Effects of Tilting in the Sagittal Plane on the Cephalad Spread of Anesthesia

Shiro OKU and Tadao SHIMIZU

The effect of tilting in the sagittal plane on the spread of anesthesia was studied in 30 healthy male patients. Two ml of 0.3% hyperbaric dibucaine was used for intrathecal injection in the lateral position. After 3 min of resting on their side, 15 patients were placed in the horizontal supine position. Other 15 patients were turned to the contralateral side at 7–8 degrees in the sagittal plane. Cephalad spread of sensory analgesia by the pin-prick method, degree of motor blockade by Bromage score, mean atrerial pressure, and heart rate were assessed. Mean spread of sensory analgesia in the non-dependent side on the dural puncture was significantly higher in the sagittal-tilt group (T7.4 ± 2.6 at 15 min) compared the horizontal group (T9.5 ± 1.4 at 15 min). There was no significant difference in the mean cephalad spread of the analgesic level in the dependent side between the two groups. Unilateral motor anesthesia of the dependent side seemed to be canceled by the sagittal tilting maneuver. A 7 to 8 degree tilt in the sagittal plane is recommended to facilitate the cephalad spread of analgesia and to avoid unilateral anesthesia. (Key words: spinal anesthesia, dibucaine, unilateral anesthesia, sagittal tilt)

(Oku S and Shimizu T: Effects of tilting in the sagittal plane on the cephalad spread of anesthesia. J Anesth 6: 455–460, 1992)

If a patient remains on one side for some time after the subarachnoid injection of the hyperbaric local anesthetics, the blockade is usually more dense and lasts longer on the dependent side. This depends on how long the patient stays on one side. We occasionally practice this maneuver for lengthening the duration of anesthesia and also inducing spinal anesthesia for Cesarean sections in the right lateral decubitus because surgery will be in the left tilt position to prevent the aorto-caval compression[1]. During the spino-epidural anesthesia, however, it takes time to insert an epidural catheter after subarachnoid injection of local anesthetics using a type H spinal-continuous epidural needle[2]. If the time setting on the lateral position after subarachnoid injection prolongs during this procedure, the discrepancies of the analgesic level and the motor blockade become greater between the non-dependent and dependent sides. Some maneuver should be needed to avoid the discrepancies. We studied the effects of tilting in the sagittal plane contralateral to the dependent side of the lateral position on the cephalad spread of analgesia and the degree of motor blockade after

Department of Anesthesia, Saiseikai-Tondabayashi Hospital, Osaka, Japan

Address reprint requests to Dr. Oku: Department of Anesthesia, Saiseikai-Tondabayashi Hospital, 1-3-36, Kohyoudai, Tondabayashi, Osaka, 584 Japan

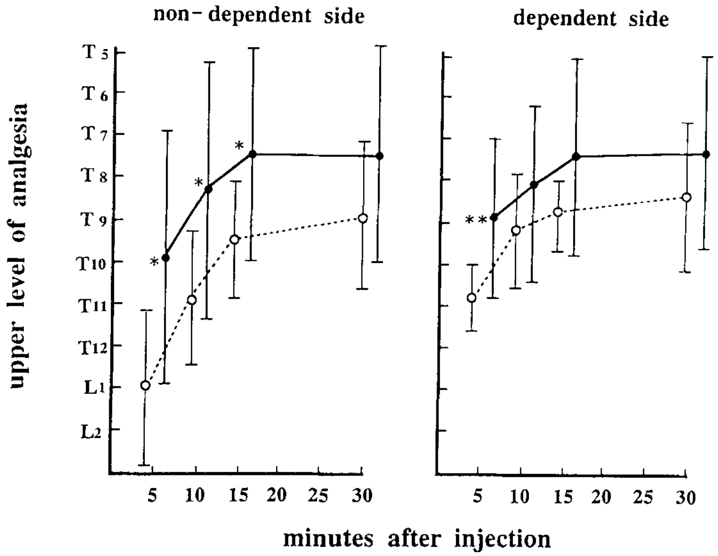

Fig. 1. Mean cephalad spread of analgesic level.
Values are mean ± SD. $^{**}P < 0.01$ by Mann-Whitney rank test.
○–○: horizontal group, ●–●: sagittal-tilt group.

placement in the supine position.

Materials and Methods

The study population consisted of 30 adult patients scheduled for transurethral resection of benign prostatic hypertrophy under spinal anesthesia. All patients belonged to ASA physical status II. We excluded patients with known neurolological diseases or with spinal column anomalies. After informed consent and institutional approval, the patients were premedicated with atropine 0.5 mg, hydroxyzine 50 mg and ranitidine 50 mg intramuscularly 30 min before anesthesia. A lumbar puncture was performed at the interspace between the second and third lumbar spines using a type H spinal-continuous epidural anesthesia needle (17 G) (Hakko Shoji, Japan) with the patient lying on his left side on a horizontal table. The epidural space was confirmed by the loss of resistance method and a 26 gauge internal spinal needle was then inserted into the subarachnoid space through the epidural needle. Free flow of cerebrospinal fluid with aspiration by a 2.5 ml syringe confirmed correct placement of the needle, and 2.0 ml of 0.3% dibucaine in 5% NaCl solution (Percamine S, Teikoku-Kagaku Japan.) was injected without barbotage at a rate of 0.05 ml per second. It required approximately 3 min after the injection of the hyperbaric anesthetic solution for placement of the epidural catheter and dressing.

Two different procedures were then used. The first involved placing the patient in the supine horizontal position for 10 min followed by the lithotomy position. The other involved placing the patient in the supine horizontal position and immediately tilting the table to the right at 7–8 degrees (maximum for safety of the patients) in the sagittal plane and for 10 min and then the patient was placed in the horizontal lithotomy position. Analgesia was assessed by the pin-prick method using a short bevel 22 gauge needle on each side of the papillary line of

Table 1. Patient Characteristics

	Horizontal	Sagittal tilt
n	15	15
Age (years)	70.8 ± 11.2	65.2 ± 11.6
Height (cm)	159 ± 6	160 ± 5
Weight (kg)	55 ± 7	55 ± 7
Injection time (sec)	40 ± 2	39 ± 9
Position change after injection (sec)	168 ± 16	157 ± 17

Values are mean ± SD; n=15 in each group. No significant differences were observed between groups.

Table 2. Differences in upper segmental analgesic level between the non-dependent and dependent sides

	Horizontal	Sagittal filt
5 min	2.2 ± 1.5	1.3 ± 2.0
10 min	1.7 ± 1.4	0.3 ± 1.3*
15 min	1.1 ± 1.0	0.1 ± 0.7*
30 min	0.7 ± 0.8	0.2 ± 0.6*

Values are mean ± SD. *$P < 0.05$ by Student no-paired T test between the horizontal vs. the sagittal tilt groups.

the trunk. Analgesia was defined as loss of the sensation of pin-prick. Motor blockade was assessed by asking the patient to move their legs using the Bromage score[3]. Assessments were made 5, 10, 15 and 30 min after subarachnoid injection. Cardiovascular changes were also measured using a non-invasive blood pressure monitor (BP-308, Colin, Japan) at the intervals of every 2.5 min. To prevent hypotension (defined as two consecutive systolic pressure reading less than 70% of the baseline value), ephedrine 8 mg was injected intravenously and repeated as required.

The results of the analgesia level and motor blockade were analyzed using the paired Student's t-test and the Mann-Whitney rank test for the difference between sides and groups respectively. Hemodynamic changes were analyzed using the non-paired Student's t-test $P < 0.05$ was considered to be a significant difference.

Results

There were no significant differences in mean age, weight, height, injection time or time laying in the lateral position between the two groups (table 1).

The mean cephalad level of analgesia in the horizontal group was significantly higher in the dependent side than in the non-dependent side at 5, 10 and 15 min (fig. 1). In the sagittal-tilt group, however, the difference between the dependent side and the non-dependent side was not significant. The mean cephalad spread of analgesia in the non-dependent side was greater in the sagittal-tilt group than in the horizontal group at 5, 10 and 15 min. However, the cephalad level of analgesia in the non-dependent and dependent sides between the two groups did not significantly differ at 30 min. In the dependent side, the mean cephalad level of analgesia was higher in the sagittal-tilt group than in the horizontal group. The mean difference in the upper segmental analgesic level between the non-dependent and dependent sides was significantly greater in the horizontal group than in the sagittal-tilt group at 10, 15 and 30 min after subarachnoid injection (table 2).

The degree of motor blockade in the dependent side was significantly greater than that of the non-dependent side in the horizontal group at 5, 10, 15 and 30 min (fig. 2). In the sagittal-tilt group, however, there was no difference in the degree in motor blockade between the non-dependent and dependent side at any time (fig. 2). There was no difference in the degree of motor blockade in the non-

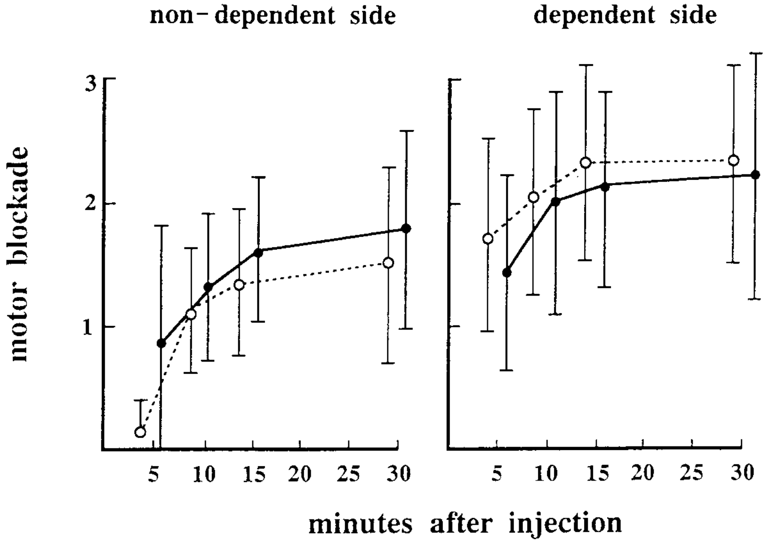

Fig. 2. Mean motor blockade in the horizontal group and the sagittal-tilt group.
○–○: horizontal group, ●–●: sagittal tilt group.

dependent side between in the sagittal-tilt method and in the horizontal method.

No significant differences in heart rate and mean arterial blood pressure could be demonstrated between the two groups. Although the frequency of pressor administration was significantly greater in the sagittal tilt group (5/15) than in the horizontal group (0/15), there was no difference in mean arterial blood pressure between the groups.

Discussion

Twenty-five factors were postulated by Greene[4] to determine the distribution of local anesthetic solution within the subarachnoid space. In spinal anesthesia using the hyperbaric solution, only the volume and amount of anesthetic solutions, related to the position of the patient and the site of injection, affect the cephalad spread of analgesia and the degree of motor blockade. To facilitate the cephalad spread of analgesia, a head-down tilt and a borbotage are used in clinical practice. The former was proved to be very useful for the cephalad spread of analgesia[4], but the latter was not[5]. The effect of gravity on the distribution of local anesthetics within the subarachnoid space, which relates to their volume and amount, has been considered the most important factor for the cephalad spread of hyperbaric spinal anesthesia[4]. The injected volume and concentration of dibucaine in hyperbaric solutions were kept constant in the horizontal and sagittal-tilt groups. The rate of injection and time in the lateral position were well controlled. Therefore, only the gravity effect of the anesthetic solution was a variable factor affecting the level of spinal analgesia in this study. This study clearly demonstrated that a 7–8 degree tilt in the sagittal plane on the supine position facilitated the cephalad spread of analgesia, not only in the non-dependent side, but also in the dependent side. The difference in segmental analgesic level between the non-dependent and dependent sides was also compensated for by this maneuver. The mechanism for the facilitation of the cephalad spread of analgesia by this sagittal-tilting is assumed to be that the change in the axis of gravity causes migration of the hyperbaric anesthetic solution in the contralateral. The thoracic curvature of the vertebral column also accelerate the analgesic level to the cephalad direction[7]. The local anesthetic in the hyperbaric solution was induced to move more rapidly to the non-dependent side by tilting in the sagittal plane. Therefore, the cephalad spread of analgesia to the contralateral side become faster. Alternatively, the disturbance and shaking of the spinal column by the sagittal-tilting maneuver may disperse the anesthetic in the cephalad direction. The greater advancement of the analgesic level induced by the sagittal-tilting might be responsible for the observed cardiovascular changes. Subsequently the frequency of pressor administration was higher in the sagittal-tilt group than in the horizontal group. Compared to the cephalad spread of analgesia, the degree of motor blockade was not clearly extended. There was no difference in motor blockade between the sides in the sagittal-tilt group. A tendency toward a more rapid onset of complete motor blockade in the non-dependent side was greater in the sagittal-tilt group than in the horizontal group. More anesthetic is usually assumed to be absorbed by the nerves and nerve roots in the dependent side during the lateral position. On the other hand, less anesthetic is absorbed by them in the non-dependent side. Therefore, the degree of motor blockade is greater in the dependent side than in the non-dependent side. This is constant with our findings in the horizontal group. Unilateral anesthesia occurs if a patient remains in the lateral position long enough for the unilateral lumbar spinal roots and spinal cord to take up the subarachnoid local anesthetics. By tilting the spinal column in the sagittal plane, more anesthetic is dispersed in the contralateral direction, resulting in more anesthetic molecules being absorbed by the non-dependent nerves and roots. On the contrary, less anesthetic is taken up by nerves and roots of the dependent side. The discrepancy in the degree of motor blockade between the non-dependent and dependent sides is expected to be canceled, as with the analgesia. Although this was not demonstrated in our study, there was a tendency to cancel the unilateral motor blockade in the sagittal-tilt group. The uptake of dibucaine during 3 min in the lateral position seems to be faster by motor nerves than by sensory nerves, because the analgesic difference between both sides was corrected by the sagittal tilting. However, the difference in motor blockade was not corrected. It is well known that the minimum anesthetic concentration for motor blockade is approximately twice that for sensory blockade[8]. A 7–8 degree tilt in the sagittal plane may not have been enough to equalize the cerebrospinal concentration of local anesthetic to block the motor nerves of the non-dependent side. Because the motor nerve roots reside ventral to the sensory roots, the cerebrospinal concentration of dibucaine in the non-dependent subarachnoid space with sagittal tilting seemed to be enough to block sensory roots but not enough to block motor roots. In spite of the sagittal-tilt the upper segmental level of analgesia after 30 min in the horizontal lithotomy position was the same in the non-dependent and dependent sides. This indicates that dibucaine may require 30 min to achieve stabilization of the analgesic level[8].

In conclusion, if remaining in the lateral position during epidural anesthetic procedures, using a type H spinal-continuous epidural anesthesia needle is prolonged after the intrathecal hyperbaric anesthetic injection, a 7–8 degree tilt in the sagittal plane is recommended to extend the upper segmental analgesic level and avoid the unilateral anesthesia.

(Received Nov. 18, 1991, accepted for publication Feb. 24, 1992)

References

1. Sprague DH: Effects of position and uterine displacement on spinal anesthesia for Cesarean section. Anesthesiology 44:164–166, 1976
2. Hanaoka K: Experience in the use of Hanaoka's needle for spinal-continuous epidural anaesthesia (500 cases). presented in the 7th Asian Australasian Congress of Anaesthesiologists, Hong Kong, 1986. Asia Pacific Congress series No 55, pp. 161.
3. Bromage PR: A comparison of the hydrochloride and carbon dioxide salts of lidocaine and prilocaine in epidural analgesia. Acta Anaesth Scand (suppl) 16:55–59, 1966
4. Greene NM: Distribution of local anesthetic solutions within the subarachnoid space. Anesth Analg 64:715–730, 1985
5. Janik R, Dick W, Stanton-Hicks M d'A: Effects of Trendelenberg position (0 vs. 10°) on the spread of hyperbaric bupivacaine and tetracaine. Regional Anesth 13:34–39, 1988
6. Kitahara T, Kuri S, Yoshida J: The spread of drugs used for spinal anesthesia. Anesthesiology 29:60–64, 1968
7. Smith TC: The lumbar spine and subarachnoid block. Anesthesiology 29:60–64, 1968
8. de'Jung RH: Cm- the minimum anesthetic concentration, Physiology and Pharmacology of Local Anesthesia. Ed. de'Jung RH, Springfield, Charles C Thomas Publisher, 1970, pp. 87–96