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Effect of Lithotomy Position on Peripheral Vascular Resistance during Spinal Anesthesia

Mayumi NAKANISHI*1, Kumiko TANABE*1, Motoyasu TAKENAKA*1
and Hiroki IIDA*1

Summary : Perfusion index (PI) is useful for measuring changes in peripheral vasoconstriction and tissue perfusion. It is known that during spinal anesthesia, PI in the lower extremity increases while that in the upper extremity decreases. Since elevation of the lower extremities causes an increase in venous return, we hypothesized that slight compensatory vasoconstriction in the upper extremities occurs in the lithotomy position compared to the supine position. Therefore, we expected that PI in the upper extremities in the lithotomy position induces a smaller decrease compared with that in the supine position under spinal anesthesia. In the present study, decrease in PI in the upper extremities in the lithotomy position was more remarkable and rapid than in the supine position. Prevention of hypotension in the lithotomy position seems to be caused by an increase in vascular resistance in the upper extremity, in addition to the increase in venous return to the upper body.

Key words : spinal anesthesia, perfusion index, lithotomy position

During spinal anesthesia, blood flow to the lower extremities increases, while that in the upper extremities decreases.[1] Many surgical procedures are performed in the lithotomy position under spinal anesthesia. Since elevation of the lower extremities, as in the lithotomy position, causes an increase in venous return to the upper body, it would likely result in less compensatory vasoconstriction in the upper extremities. However, the distribution of blood and resultant vasoconstriction in each extremity under spinal anesthesia in the lithotomy position is not clear.

Perfusion index (PI) is the ratio of pulsatile blood flow to nonpulsatile blood flow and static blood in peripheral tissues.[2] This index is reportedly useful for measuring changes in peripheral vasoconstriction and tissue perfusion in real time.[2] It has been demonstrated that the efficacy of thoracic epidural anesthesia and nerve block, such as sympathectomy, can be evaluated based on changes in PI.[3,4] We hypothesized that PI in the upper extremities in the lithotomy position induces a smaller decrease compared with that in the supine position under spinal anesthesia. In the present study, we compared the influence of position, namely supine and lithotomy positions, on changes in the PI in the upper and lower extremities and hemodynamics during spinal anesthesia.

This retrospective, observational study conducted at Gifu University Graduate School of Medicine, was approved by the local institutional ethics committee. Written informed consent for this study was waived by the local institutional ethics committee because no clinical intervention was performed and all protected health information was removed after date abstraction. Our study focused on patients undergoing surgical procedures under spinal anesthesia between January 2010 and July 2014, in whom PI in the toe was monitored to assess the effect of spinal anesthesia, in addition to monitoring of finger oxygen saturation by a PI monitor. A total of 42 patients, ASA physical status I or II, aged 34–85 years, were included in the present study. Pulse oximetry was monitored using a tissue PI monitor (Masimo Radical®; Masimo Corp., Irvine, CA, USA). The probes were placed on one of the left fingers and toes, following which spinal anesthesia was administered in the left lateral position. After intrathecal administration of 10–13 mg of hyperbaric bupivacaine, the patients were returned to the supine position. Twenty-two patients were placed in the lithotomy position soon after the injection of local anesthetic (L-group). The other 20 patients were maintained in the supine position (S-group). Blood pressure, heart rate, and PI values for 20 min after spinal anesthesia were retrospectively obtained from the patients' anesthesia records. Anesthetic level was checked by assessing cold thermal hypesthesia using ice. Ephedrine was administrated intravenously if

*1 Department of Anesthesiology and Pain Medicine, Gifu University Gradurate School of Medicine, Gifu, Japan

hypotension of more than 20% below baseline BP values was observed. Data were expressed as mean ± SD. The patients' characteristics in the two groups were compared by the t-test. Changes in PI in the supine and lithotomy position were compared by repeated measures analysis of variance. Values of PI at the same time points in the two groups were compared by post hoc tests. Decreases in mean arterial pressure (MAP) by more than 20% below baseline in the supine and lithotomy positions were compared by the χ^2 test. A P value of less than 0.05 was considered to be significant.

There were no statistically significant differences in age, body weight, height, and dose of local anesthetic in the two groups. The maximal level of spinal block, as assessed by the height of cold hypesthesia, in the L-group was significantly lower than that in the S-group (Table). In 7 of 22 patients in the L-group and in 10 of 20 patients in the S-group, MAP decreased by more that 20% compared with baseline level (Table). In the L-group, PI in the finger significantly decreased from 3.6 ± 2.4 to 2.4 ± 1.4 at 1 min (Fig. 1) and PI in the toe significantly increased from 2.0 ± 1.5 to 2.7 ± 1.4 at 2 min after spinal injection of the local anesthetic (Fig. 2). In the S-group, PI in the finger significantly decreased from 3.4 ± 1.7 to 2.4 ± 1.0 at 4 min (Fig. 1), and PI in the toe significantly increased from 1.2 ± 0.8 to 2.8 ± 1.9 at 2 min after injection (Fig. 2). PI in the finger in the L-group significantly decreased as compared to the corresponding values in the S-group at the same time points, i.e. at 1, 2, and 3 minutes after spinal anesthesia.

The present study showed that the lithotomy position could reduce the hypotension caused by spinal anesthesia, which is consistent with previous reports. It has been reported that adopting the lithotomy position after spinal anesthesia attenuates the decrease in arterial blood pressure.[5] The pooled venous blood from the lower extremities (500–1,000 ml) returns to the heart in the lithotomy position. Therefore, it is suggested that attenuation of the decrease in blood pressure is caused by an autotransfusion effect in the lithotomy position.[5] In our study, the PI in the toe significantly increased at 2 min in both groups. It has been previously reported that the blood content in the legs increases after lumbar epidural anesthesia.[1] Our results reflect the results of the previous report. Since venous return increases in the lithotomy position, we investigated the change in the PI in

Table Clinical characteristics of the 42 patients

	S-group (n = 20)	L-group (n = 22)
Male : Female	14:6	16:6
Age (years)	71 ± 11	70 ± 13
Height (cm)	163 ± 7	161 ± 9
Weight (kg)	59 ± 7	60 ± 12
Bupivacaine (mg)	12 ± 1	12 ± 1
Maximal block height (dermatome)	Th 1	Th 3
Hypotension of more than 20% below baseline	10 (50%)	7 (32%)

Data are presented as number (%) of patients or mean ± SD.

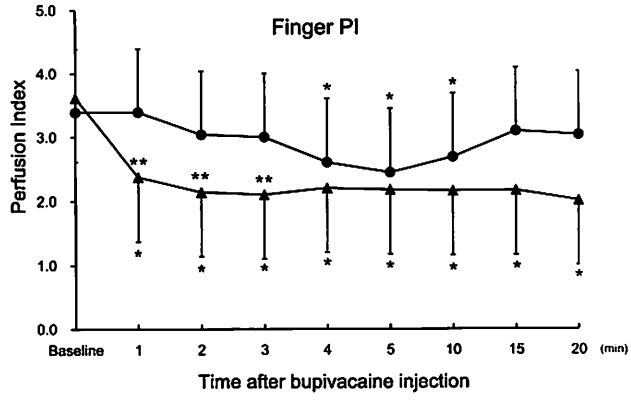

Figure 1. Changes in finger perfusion index (PI) under spinal anesthesia
After intrathecal administration of hyperbaric bupivacaine in the lateral position, the patients were returned to the supine position. Patients were placed in the lithotomy position soon after bupivacaine injection (L-group, triangles), or were maintained in the supine position (S-group, circles). PI in a finger of the left hand was recorded for 20 min. $*P < 0.05$, compared to baseline values, $**P < 0.05$, compared to the value in the S-group at the same time.

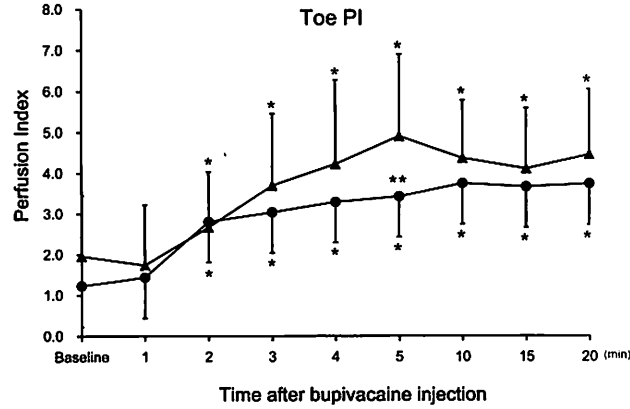

Figure 2. Changes in toe perfusion index (PI) under spinal anesthesia
After intrathecal administration of hyperbaric bupivacaine in the lateral position, the patients were returned to the supine position. Patients were placed in the lithotomy position soon after bupivacaine injection (L-group, triangles), or were maintained in the supine position (S-group, circles). PI in a toe of the left foot was recorded for 20 min. $*P < 0.05$, compared to baseline values, $**P < 0.05$, compared to the values in the S-group at the same time.

the upper extremity in the lithotomy position. In our study, PI in the finger decreased significantly in both groups. However, the decrease in PI in the upper extremity in the lithotomy position was more remarkable and rapid than that in the supine position. This could indicate that peripheral vasoconstriction in the upper extremity increases in the lithotomy position as compared to that in the supine position. This result was contrary to our hypothesis. Reportedly, volume expansion under general anesthesia induces a tendency toward decrease in finger PI.[6] In our study as well, it is speculated that the decrease in finger PI was induced by an increase in venous return in the lithotomy position. Our results suggest that prevention of hypotension in the lithotomy position is caused by an increase in vascular resistance in the upper extremity due to some kind of vasoreflex, in addition to the increase in venous return to the upper body.

In conclusion, in addition to the increase in venous return, vasoconstriction in the upper extremities could contribute to prevention of hypotension secondary to spinal anesthesia in the lithotomy position.

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