min. Hemodynamic alterations and the levels of motor and sensory blockade were documented in the patients.

Results: Patients in Group 1 had less hypotension and bradycardia than the other groups. In terms of sensory and motor block, it was discovered that in Group 1, block developed earlier on the operative side than in the other groups, but later on the contralateral.

Conclusion: This study illustrates that spinal column flexion is a viable alternative method, offering advantages such as minimal hemodynamic impact and expedited block formation for unilateral anesthesia.

Keywords: Anesthesia unilateral, Hemodynamics, Lateral decubitus, Spinal anesthesia

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INTRODUCTION

Applications of spinal anesthesia in the lateral decubitus position, particularly in cases that are appropriately chosen, lessen the negative effects of spinal anesthesia.[1] The sympathetic block caused by spinal anesthesia reduces the preload of the heart, leading to a decrease in blood pressure.[2] When unilateral spinal anesthesia is performed, the sympathetic chain on the opposite side is less affected, allowing the resulting drop

Address for correspondence: Mehmet Sahap. Department of Anesthesiology and Reanimation, Ankara Yıldırım Beyazıt University, Ankara Bilkent City Hospital, Ankara, Türkiye

E-mail: drsahap@gmail.com **ORCID ID:** 0000-0003-3390-9336

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in blood pressure to be compensated. Many methods are used to create unilateral spinal anesthesia. In the literature, there are many studies that have attempted to create a unilateral block by testing methods such as the dose of injected local anesthetic, baricity, amount of local anesthetic, infusion rate, duration of lateral decubitus position, and the use of different types of spinal needles.[3-6] In the cerebrospinal fluid, the cauda equina can move around a lot. By pulling on nerves along the spine, spinal flexion (knee–chest position) in the supine position moves the cauda equina from a dorsal-dependent area to a ventral-nondependent area. In the lateral position, when the spinal column straightens, the cauda equina falls and moves to the dependent side. When the spinal column bends to the side, the tightened cauda equina moves to the side that is not dependent and rests in the middle of the intrathecal sac.[7-9] The gathering of the cauda equina at the midline in the flexion position may provide a potential advantage for creating a unilateral block with spinal anesthesia.

This study aimed to investigate the effects of flexing the spine in the lateral decubitus position and holding it in the knee-chest position on hemodynamics and unilateral block quality in patients who underwent spinal anesthesia. Patients suitable for unilateral spinal anesthesia who will undergo unilateral inguinal hernia surgery were selected for this study.

MATERIALS AND METHODS

This study was conducted within the Department of Anesthesiology and Reanimation at Kecioren Education and Research Hospital, with the approval of the ethics committee obtained through the Clinical Research Application Form registered under B.10.4.ISM.4.06.68.49. This study was conducted in accordance with the current principles of the Helsinki Declaration. A total of 60 patients, planned for elective unilateral inguinal hernia repair and classified as the American Society of Anesthesiologists (ASA) I-II risk group and aged 18–65, were included in the study after reading and signing the informed consent form. Patients who did not accept regional anesthesia, had an intracranial mass, lumbar deformity, respiratory or heart failure, peripheral neuropathy, and known local anesthetic allergy were not included in the study.

Patients were divided into three groups. Spinal anesthesia was performed in all three groups with intrathecal administration of 12.5 mg hyperbaric bupivacaine. In Group 1, the patients were positioned laterally with the operative side down and their legs flexed (fetal position). The local anesthetic was administered in the subarachnoid space at the L3-L4 level without barbotage within 60 s. The patients were kept in this position without changing for 10 min. In Group 2, the same position as in Group 1 was given, and a local anesthetic was administered within 60 s without performing a barbotage. After spinal anesthesia was applied in this group, the patients were kept in a lateral decubitus position with their legs straight for 10 min. In Group 3, the local anesthetic was administered within 60 s without performing a barbotage, entering the subarachnoid space at the L3-L4 interval while in a sitting position. Then, the patients were kept in a lateral decubitus position with the operation side down and legs straight for 10 min, as in Group 2. In all groups, after the 10th min, the patients were placed in the supine position and handed over to the surgical team. Bupivacaine (Heavy Marcain 0.5% 4 mL amp, AstraZeneca) was used as a local anesthetic.

The sensory and motor block levels of spinal anesthesia were assessed every 3 min during the first 10 min, every 5 min until the 30th min, and subsequently every 10 min until the 80th min. The hemodynamic indicators, including heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and peripheral oxygen saturation (SpO2), were recorded every 3 min during the first 10 min and then every 5 min during the first 30 min of the operation. The level of sensory block was evaluated using a blunt-tipped needle with the "pin prick" test, and the degree of motor block was assessed using the Modified Bromage Scale (MBS). The presence of analgesia at the T10 level was considered sufficient for sensory block, and the surgery was allowed to commence. The evaluation of the sensory and motor block was conducted during the operation with the knowledge of the surgical team.

The evaluations related to the sensory and motor block were conducted according to the definitions below.

The two-segment regression time of the sensory block: The duration from the moment the highest dermatome level is first reached to the moment two dermatomes have regressed.

- Motor block onset time: The duration until a score of 1 according to the MBS is achieved after spinal anesthesia is administered.
- Sensory block onset time: The duration from the administration of spinal anesthesia until there is no pain in the lowest dermatome area.
- Sensory block termination time: The duration from the onset of the sensory block to the point where the sensory block is determined to have resolved in all dermatomes through the pin prick test.
- Motor block resolution time: The duration from the onset of the motor block until the Modified Bromage score returns to 0.
- Maximum dermatom level reached for sensory block: The maximum dermatom level reached after spinal anesthesia was measured using the "pin prick test."

When the SAB dropped more than 30% according to the control values or the OAB fell below 60 mmHg, hypotension was accepted, and rapid fluid replacement was performed. If no response was obtained within 3 min, treatment was administered with a 5 mg IV bolus of ephedrine (Efedrin HCl amp, 0.05g, 1mL, OSEL, Istanbul). The decrease in HR below 50 beats/min was evaluated as bradycardia and treated with atropine (Atropine sulfate 0.5 mg, 1 mL amp, OSEL, Istanbul) 0.5 mg IV bolus. The administered medications were recorded on the form.

Patients were monitored for side effects such as hypotension, bradycardia, nausea, vomiting, pain, shivering, restlessness, and respiratory depression throughout the operation. When the surgical procedure was completed, the patients were taken to the recovery room, and their sensory and motor block levels were recorded. Patients whose follow-up parameters in the recovery room were normal were sent to the general surgery ward. In the ward, sensory and motor block levels, the time of the first urination, the time of the first mobilization, and the time of the first analgesic administration were recorded. Patients were advised to consume 3 L of fluid for 3 days from the moment oral intake was permitted after the operation. After discharge, they were advised to contact the researchers in case of complications such as headaches, back pain, loss of strength, numbness in the legs, or inability to control urination and defecation.

Statistical Analysis

PASS 11 power analysis based on past studies of block formation times showed that a minimum sample size of 54 was needed to get about 82% power. Sixty cases were included to account for possible losses. SPSS 22.0 (SPSS Inc., Chicago, IL, USA) was used to examine the data. Mean ± standard deviation, median (min–max), frequency, and percentage were used to show descriptive data. The Pearson Chi-square test was used to look at categorical factors. Visually and mathematically (Kolmogorov–Smirnov/Shapiro–Wilk tests), it was checked for normalcy. One-way ANOVA was used for variables with a normally distributed, whereas the Wilcoxon Signed-Rank test (two dependent groups) and the Kruskal–Wallis test (three independent groups) were used for variables with a non-normal distribution. The Mann–Whitney U-test with Bonferroni correction was used for pairwise comparisons after the fact. A $p<0.05$ was thought to be statistically significant.

RESULTS

A total of 60 patients were included in the study, and all were accepted for analysis. No statistically significant differences were found between the study groups in terms of age, gender, height, BMI, and ASA classification ($p>0.05$) (Table 1). "In Group 1, SBP values did not differ significantly from baseline at any measurement time ($p>0.05$). In contrast, in Group 2 and Group 3, SBP values were significantly lower than baseline starting from the 3rd min and thereafter ($p<0.05$).

Table 1. Distribution of descriptive characteristics among study groups

	Group 1 (n=20)	Group 2 (n=20)	Group 3 (n=20)	p
Age (year)	40.65±13.89	46.50±12.74	46.40±14.93	0.320*
Height (cm)	170.55±6.86	175.15±6.42	172.50±5.18	0.070*
Weight (kg)	73.70±11.70	75.20±7.68	74.05±8.27	0.870*
BMI (kg/m^2)	25.22±2.86	24.49±1.94	23.1±0.52	0.631*
Gender				
Male	16 (80.0)	17 (85.0)	17 (85.0)	0.887
Female	4 (20.0)	3 (15.0)	3 (15.0)	
American Society of Anesthesiologists				
I	12 (60.0)	7 (35.0)	6 (30.0)	0.119
II	8 (40.0)	13 (65.0)	14 (70.0)	

Continuous variables are presented as "mean±standard deviation," and gender is presented as "number (column percentage). One-Way Analysis of variance. BMI: Body Mass Index.

Regarding DBP, patients in Group 2 showed significantly lower values compared to baseline from the 6th min onward ($p<0.05$). In Group 3, DBP values were significantly lower at the 6th, 15th, 20th, 25th, and 30th min, while no significant differences were observed at the 3rd and 10th min ($p>0.05$). In Group 1, DBP values remained comparable to baseline throughout the study ($p>0.05$) (Table 2)." In Group 1, statistically significant differences in sensory block levels on the operative side were observed at the 3rd, 5th, 10th, and 80th min ($p<0.05$). No significant differences were detected at the other time points ($p>0.05$). Post-hoc pairwise comparisons revealed that the significant differences at the 3rd, 5th, and 10th min were attributable to Group 3, whereas the significant difference at the 80th min was attributable to Group 2. In the patients in Group 3, the sensory block levels on the operative side at 3, 5, and 10 min were significantly lower than those in Group 1 and Group 2, while the sensory block level on the operative side of the patients in Group 3 at 80 min was significantly higher than those in Group 1 and Group 2. When evaluating the sensory block levels between the operative side and the other side within each group of patients, in Group 1, a statistically significant difference was found at all times ($p<0.05$). Group 1 had a significantly higher sensory block level on the operative side compared to the other side at all times (Fig. 1). Among the study groups included in

Table 2. Distribution of heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, and peripheral oxygen pressure at various times during the operation period among the study groups

Time	Group 1 (n=20) $\bar{X}$±S	Group 2 (n=20) $\bar{X}$±S	Group 3 (n=20) $\bar{X}$±S	p*
Heart rate (beats/min)				
Initial	85.20±13.48	84.20±12.52	88.85±10.13	0.251
3rd min	85.55±14.16	81.25±11.01	86.55±10.10	0.269
6th min	84.25±9.55	81.15±9.45	84.75±7.29	0.540
10th min	82.85±9.73	79.55±11.88#	82.25±9.55#	0.812
15th min	83.00±11.97	72.95±10.46#	78.40±10.71#	0.034[a]
20th min	79.85±10.11	72.75±10.88#	75.20±8.72#	0.147
25th min	78.20±6.94#	73.75±10.34#	75.60±8.49#	0.484
30th min	77.55±6.12#	72.95±12.73#	76.00±9.62#	0.400
p-value**	0.052	<0.001	<0.001	
SBP (mmHg)				
Initial	125.05±15.90	131.65±12.68	132.70±16.66	0.117
3rd min	120.70±14.47	126.50±15.70#	126.25±15.54#	0.508
6th min	118.80±15.99	122.40±10.98#	122.15±16.07#	0.812
10th min	120.20±18.25	121.50±10.53#	123.50±12.02#	0.806
15th min	121.65±11.52	120.25±10.28#	120.65±10.51#	0.971
20th min	119.55±15.16	119.50±11.04#	119.50±9.47#	0.766
25th min	118.90±11.90	120.00±9.45#	120.80±8.62#	0.805
30th min	118.70±10.33	119.40±12.97#	118.05±12.65#	0.983
p-value**	0.351	<0.001	<0.001	
DBP (mmHg)				
Initial	75.70±11.72	76.70±10.46	81.15±13.89	0.205
3rd min	74.25±12.45	75.95±11.68	77.85±13.11	0.317
6th min	71.35±11.57	73.15±11.85#	74.05±14.35#	0.710
10th min	70.60±13.01	72.35±9.11#	77.60±11.29	0.129
15th min	72.85±7.61	68.40±8.33#	74.70±9.36#	0.099
20th min	70.95±9.17	70.30±8.96#	75.00±9.23#	0.191
25th min	71.55±10.73	72.00±10.02#	74.85±10.82#	0.589
30th min	71.60±9.40	68.90±8.30#	73.05±9.47#	0.280
p-value**	0.154	<0.001	0.002	
MAP (mmHg)				
Initial	91.60±12.35	91.60±9.89	98.15±13.75	0.172
3rd min	89.75±11.81	94.90±13.17	95.15±12.88	0.224
6th min	89.20±11.87	91.00±11.76	90.20±13.69#	0.971
10th min	88.25±12.77	89.25±11.91	91.60±10.09#	0.578
15th min	89.20±8.99	86.85±9.09#	87.55±9.74#	0.464
20th min	85.75±11.99	86.75±9.26#	87.00±9.35#	0.923
25th min	86.25±11.23	86.90±8.80#	88.10±10.79#	0.864
30th min	84.50±11.51	85.70±10.57#	86.35±11.67#	0.764
p-value**	0.018	0.001	<0.001	

*Kruskal–Wallis Test, **Friedman Test. Significant difference between "Group 1" and "Group 2" # compared to baseline value p<0.05. $\bar{X}$: Mean, S: Standard Deviation, HR: Heart Rate, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, MAP: Mean Arterial Pressure.

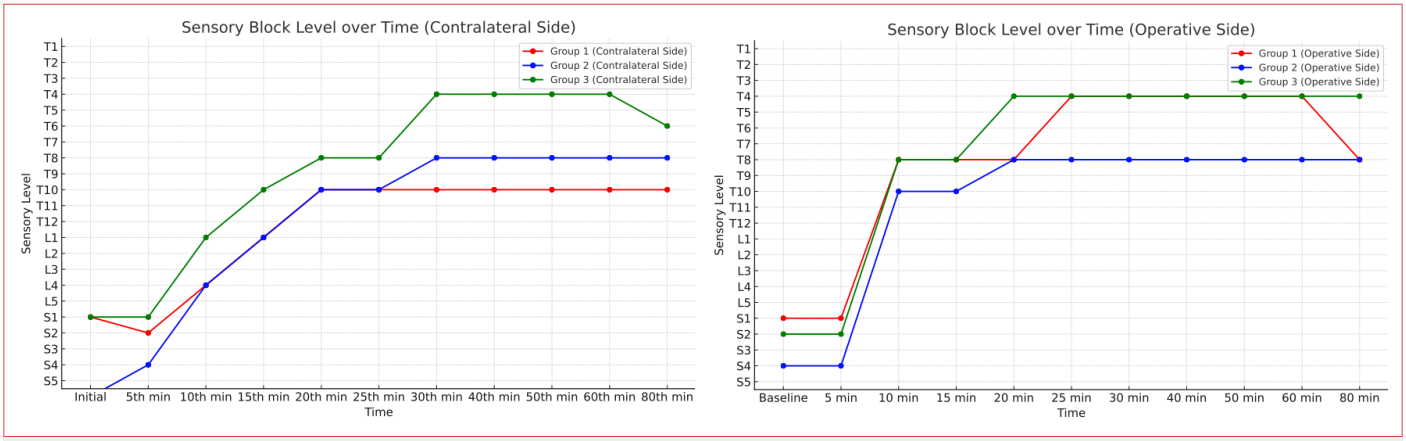

Figure 1. Dermatomal distribution of sensory block levels.

the research, a statistically significant difference was found only in the first 10 min between the operative side and the other side in the intra-group comparisons ($p<0.05$). When comparing the other sides between the groups in the first 10-min segment, lower MBS values were found in Group 1 compared to Groups 2 and 3, and in Group 2 compared to Group 3 (Fig. 2). In Group 1, the sensory and motor blocks of the other side of the patients started significantly later compared to Groups 2 and 3, while the two-segment regressions occurred significantly earlier. The sensory regression times of the other sides of the patients in Group 2 were significantly longer compared to Group 1 and Group 3. It was observed that the significant differences in the sensory block initiation times and two-segment regression times of the patients' operative sides originated from Group 1, whereas the significant difference in sensory regression times originated from Group 2. The operation sides of the patients in Group 1 had significantly earlier sensory block and two-segment regression times compared to Group 2 and Group 3 (Table 3).

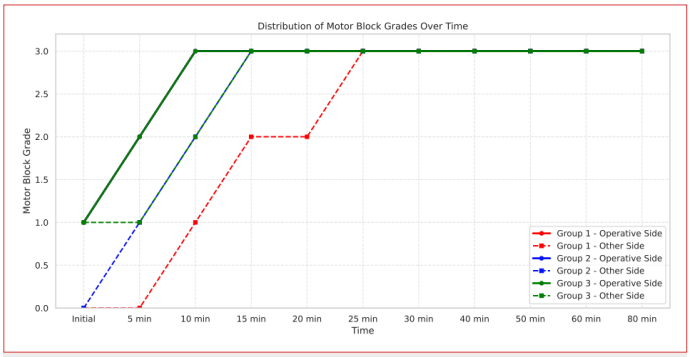

Figure 2. Distribution of engine block grades.

DISCUSSION

This study investigated the effect of spinal column flexion on the quality of unilateral block and hemodynamic safety in patients undergoing inguinal hernia surgery in the lateral decubitus position. The results indicate that spinal anesthesia administered in the flexion position (Group 1) produced a faster and stronger sensory block on the operative side compared to other positions. The contralateral side developed a block later, which enhanced block lateralization. Moreover, Group 1 had lower incidences of hypotension and bradycardia. These results show that the bending position might be able to change how the intrathecal local anesthetics are distributed. Takiguchi et al.[8,9] demonstrated in anatomical studies that flexion of the lower extremities in the lateral decubitus position results in medial displacement of the cauda equina, which may facilitate more targeted intrathecal drug distribution during spinal anesthesia. In this situation, bending the spinal column can be seen as a good way to make isolated blocks.

Spinal anesthesia can induce a sympathetic block, leading to hypotension and bradycardia. By selectively blocking the sympathetic chain on one side, unilateral spinal anesthesia reduces cardiovascular side effects and provides effective surgical anesthesia with a lower dose of local anesthetic. When compared to bilateral spinal anesthesia, the unilateral sympathetic block has a lower chance of low blood pressure because the unblocked side can make up for it. Hence, the risks of low blood pressure, slow HR, sickness, and vomiting that come with high spinal anesthesia can be lowered. Unilateral spinal anesthesia tries to make the anesthesia better and lower the risk of side effects by only blocking movement and sensory nerves in the area that needs it and using less of the anesthetic.[10,11]

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Table 3. Distribution of sensory and motor block onset time, sensory and motor regression time, and two segment recession time for the operative side and the other side within each group and between study groups

	Group 1 (n=20) $\bar{X}$±S (min-max)	Group 2 (n=20) $\bar{X}$±S (min-max)	Group 3 (n=20) $\bar{X}$±S (min-max)	p*
SB Onset time (min)				
Operative Side	1.35±0.49 (1–2)	1.95±0.69 (1–3)	2.20±0.77 (1–3)	0.001[a]
Other Side	7.55±1.64 (5–10)	5.50±1.93 (2–10)	4.65±1.87 (2–8)	<0.001[a]
p-value**	<0.001	<0.001	<0.001	
MB Onset time (min)				
Operative Side	2.25±0.97 (1–5)	2.10±0.64 (1–3)	2.90±1.68 (1-7)	0.247
Other Side	10.50±1.85 (8–15)	7.30±1.87 (5–10)	5.45±2.58 (2–10)	<0.001[a]
p-value**	<0.001	<0.001	<0.001	
Motor regression time (min)				
Operative Side	147.50±28.99 (110–200)	159.00±20.24 (120–180)	163.50±17.55 (130–190)	0.079
Other Side	127.00±30.80 (80–180)	140.50±20.38 (100–180)	148.00±18.24 (120–180)	0.039[b]
p-value**	<0.001	<0.001	<0.001	
Sensory regression time (min)				
Operative Side	191.75±18.52 (150–230)	207.25±17.58 (180–240)	189.50±18.77 (150–210)	0.011[c]
Other Side	169.25±18.94 (140–210)	189.25±18.94 (150–220)	171.00±23.15 (120–200)	0.005[c]
p-value**	<0.001	<0.001	<0.001	
Two-segment regression time (min)				
Operative Side	72.45±6.72 (60–86)	91.10±17.13 (60–150)	84.65±10.34 (60–110)	<0.001[a]
Other Side	67.60±7.50 (50–80)	90.95±15.29 (60–140)	84.65±10.34 (60-110)	<0.001[a]
p-value**	0.001	0.500	1.000	

*Kruskal Wallis Test, **Wilcoxon Signed- Rank Test, a The source of the significent "Group 1," bThe source of the significent between "Group 1" and "Group 3," cThe source of the significent "Group 2." **X**: Mean, S: Standart Deviation, SB: Sensory Block, MB: Motor Block.

According to the research by Esmaoğlu et al.,[12] for unilateral spinal anesthesia, at least 2 mL (10 mg) of hyperbaric bupivacaine should be used for operations above the knee, and 1.5 mL (7.5 mg) should be used for operations below the knee. We decided to use 2.5 mL (12.5 mg) of hyperbaric bupivacaine for spinal anesthesia because our study is in the inguinal area and includes abdominal adjacency. As part of a study, Al Malyan et al.[10] put one group of people under spinal anesthesia while they were lying on their side (lateral decubitus) and another group while they were sitting. Both groups were going to have surgery on their lower abdomens. After the treatment, the patients who had spinal anesthesia were put into the lateral decubitus position while they were still sitting. Both groups stayed in this position for 20 min. In their later follow-ups, they did not find any difference between the groups in terms of the levels of sensory block on the surgical side. However, they did notice that people in the lateral decubitus position got a surgical block much faster than people in the sitting position. These findings highlight the critical role of patient positioning in spinal anesthesia.[11] In our study, the patients were split into three groups. Two groups were put in the lateral decubitus position, which is also known as the fetal position. The third group was put in the lateral decubitus position with the operative side down right after spinal anesthesia was given while they were sitting, and they stayed in this position for 10 min. In Group 1 of these 3, the fetal position that was used during spinal anesthesia was kept up for 10 min without being moved. To make sure the patients in Group 2 and Group 3 had a straight spinal column, they were kept in a lateral decubitus position for 10 min, lying on their side or flat on their back. We then wanted to see what happened to unilateralism when the spinal column bent.

A lot of research was done on the waiting time in unilateral spinal anesthesia. We chose 10 min because we thought that waiting in the lateral decubitus (LD) position for longer would not have a big effect on the unilateral block, taking into account the conditions in the operating room and the flow of the case.

İn our study, there was no significant difference among the groups in the incidence of hypotension or bradycardia. In all

three groups, when patients returned to the supine position after a while, their HR was lower than baseline due to the bilateral spread of the block. For Group 1, these drops in pulse rate were seen after 25 min. For Group 2 and Group 3, they were seen after 10 min. This finding suggests that the decrease in heart rate occurred later in Group 1 compared to Groups 2 and 3. This is because bilateral sympathetic blocking started later in Group 1.

When we looked at other hemodynamic measures in our study, SBP, DBP, and MAP in Group 1 did not change significantly from the starting point. However, in Groups 2 and 3, SBP began to drop sharply after the 3rd min, DBP after the 6th min, and MAP after the 15th min in Group 2 and the 6th min in Group 3. Due to this, hemodynamic changes were not as noticeable in Group 1 where spinal column bending was used. Flexing the spinal column has a good effect on the formation of unilateral blocks, as shown in this case.

To our knowledge, there are not many studies that look at how bending the spinal column affects a single block after spinal anesthesia. Kim et al.[13] did a study where 32 people who were going to have knee arthroscopy were split into two groups. One group (Group F) got spinal anesthesia while lying in a lateral decubitus position and was then kept in this position for 15 min. The other group (Group N) got spinal anesthesia while lying in the same lateral decubitus position and was then kept in this position with their knees stretched out for 15 min. There was not a lot of information in this study about the changes in blood flow between the groups.

When we looked at the patients' sense blocks, we found that in all three groups, the level of blockage on the side that had surgery was higher than the level on the other side. It was seen that in Group 1, the amount of sensory block increased more quickly on the side that had surgery than on the other sides. On the other sides, it increased more slowly. This means that unilateralism worked better in group 1. However, after the 10th min, when the patients were put on their backs, unilateralism got weaker over time, and a block was seen on both sides. Our study, like the one by Kim et al.,[13] found that the group that had spinal column bending had better unilateralism. However, after 15 min, sensory and motor block started to happen on the other side. In Group F, there was no block on the other side for 15 min. In our study, however, after 5 min, a block started to form on the other side.[13] It seems that the reason for this is that the local anesthetics were used at a lower dose and at a slower rate, and the patient waited longer in the LD position, which led to a better unilateral block than ours. In our study, we found that giving local anesthesia for 60 s was the right amount of time. In a study by Enk et al.,[14] it was stressed that a slower application of local anesthetic would give a better unilateral block than a fast infusion.

The type of spinal needle used is another thing that can change how an isolated block forms. One-way needles, especially the Whitacre type needle, have been shown to work better for blocking one side of the body.[15] However, we used the Quincke type spinal needle because our hospital had them.

CONCLUSION

It is known that many factors affect the creation of a unilateral block in the lateral decubitus position. Factors such as the injected dose, baricity, amount of local anesthetic, infusion rate, duration of the lateral decubitus position, and type of spinal needle are known examples of this situation. We believe that spinal column flexion is a good alternative method for creating unilateral blocks, as demonstrated in our study. We believe that due to the limited number of studies conducted on this topic, there is a need for research involving larger series.

DECLARATIONS

Ethics Committee Approval: The study was approved by Kecioren Education and Research Hospital Ethics Committee (No: B.10.4.ISM.4.06.68.49, Date: 22/04/2015).

Informed Consent: Informed consent was obtained from all participants.

Conflict of Interest: The authors declare that there is no conflict of interest.

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