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The Influence of Lateral Decubitus Position in Patients Receiving Unilateral Spinal Anesthesia on the Sensory Block, Motoric Block and Hemodynamic Stability in Lower Limb Surgery

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Abstract: Unilateral spinal anesthesia is used to limit sympathetic, sensory and motor blocks and minimize hemodynamic changes. This study aimed to assess the effect of unilateral spinal anesthesia on patients with lower limb surgery when they were kept in the lateral decubitus position for 10, 15 and 20 min. We observed the effect of hyperbaric bupivacaine (0.5% of 10 mg) on sensory block, motor block and hemodynamic stability. This single-blind, randomized clinical trial was conducted on 51 subjects divided into 3 groups (each consisted of 17 subjects). Each group received spinal anesthesia (with the surgery side down) using hyperbaric bupivacaine (0.5% of 10 mg). Bevel was directed toward the surgery side and the injection was given slowly over 60 seconds without barbotage. After administration of spinal anesthesia, the lateral decubitus position was maintained for 10 min in group A, 15 min in group B and 20 min in group C. After that, patients returned to the supine position and block onset, duration and height and the patients' hemodynamics were assessed. The findings of this research revealed that there was no significant difference in the onset of sensory and motor blocks, nor on the height of the sensory and motor blocks on the surgery side ($p<0.05$). The height of the sensory block on the independent side was Th12 (group A), L3 (group B) and S1 (group C). The duration of the sensory block on the independent side was 71.47±10.4 min (group A), 63.53±4.9 minutes (group B) and 50.59±13.4 min (group C). This showed significant difference ($p<0.05$). The duration of the motor block on the independent side was 109.41±18.2 min (group A), 84.71±33.9 min (group B) and 7.06±19.9 min (group C). This also showed a significant difference ($p<0.05$). Unilateral motor block was 88.2% in group C and 11.8% in group B; however, it was not achieved in group A. The three groups showed hemodynamic stability in mean arterial pressure and heart rate. Lateral decubitus position lasting 10, 15 and 20 min after unilateral spinal anesthesia had different influences on sensory and motor blocks on the independent side.

Key words: Unilateral spinal anesthesia, hyperbaric bupivacaine, lower limb surgery

INTRODUCTION

Spinal anesthesia is commonly used for lower abdominal, perineum and lower extremity surgical procedures. The most common effect of spinal anesthesia is systemic hypotension, which occurs in 16-33% of the patients. Some risk factors causing hypotension include a block height above thoracic 5 (T5), increased age, basal blood pressure less than 120 mmHg, a combination of general anesthesia and neuraxial anesthesia and intrathecal injection above the gap between lumbar 3-4. Limiting the spread of a spinal block has many clinical advantages; first and foremost is that limiting the spread greatly reduces the hemodynamic effects of spinal anesthesia (Scavone *et al*., 2007).

Attempts to restrict spinal block anesthesia in surgery are influenced by several factors, including the density of the local anesthetic, the patient's position during the induction of spinal anesthesia, the shape of the spinal needle, the speed of intrathecal injection and the dose of local anesthetic (Borghi and Bacchilega, 2014).

Several studies have compared the position of the patient after intrathecal injection by comparing unilateral and bilateral blocks. Kirdemir *et al*. (2006), using hyperbaric bupivacaine (0.5% of 10 mg) injected for 40 sec, concluded that unilateral spinal anesthesia is recommended for lower limb orthopedic procedures because of the longer analgesic effect without hemodynamic changes.

Ijaz *et al*. (2013), using hyperbaric bupivacaine (0.75% of 15 mg) in adult patients undergoing inguinal hernia repair surgery, concluded that the frequency of hypotension was significantly more reduced in unilateral than in bilateral spinal anesthesia.

Another study also compared different doses of local anesthesia with unilateral spinal anesthesia. Atef *et al*. (2010) compared doses of hyperbaric bupivacaine (0.5% of 5, 7.5, 10 and 12.5 mg) for unilateral spinal

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anesthesia during diagnostic knee arthroscopy. The study concluded that the unilateral sensory and motor blocks can be achieved with a dose of 5 and 7.5 mg while maintaining stable hemodynamic status. However, hyperbaric bupivacaine (0.5% of 7.5 mg) is needed for adequate unilateral spinal anesthesia.

Kim *et al.* (2013) in his study compared affect of sensory block in patients kept in the lateral decubitus position for 15 min after intrathecal injection with spinal flexion (knee to chest position) and those with correct hip and spine position. The study concluded that strict unilateral sensory block was not achieved even after patients maintained lateral decubitus position with spinal flexion and received hyperbaric bupivacaine (0.5% of 8 mg) manually at a slow rate through spinal needle injection. However, maintaining spinal flexion while the patient is in the lateral decubitus position could change the early onset of sensory block related to laterality.

Martin-Salvaj *et al.* (1994) compared the durations of sensory blocks in patients maintaining the lateral decubitus position and using hyperbaric tetracaine, dividing subjects into four groups of duration: 0, 6, 12 and 18 min. The study shows the correlation between the duration of the lateral decubitus position and the duration of the sensory block on the operated side.

Based on this background, this study aimed to compare the effectiveness of the unilateral block depending on the duration of the lateral decubitus position for 10, 15 and 20 min after spinal anesthesia using hyperbaric bupivacaine agent (0.5% of 10 mg) on patients with lower limb surgery.

MATERIALS AND METHODS

Site and research design: This study was conducted for three months, from January 2015 to March 2015, in the Educational General Hospital of Dr. Wahidin Sudirohusodo Makassar and its network. This study was a single-blind, randomized clinical trial.

Population and sample: The populations included in this study were patients undergoing lower limb surgery with spinal anesthesia in the Educational General Hospital of Dr. Wahidin Sudirohusodo Makassar and its network in Makassar during the study period. The subjects were 51 people who met the inclusion criteria: they were patients planning to have lower limb surgery with spinal anesthesia, ASA PS class 1-2, age 18-64 years, height above 150 cm and a body mass index of 18-25 kg/m^2 who agreed to participate in the study and signed a research agreement. Subjects were randomly divided into three groups: group A, which maintained the lateral decubitus position for 10 min after spinal anesthesia; group B, which maintained the lateral decubitus position for 15 min after spinal anesthesia and group C, which maintained the lateral decubitus position for 20 min after spinal anesthesia.

Method of collecting data: Data were collected after obtaining the ethical approval recommendation from the Health Research Ethics Commission of the Medical Faculty of Hasanuddin University. Data were collected by researchers assisted by the Specialist Education Program of Anesthesiology Medical Faculty of Hasanuddin University.

On arrival in the operating room, the patients undergoing lower limb surgery with spinal anesthesia were randomly divided into 3 groups. A routine was established to monitor blood pressure non-invasively with electrocardiogram (ECG) and SpO2.

Before preloading fluid was given to each group, mean arterial pressure was measured non-invasively and heart rate was recorded using ECG. Ringer's lactate (7 ml/kg) was preloaded within 15 min prior to the spinal injection.

The patients were positioned in lateral decubitus, knee-to-chest position with the operating side facing down. Spinal anesthesia was given with a spinal needle (spinocain) (25 G size) on the lumbar vertebra 3-4, using the midline approach. After penetrating the dura mater (characterized by the flow of cerebrospinal fluid), the spinal needle bevel was geared to the operating side. Local anesthetic of hyperbaric bupivacaine (0.5% of 10 mg) was then injected for 60 sec (0.2 ml per 6 sec), without barbotage. After intrathecal injection, the patient was maintained in the lateral decubitus, knee-to-chest position for 10 min for group A, 15 min for group B and 20 min for group C; then the patients were returned to the supine position.

The height of the sensory block was assessed using the "pinprick test" on the left and right midclavicular line. Motor block was measured using Bromage scale. The onset of the sensory and motor blocks was evaluated every minute until the 10th minute. The height of the sensory block and Bromage scores were evaluated at min 25, 30, 45, 60, 90, 120, 150 and 180.

Mean arterial pressure and heart rate were measured every two minutes until 20 min after spinal anesthesia and then every five minutes up to 180 min. Mean arterial pressure was measured by non-invasive methods and heart rate was recorded using ECG. If mean arterial pressure became <20% of the initial mean arterial pressure, a fluid bolus of RL2 mL/kg was given up to three times. When intravenous fluid supplementation failed to overcome hypotension, a dose of ephedrine 5-10 mg/iv bolus was administered. In the event of bradycardia (heart rate<60 beats/minute), atropine sulfate (0.5 mg/iv) was given (maximum dose 2 mg). Patients were also monitored for additional effects during the surgery.

Data analysis: The data obtained were analyzed using SPSS 18 for Windows. Data processing results are displayed in the tables, charts and narrative.

Characteristics such as age, height, BMI, duration of surgery, onset of operational sensory block, onset of operational motor block, duration of sensory and motor blocks, mean arterial pressure and heart rate in all three groups were tested by one-way ANOVA if the data were normally distributed. A Kruskal-Wallis analysis was performed if the data distribution was abnormal. Characteristics of gender, ASA PS, type of operation and height of sensory and motor blocks in all three groups were tested by chi-square test if qualified and tested by Kolmogorof-Smirnov test when the chi-square test did not qualify. The significance level was 5%, meaning if $p<0.05$, the differences were declared statistically significant with 95% confidence intervals.

RESULTS

Sample characteristics: This study included 51 patients, with 17 patients in each group. As Table 1 shows, no significant difference was observed in patients based on age, height, BMI, or duration of the operation.

Sensory block: Characteristics of sensory block in all three groups is shown in Table 2.

The onset of sensory block on the operation side in group A was 5.71±0.6 min, group B was 5.65±0.6 min and group C was 5.47±0.7 min; no significant difference was seen ($p = 0.373$)among the groups. In terms of duration of the sensory block on the operation side among the three groups, no significant difference ($p = 0.419$) was observed. In group A, duration was 95.0±12.5 min; in group B, it was 90.0±14.9 min and in group C, it was 95.9±10.5 min. However, the duration of the sensory block on the independent side in group A was 71.47±10.4 min, 63.53±4.9 min in group B and 50.59±13.4 min in group C, showing significant difference ($p = 0.000$).

Table 3 shows the height of the sensory block among the three groups was the same, where group A dermatomes Th10 was Th9-Th11, group B Th10 was Th8-Th11 and group C Th10 was Th9-Th11. However, the height of the sensory block in the independent side showed a difference, where the group A dermatome Th12 was Th10-L2, group B L3 was L1-L4 and group C S1 was L4-S2.

Motor block: Characteristics of motor block in all three groups are shown in Table 2. The onset of motor block on the operation side in group A was 6.53±0.7 min, group B was 6.47±0.7 minutes and group C was 6.35±0.6 min. A significant difference could not be observed among the groups ($p = 0.752$). The duration of the motor block on the operation side among the three groups was not significantly different ($p = 0.574$): 174.71±11.8 min in group A, 176.47±9.9 min in group B and 178.24±7.3 min in group C. The duration of the motor block on the independent side in group A was 109.41±18.2 min, 33.9±84.71 in group B and 7.06 min ±19.9 minutes in group C, showing a significant difference ($p = 0.000$).

Height of the motor block was assessed by Bromage score. Bromage score on the operating side was 3 in each group. The Bromage score on the independent side showed a significant difference ($p = 0.000$).

Mean arterial pressure and heart rate: Figure 1 shows observations made during mean arterial pressure monitoring.

In this study, although statistically significant differences were found in mean arterial pressure among the three groups, the differences were not clinically significant because there was not a change of at least 20% in blood pressure after initiation of treatment (as measured by mean arterial pressure). Figure 2 shows observations made during heart rate monitoring.

The differences in mean heart rate value after spinal anesthesia from minute 0 to min 180 among the three groups was found to be statistically significant ($p<0.05$) in the 10, 20 and 165th min. However, it was not clinically significant because bradycardia or tachycardia did not occur.

Effects: Incidence of effects such as hypotension, bradycardia, nausea/vomiting and pruritus was not found among the three groups. Incidence of shivering found in group A was 2 (11.8%), in group B was 1 (5.9%) and in group C was 1 (5.9%).

DISCUSSION

This study shows that maintaining a patient in the lateral decubitus position for 20 min is more effective than doing so for 10 or 15 min in the case of unilateral sensory and motor blocks. The three groups show the hemodynamic stability of this procedure.

There were no significant differences ($p>0.05$) in the onset of sensory and motor blocks in any of the groups. The onset of sensory and motor blocks in this study differs from previous studies (Singh *et al*., 2014). Differences in the onset of sensory and motor blocks were estimated because they related to differences in doses of the hyperbaric bupivacaine used (Atef *et al*., 2010) and the speed of intrathecal injection (Mirea *et al*., 2012).

The height of sensory and motor blocks in this study were lower on the independent side than on the operating side. This is consistent with previous studies (Singh *et al*., 2014; Atef *et al*., 2010). The height difference of the block was thought to be caused by differences in the doses of bupivacaine hyperbaric (Atef *et al*., 2010), the speed of the intrathecal injection (Mirea *et al*., 2012) and the duration of the lateral decubitus position (Martin-Salvaj *et al*., 1994).

Table 1: Characteristics of age, height, BMI and duration of surgery

	--- Group A (n = 17) ---		--- Group B (n = 17) ---		-- Group C (n = 17) ---		
Variable	Mean	SD	Mean	SD	Mean	SD	P
Age (year)	40.71	15.41	37.65	14.46	39.88	13.16	0.814*
Height (cm)	160.12	3.99	160.06	5.95	160.06	5.25	0.999*
BMI (kg/m^2)	22.09	2.26	22.09	1.43	22.39	2.17	0.808**
Duration of surgery (min)	62.35	21.87	69.12	25.94	62.06	22.64	0.616*

Data were presented in the form of the average value (mean)±standard deviations;
*Data were normally distributed; the probability (p-value) was tested by one-way ANOVA, p<0.05 was considered significant
**Data were not normally distributed, the p-value was tested by Kruskal-Wallis, p<0.05 was considered significant

Table 2: Characteristics of sensory block and motor block

	------ Group A (n = 17) -------		----- Group B (n = 17) -----		---- Group C (n = 17) -----		
Variable	Mean (SD)	Median	Mean (SD)	Median	Mean (SD)	Median	P
Sensory block onset OS (min)	5.71 (0.6)	6.0	5.65 (0.6)	6.0	5.47 (0.7)	5.0	0.373
Duration of sensory block OS (min)	95.0 (12.5)	100.0	90.0 (14.9)	100.0	95.9 (10.5)	100.0	0.419
Duration of sensory block IS (min)	71.47 (10.4)	70.0	63.53 (4.9)	60.0	50.59 (13.4)	40.0	0.000
Motor block onset OS (min)	6.53 (0.7)	6.0	6.47 (0.7)	6.0	6.35 (0.6)	6.0	0.752
Duration of motor block OS (min)	174.71 (11.8)	180.0	176.47 (9.9)	180.0	178.24 (7.3)	180.0	0.574
Duration of motor block IS (min)	109.41 (18.2)	120.0	84.71 (33.9)	90.0	7.06 (19.9)	0.0	0.000

Data are presented in the form of the mean (Standard Deviation) and median; the p value was tested by Kruskal-Wallis because the data were not normally distributed; p<0.05 was considered significant. OS: Operating Side, IS: Independent Side

Table 3: Characteristics of the height of sensory block between the operating side and the independent side in all three groups

	--------- Group A (n = 17) ----------			---------- Group B (n = 17) ----------			---------- Group C (n = 17) ---------		
Sensory block	Median	Max.	Min	Median	Max.	Min	Median	Max.	Min
Highest block (OS)	Th10	Th9	Th11	Th10	Th8	Th11	Th10	Th9	Th11
Highest block (IS)	Th12	Th10	L2	L3	L1	L4	S1	L4	S2

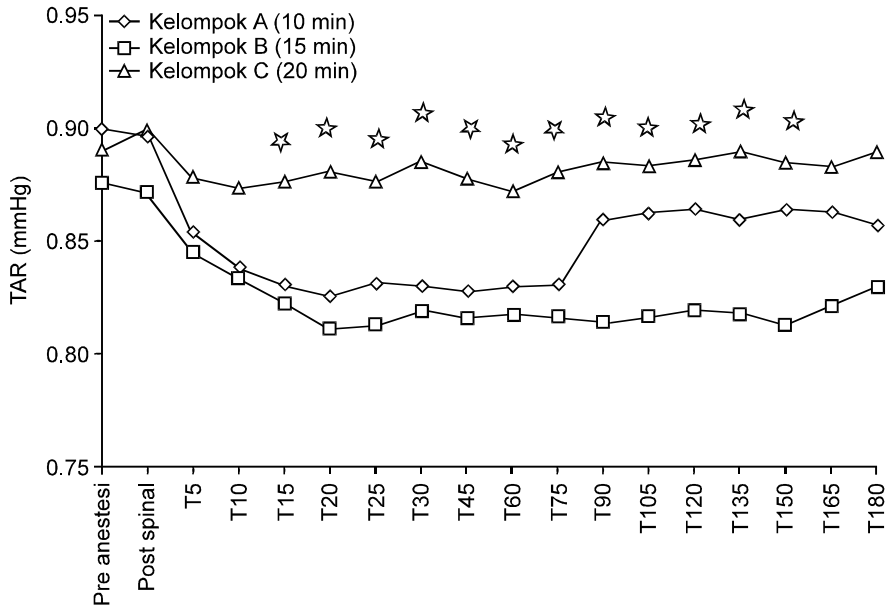

Fig. 1: Mean comparison of mean arterial pressure among the three groups.
*p-value was tested by (one way) ANOVA because the data were not normally distributed, p<0.05 was considered significant

The duration of the lateral decubitus position affects the height of the sensory block between the operating side and the independent side. This causes differences in the duration of the sensory and motor blocks on both sides. Martin-Salvaj *et al*. (1994) found a positive correlation between the duration of the lateral decubitus position and differences in the duration of sensory and motor blocks between the dependent and independent sides. The longer the duration of the lateral decubitus position, the greater the difference in the duration of the sensory and motor blocks.

The duration of the sensory and motor blocks on the independent side was shorter than the duration on the operating side in this study. Differences in the duration

Fig. 2: Mean comparison of heart rate among the three groups.
*p-value was tested by Oneway ANOVA for normal distribution of data, p<0.05 declared meaningful,
**p-value with the Kruskal-Wallis test for abnormal distribution data, p<0.05 declared meaningful

of the sensory and motor blocks between the operating side and the independent side were allegedly associated with the dose of bupivacaine hyperbaric used (Atef *et al*., 2010), the duration of the lateral decubitus position (Martin-Salvaj *et al*., 1994), the speed of the intrathecal injection (Mirea *et al*., 2012) and the addition of adjuvant in local anesthesia (Singh *et al*., 2014).

Strict unilateral sensory block was not reached in this study, though differences in strict unilateral sensory blocks were shown to be influenced by the number of doses of local anesthetic (Atef *et al*., 2010). In the research conducted by Casati *et al*. (2004), tighter unilateral sensory block was achieved in six patients (30%).

Strict unilateral motor block was achieved in as many as 88.2% in group C and 11.2% in group B. In group A, strict unilateral motor block was not achieved after the patient was positioned supine. In the study by Kim *et al*. (2013), strict unilateral motor block was reached in the 15th min and was not maintained by the 50th min in 62.5% of patients who were in the knee to chest flexion position for 15 min after receiving spinal anesthesia. This study showed no significant hemodynamic changes. Hypotension and bradycardia were not found in any of the three groups. This is consistent with previous studies (Kirdemir *et al*., 2006).

Several studies have shown the effects of hypotension and bradycardia. In a study by Ijaz *et al*. (2013), 6.7% of patients showed hypotension and 6.7% showed bradycardia. Casati *et al*. (2004), found the incidence of hypotension was 5%.

Incidence of hypotension was associated with the speed of injection of local anesthetic (Mirea *et al*., 2012). Mirea *et al*. (2012), found that a slower injection speed decreased the incidence and severity of hypotension with the spinal anesthesia.

Conclusions and recommendations: Placing a patient in the lateral decubitus position for 10, 15 and 20 min after unilateral spinal anesthesia has different effects, in terms of sensory and motor blocks, on the independent side. However, in terms of hemodynamic stability, none of the three groups showed significant hemodynamic changes. Further research is needed involving the use of adjuvants to varying doses of local anesthetic to evaluate how spinal anesthesia can be used in high-risk patients while maintaining their hemodynamic stability.

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