—**Original**—

Usefulness of Posturography after Epidural Block

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Abstract

After a nerve block, observation of the course of effects is necessary until discharge of patients. Particularly epidural block in the lumbar region markedly affects ambulation and postural stability. Although there are few methods of objective evaluation of the postural stability, safe and early discharge is desired. We evaluated the influences of epidural block with 5 m*l* of 1% lidocaine on equilibrium before as well as 30,60 and 90 minutes after epidural block. Computerized posturography allows the objective evaluation and quantitative assessment of impairment of receptors and the central nervous system involved in the maintenance of postural stability by analyzing of results. Locus length per unit area with the eyes open and that with the eyes closed 30 minutes after epidural block (27.339±11.761 cm and 25.804±10.561 cm, respectively) were significantly (P =0.0067 and 0.0175, respectively) higher than baseline values (19.528±8.240 cm and 19.496±7.450 cm, respectively). Sway area with the eyes open 30 minutes after epidural block (3.923±2.494 cm^2) was significantly (P =0.0190) larger than the baseline value (2.533±1.309 cm^2). These results suggest that marked effect remain after epidural block even when standing appears to be stable, and the observation of the course of effects after epidural block is still necessary for the safety of patients. We considered that locus length per unit area is a useful parameter for the assessment of an early discharge.
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Key words: Computerized posturography, Discharge, Postural stability, Epidural block, Locus length per unit area

Introduction

In pain management, various types of nerve block have been used. After a nerve block, observation of the course of effects is necessary until discharge of patients, considering the influences of the nerve block and the risk of complications[1]. Epidural block is an important therapeutic technique not only for surgery but also for outpatients. Particularly when performed in the lumbar area, it affects ambulation and postural stability. In addition, local anesthetics used for epidural block are still controversial[2]. However, there are few methods available for the objective evaluation of postural stability that is desired for a safe and early discharge. Thus we designed this study to evaluate the time course of effects of epidural block on postural stability using posturography. Computerized posturography has been extensively used for clinical evaluation of balance disorders and allows the investigators to assess the contribution to balance of visual, vestibular, and somato-

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sensory inputs[3-5]. Our results suggest that computerized posturography allows the objective evaluation and quantitative assessment of the effects of epidural block.

Materials and Methods

We had obtained the approval of Nippon Medical School Ethical Committee. The subjects were enrolled 46 patients (ASA classification, I or II) undergoing epidural block in the lumbar area at our outpatient pain clinic from whom written informed consent was obtained. Patients with known musculoskeletal disease, psychological disorders, symptoms suggestive of vestibular or neurological disorders, current or past medical diagnosis or injury affecting equilibrium function were excluded.

Before epidural block, blood pressure, heart rate and pain using VAS (0 = no pain at all, 10 = worst pain, imaginable) were measured, and posturography was performed using a SYNPACK® (Nihon Electric Company, Tokyo, Japan) to obtain baseline values as control. SYNPACK® is mobile equipment consisting of dual static force plates and a computerized monitor. Each footplate rests on two force transducers, with the sensitive axes oriented vertically. The transducers in turn provide input to the computer. The software program filters the center of gravity on the monitor. Data from the assessment can be recorded and reviewed on screen or printed out, in the forms of various parameters.

Posturography was performed according to the "Q & A and manual of posturography (1995)" published in 1996 by the steering committee of Equilibrium Research, Japan[4]. Objects that cross or obstruct the visual field of the subjects were removed. The room was maintained quiet with a constant degree of brightness. The subjects stood with bare feet, the legs closed (the medial margins of the feet are in contact with each other), and the arms lightly touching the sides of the body. They looked at a target 2 m away on the wall at eye level. To exclude transitional sway, the subjects waited for several seconds, and they themselves told the examiner that their standing became stable, at which time measurement was initiated. After the end of measurement with the eyes open, the subjects remained on the force plate, and similar measurements were performed with the eyes closed.

After posturography, the subjects rested in the lateral position. The epidural space was confirmed by loss of resistance with a paramedian approach using a 21-G epidural puncture needle via the 3rd-4th lumbar intervertebral space, and 1% lidocaine 5 m*l* as a local anesthetic was injected.

Blood pressure and heart rate were measured 5, 10, 15, 20, and 30 minutes after epidural block.

Fifteen minutes after epidural block, the range of analgesia was assessed using the cold wipe with alcohol.

Thirty minutes after epidural block, blood pressure, heart rate and VAS were measured, and side effects such as nausea, vomiting, or dizziness and motor power was assessed using modified Bromage scale (0 = no motor block, 1 = inability to raise extended legs, 2 = inability to flex knees, and 3 = inability to flex ankle joints)[6]. If there was no significant deficit of blood pressure (less than 30% decreases from baseline value), motor power (0 or 1 in Bromage scale) or side effect, the patients were invited to stand up and posturography was performed as above. If the patients were unable to complete the posturography, they were excluded from the study and the reason for discontinuation recorded.

VAS and modified Bramage scale were measured and posturography was performed 60 and 90 minutes after epidural block with rest in the supine position for 30 minutes during each interval until the next posturography.

Kruskal-Wallis tests were performed for VAS before as well as 30, 60, 90 minutes after epidural block.

Variance analysis (with Scheffè F test) was performed for blood pressure and heart rate values before as well as 5, 10, 15, 20, and 30 minutes after epidural block, VAS and modified Bromage scale, locus lengths per unit time (total locus length: total locus distance of the center of foot pressure for 60 seconds; locus length per unit time: mean locus length for 1 second), sway area (area of sway from the outermost part of the locus of the center of foot pressure), locus length per unit area (total locus length/sway area), the Romberg ratio of the locus length per unit time and that of the sway area (eyes closed/open sway ratio, generally obtained using the sway area), and the area ratio of power spectra (representing frequency components of sway in the right-and-left direction, i.e., the X axis and in the anteroposterior direction, i.e., the Y axis in barycentric coordinates) in frequency ranges of 0.02〜0.2, 0.2〜2, and 2〜10 Hz with the eyes open and closed obtained by posturography before as well as 30, 60, and 90 minutes after block,. A P-value<0.05 was considered to indicate significant. Statistical analysis was performed using Statview 5.0 (Abacus Concepts, Berkeley, CA, USA).

Table 1 Demographic data and analgesia range

Age (yr)	52.8 ± 16.9
Weight (kg)	60.7 ± 7.5
Height (cm)	164.4 ± 7.1
Sex (men/women)	31/15
ASA Status (Ⅰ / Ⅱ)	28/18
Analgesia Range (Cephalic level)	Th11 ± 2.4
Analgesia Range (Caudal level)	S2 ± 2.6

n=46, Demographic Data presented as mean ± SD
Analgesia Data presented as median ± SD
Analgesia Range was assessed using the cold wipe with alcohol 15 minutes after epidural block.

Results

Two patients were excluded due to nausea, therefore 46 patients were enrolled.

Table 1 shows the age, height, body weight, and the area of anesthesia in the subjects. Blood pressure decrease requiring a vasopressor drug was not observed in any patient.

All patients were assessed motor block in modified Bromage scale 0 at each measurement point.

There was significant difference (P<0.0001) among groups in VAS (**Fig. 1**).

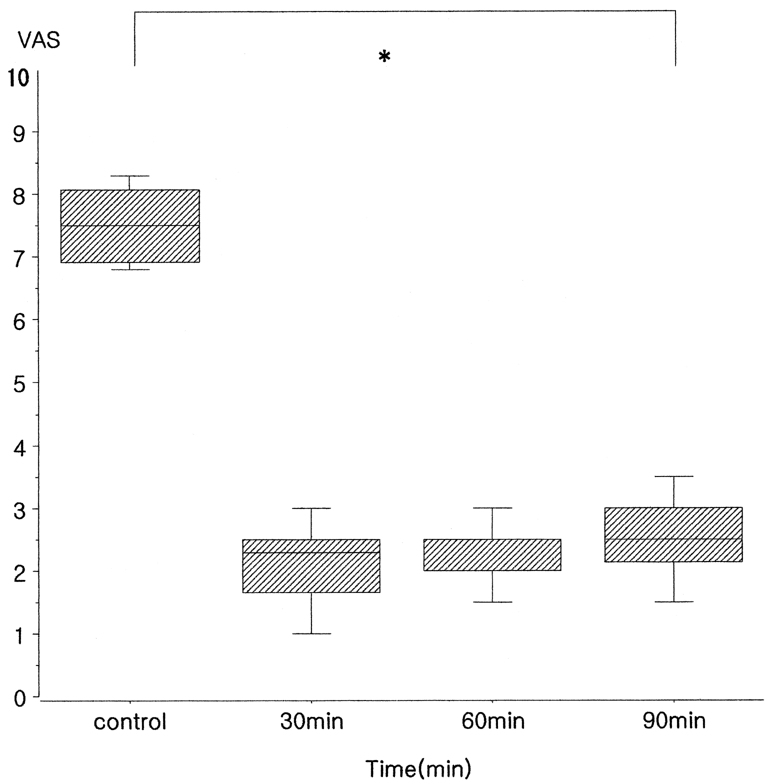

Fig. 1 Changes in VAS after epidural block
Pain using VAS (0=no pain at all, 10=worst pain, imaginable) were measured before as well as 30, 60, and 90 minutes after epidural block. Kruskal-Wallis test was performed for VAS at each measurement point. A P-value<0.05 was considered to indicate significant difference. There was significant difference (*P<0.0001) among groups.

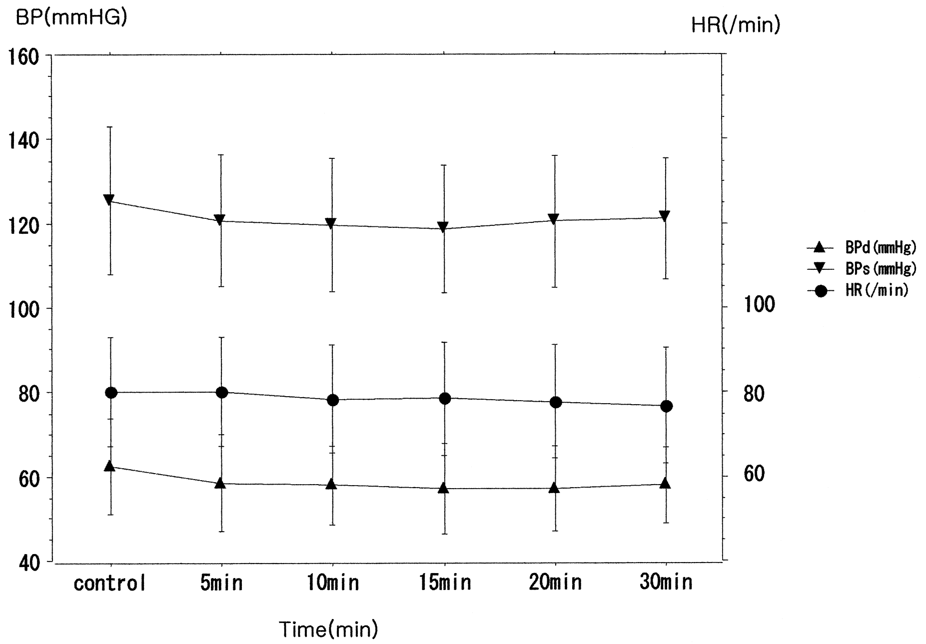

Fig. 2 Changes in vital signs after epidural block
Valiance analysis (with Scheffè F test) was performed for systolic blood pressure (BPs), diastolic blood pressure (BPd) and heart rate (HR) values before as well as 5, 10, 15, 20 and 30 minutes after epidural block.
A *P*-value<0.05 was considered to indicate significant. No significant changes were observed in BPs or BP or HR at any measurement point.

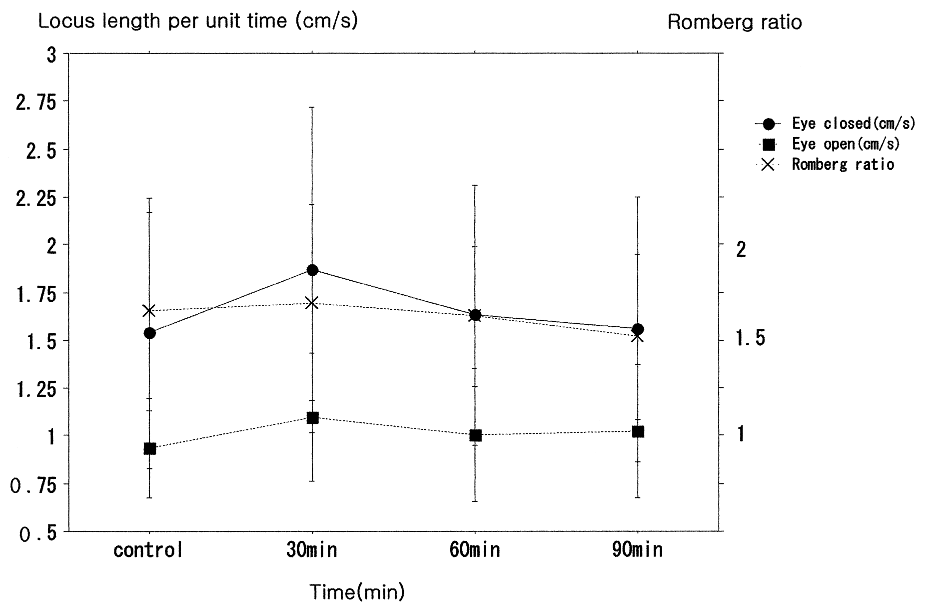

Fig. 3 Changes in locus length per unit time after epidural block
Valiance analysis (with Scheffè F test) was performed for locus lengths per unit time (total locus length: total locus distance of the center of foot pressure for 60 seconds; locus length per unit of time: mean locus length for 1 second) with the eyes open and that with the eyes closed obtained by posturography before as well as 30, 60, and 90 minutes after epidural block, and the Romberg ratio of the locus length per unit time (eyes closed/open sway ratio).
A *P*-value<0.05 was considered to indicate significant. No significant changes were observed in locus length per unit time with the eyes open and closed at any measurement point.

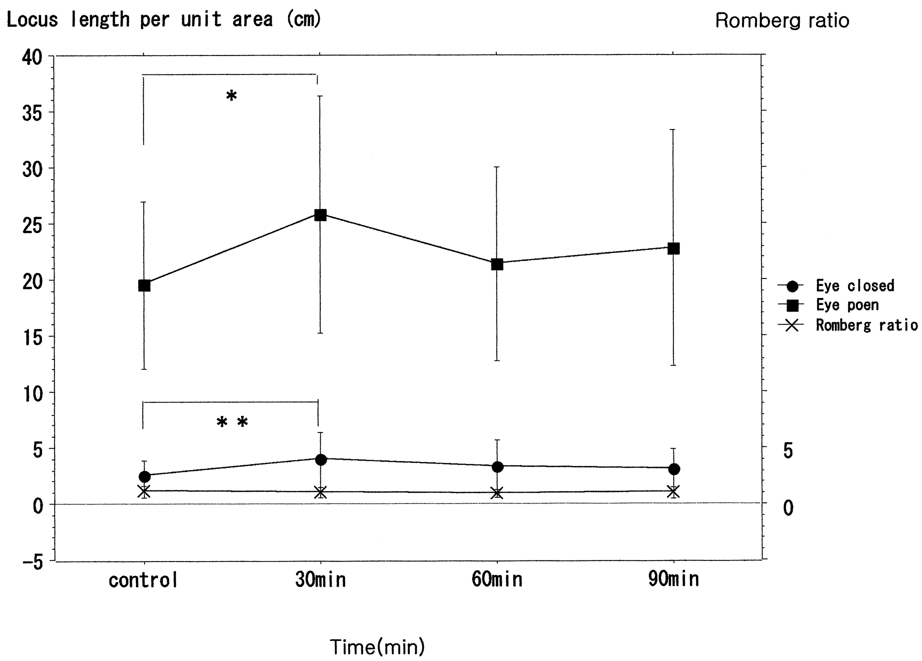

Fig. 4 Changes in the locus length per unit area after epidural block
Valiance analysis (with Scheffè F test) was performed for locus length per unit area (total locus length/sway area) with the eyes open and that with the eyes closed obtained by posturography before as well as 30, 60, and 90 minutes after epidural block, and the Romberg ratio of locus length per unit area (eyes closed/open sway ratio).
A P-value<0.05 was considered to indicate significant. Locus length per unit area with the eyes open and that with the eyes closed 30 minutes after block (27.339 ± 11.761 cm and 25.804 ± 10.561 cm, respectively) were significantly (*P = 0.067 and **P = 0.0175, respectively) higher than baseline values (19.528 ± 8.240 cm and 19.496 ± 7.450 cm, respectively)

No significant changes were observed in systolic or diastolic blood pressure or heart rate at any measurement point (**Fig. 2**).

There was no significant difference between the value of locus lengths per unit time with the eyes open and closed at any measurement point (**Fig. 3**).

Locus lengths per unit area with the eyes open and that with the eyes closed 30 minutes after epidural block (27.339 ± 11.761 cm and 25.804 ± 10.561 cm, respectively) were significantly (P = 0.067 and 0.0175, respectively) higher than the baseline values (19.528 ± 8.240 cm and 19.496 ± 7.450 cm, respectively) (**Fig. 4**).

Sway area with the eyes open 30 minutes after epidural block (3.923 ± 2.494 cm^2) was significantly (P = 0.0190) larger than the baseline value (2.533 ± 1.309 cm^2) (**Fig. 5**).

The Romberg ratios of locus length per unit time and that of sway area at any measurement point were similar to the baseline values (1.65 ± 0.52 and 0.46 ± 0.07, respectively) (**Figs. 4 and 5**).

There was no significant difference between the area ratio of power spectra in frequency range of 0.02～0.2, 0.2～2, 2～10 Hz for the X- or Y-axis component with the eyes open or that with the eyes closed at any measurement point (**Fig. 6**).

Discussion

Pain is treated by various methods such as drugs, physical, surgical, and psychological therapies. Epidural block is an important therapeutic technique and it is indicated not only in pain but also in various disorders such as ischemic lesions in the four limbs. Thus, it is frequently used in pain clinics where, unlike anesthesia for surgery, marked degrees of analgesia, anesthesia, and areflexia are not necessary, and selective effects predominantly on

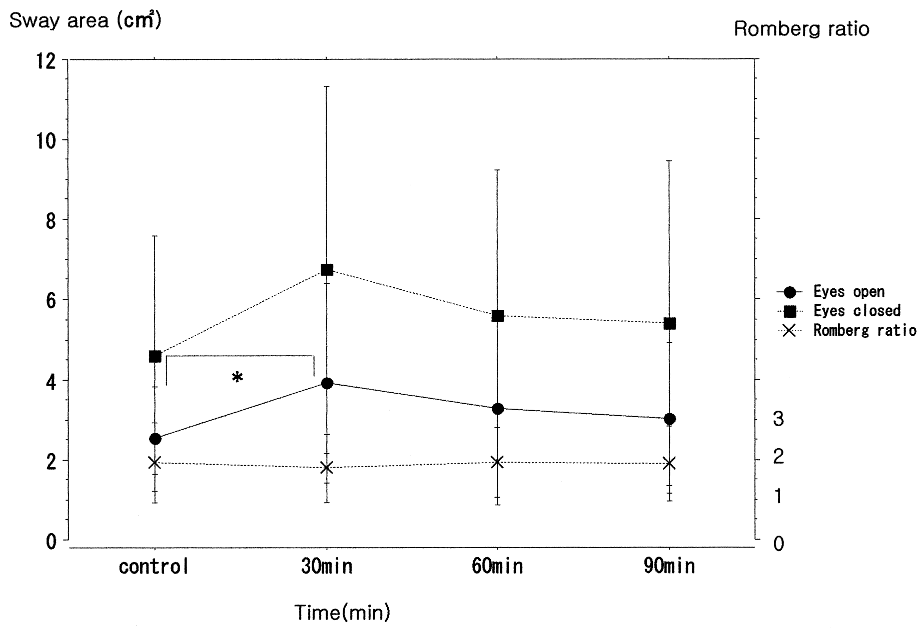

Fig. 5 Changes in sway area after epidural block
Valiance analysis (with scheffè F test) was performed for sway area (area of sway from the outermost part of the locus of the center of foot pressure) with the eyes open and that with the eyes closed obtained by posturography before as well as 30, 60, and 90 minutes after epidural block, and the Romberg ratio of sway area (eyes closed/open sway ratio).
A P-value$<$0.05 was considered to indicate significant. Sway area with the eye open 30 minutes after block (3.923 ± 2.494 cm^2) were significantly ($^*P = 0.190$) larger than baseline values (2.533 ± 1.309 cm^2).

the sensory nerves are important.

After any block, considering the effects of nerve block and the risk of complications, the patient's condition should be observed until discharge. In outpatients who undergo day treatment in principle, careful attention is necessary to determine the timing of discharge after epidural block. This is also true with day-care surgery. Various factors should be considered such as stabilization of vital signs, the presence or absence of complications, ability to stand or walk, the presence or absence of a care provider, the means, distance, and transportation time, and measures against emergency[7-10]. However, the timing of discharge in pain clinics or after ambulatory anesthesia is controversial, because the type, volume, and concentration of local anesthetics were various, which differ among institutions, and the patient background factors. Local anesthetics used for epidural block are still controversial[3]. Considering such factors, we selected 5 m*l* of 1% lidocaine that we were well aware of.

Discharge criteria and a scoring system for day-care surgery assessed vital signs, ambulation, nausea and vomiting, pain, and surgical bleeding[7]. Scoring for ambulation is as follows: 2 = steady gait/no dizziness, 1 = with assistance and 0 = none/dizziness. This scoring system includes the "ambulation" item to evaluate activity. Quantitative evaluation of ambulation is suit for gait analysis. Gait analysis is popular with rehabilitation assessment such in patients with prosthetic foot or osteoarthrosis of the hip as well as in the recovery process after cerebrovascular diseases[8,9]. We thought that gait analysis prefers long term rehabilitation assessment than slight changes with the time course recovery after nerve block.

The Romberg test (examination of the difference in standing sway between eyes open and eyes closed) is an important parameter of the function of the visual righting reflex but can not be used for evaluating the maintenance of appropriate posture[10]. Furthermore simple gait examination that only compares walking rate is not appropriate for safety assessment after day-care surgery. Contrary, normal gait is not always possible even when the results of the Romberg test are normal[11]. However, complete steady gait with no assistance is not required to discharge. We considered that assessment of the stability of standing instead of gait is clinically useful.

To evaluate the recovery process after anesthesia or the stability of ambulation following regional analgesia for labor, many studies have used postrugraphy[12-17]. Computerized posturography is readily feasible and allows objective quantitative assessment. The equilibrium of the upright posture is dynamically maintained by continuous slight sway by adjustments of the visual/semicircular duct, propriospinal reflex, cerebellar system, basal ganglia systems. Results of measurement by posturography are analyzed and used to clarify impairment in each receptor and the central nervous system involved in the maintenance of body equilibrium for the evaluation of the degree of dizziness/equilibrium dysfunction. Posturography, which allows evaluation of the degree of dysfunction, appears to be appropriate for evaluation of the time course influences after epidural block.

Movements of the center of foot pressure (the center of pressure in the X-Y 2-dimensional coordinates that is vertically applied to the sole as a support surface of the body weight in the standing position) are recorded, and the measurement values are analyzed. We did record changes in the center of ground reaction force, but did not record changes in the center of the gravity of the body. However, they are considered to be similar for the upright standing position with gentle sway of small amplitude[4]. If there is nonincidental great sway that causes a difference between the center of the gravity of the body and the center of ground reaction force, observation of the course is still necessary.

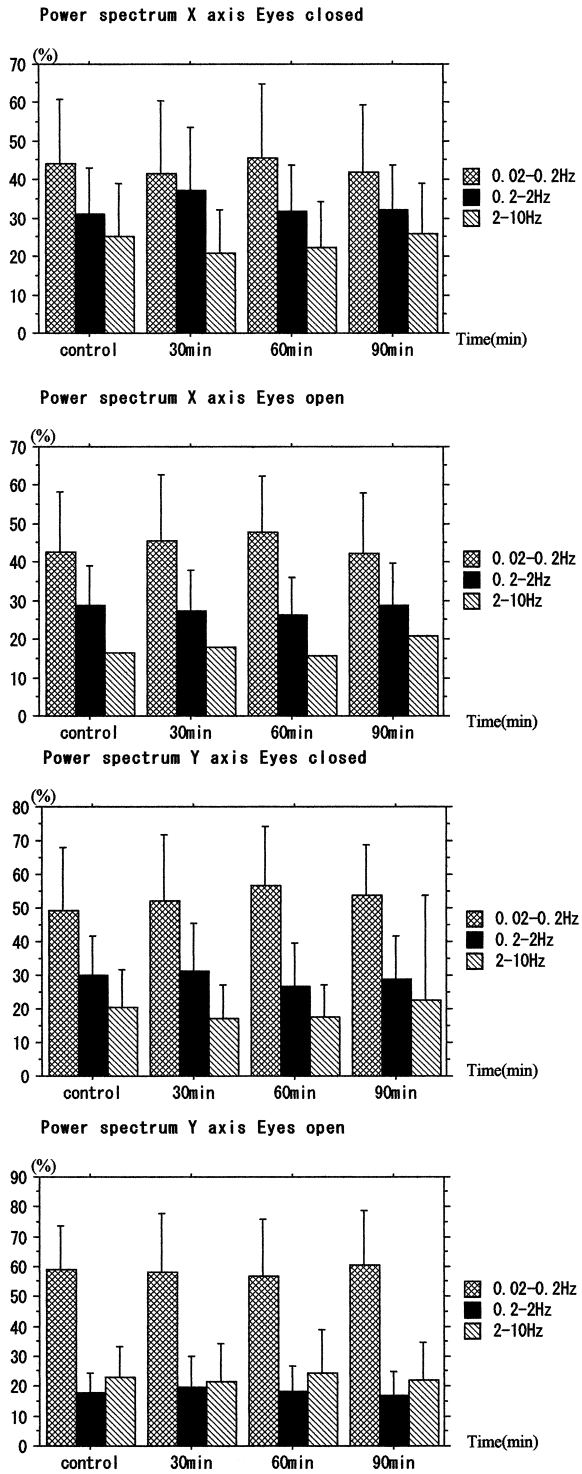

Fig. 6 Changes in power spectrum after epidural block
Valiance analysis (with Scheffè F test) was performed for the area ratio of power spectra (representing frequency components of sway in the right-and-left direction, i.e. the X axis and in the anteroposterior direction, i. e. the Y axis in barycentric coordinates) in frequency ranges of 0.02∼0.2, 0.2∼2, and 2∼10 Hz. A P-value<0.05 was considered to indicate significant. There is no significant difference between the area ratio of power spectra in frequency range of 0.02∼0.2, 0.2∼2,2∼10 Hz for the X- or Y-axis component with the eyes open or closed at any measurement point.

Locus length per unit time is an important parameter, indicating the instability of body sway. However, we considered that locus length per unit area is the best parameter of this study because this parameter represents minute postural control and reflects the postural control of propriospinal reflex system[18,19]. A significant increase 30 minutes after block was observed in locus length per unit area but not in locus length per unit time. These results suggest that marked effect remain after epidural block even when standing appears to be stable, and the observation of the course of effects after epidural block is still necessary for the safty of patients.

Sway area represents impairment in equilibrium function, and its value with the eyes closed increases with an increase in the importance of visual function in postural control. Sway area is most frequently used among the area parameters, but it is sometimes affected by 1～2 incidental sways. Epidural block was expected to most markedly affect the propriospinal reflex system and slightly affects sway area. Although sway area did not increase with the eyes closed, it increased significantly with the eyes open 30 minutes after epidural block. This suggests that epidural block may typically effect on the sway area with eyes open. To correct subjective feeling of discrepancy between before and after epidural block, visual function on equilibrium may produces incidental sway.

The Romberg ratio reflects upright postural control by the functions of the visual system, the cerebellar system and the labyrinth. We expected no significant changes in the Romberg ratio after epidural block, and our results of posturography supported our expectation.

Concerning power spectral analysis, the international criteria proposed the percentages of power in frequency zones of 0.02～0.2, 0.2～2, and 2～10 Hz. Increases in specific frequency zones according to disorders and sites of impairment have been reported[20]. Based on such increases, the system or site of impairment can be estimated in some cases. But associated disorders are mostly those in the labyrinth or cerebellum. Our results also suggested slight effects of epidural block on power spectra.

Posturography is considered to be useful examination when its application is appropriate. However, in addition to measurement values, various conditions of subjects during measurement including fatigue and the psychological state should not be ignored.

Type, concentration, and volume of local anesthetics used for epidural block are still controversial. Although there are few methods of objective evaluation of postural stability, safe and early discharge is desired. Our results suggest that marked effect remain after epidural block even when standing appears to be stable, and the observation of the course of effects after epidural block is still necessary for the safety of patients. We considered that locus length per unit area is a useful parameter for the assessment of an early discharge.

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References

1. Brown DL: Spinal, epidural, and caudal anesthesia. Anesthesia fifth edition (Miller RD, ed), 2000; pp 1491–1519, Churchill Livingstone Company, Philadelphia.
2. Dernedde M, Stadler M, Bardiau F, Boogaerts JG: Continuous epidural infusion of large concentration/small volume versus small concentration/large volume of levobupivacaine for postoperative analgesia. Anesth Analg 2003; 96: 796–801.
3. Cyr DG, Moore GF, Moller CG: Clinical application of CDP. Ear Nose Throat J 1988; Suppl 9: 36–37.
4. Suzuki J, Matsunaga T, Tokumasu K, Taguchi K, Watanabe I: Q & A and manual of postural sway (1995). Equilibrium Res 1996; 55: 64–77.
5. Tokita T: Systems and functions examined by posturography. Posturography, practice and interpretation, 1995; pp 3, Anima Conpany, Tokyo.
6. Bromage PR: A comparison of hydrochloride and carbon dioxide salts of lidocaine and prilocaine in epidural analgesia. Acta Anaesthesiol Scand 1965; Suppl 20: 55–69.
7. Chung F: Are discharge criteria changing? J Clin Anesth 1992; 5 : 64 S.
8. Tsuchiya K: Analysis of temporal and distance factor. Introduction to Clinical Gait Analysis, 1989; pp 11–23, Ishiyaku Shuppan, Tokyo.
9. Nancy MS, Nancy E, Higgins J, Ahmed S, Finch LE,

Richards CL: Responsiveness and predictable of gait speed and other disability measures in acute stroke. Arch Phys Med Rehabil 2001; 82: 1204–1211.
10. Hiller A, Pyykkö I, Saarivaara L: Evaluation of postural stability by computerized posturography following outpatient paediatric anaesthesia. Comparison of propofol/alfentanyl/N_2O anaesthesia with thiopental/halothane/N_2O anaesthesia. Acta Anaesthesiol Scand 1993; 37: 556–561.
11. Korttila K, Linnolia M: Recovery and skills related to driving after intravenous sedation: dose-response relation with diazepam. Br J Anaesth 1975; 47: 457–463.
12. Larsen LE, Gupta A, Ledin T, Doolan M, Linder P, Lennmarken C: Psychomotor recovery following propofol or isoflurane anaesthesia for day-care surgery. Acta Anaesthesiol Scand 1992; 36: 276–282.
13. Vuyk J, Hennis PJ, Burm AGL: Comparison of midazolam and propofol in combination with alfentanyl for total intraveneous anesthesia. Anesth Analg 1990; 71: 645–650.
14. Gupta A, Ledin T, Larsen LE, Lennmarken C, Ödkvist LM: Computerized dynamic posturography: a new method for evaluation of postural stability following anaesthesia. Br J Anaesth 1991; 66: 667–672.
15. Ledin T, Gupta A, Tator M: Postural control after propofol anaesthesia in minor surgery. Acta Anaesthesiol Scand 1995; Suppl 520: 313–316.
16. Song D, Chung F, Wong J, Yogendran S: The assessment of postural stability after ambulatory anesthesia: A comparison of desflurane with propofol. Anesth Analg 2002; 94: 60–64.
17. Antony EP, Martin GP, Basil O, Roshan F: Effect of combined spinal-epidural ambulatory labor analgesia on balance. Anesthsiology 1999; 91: 436–441.
18. Okawa T, Tokita T, Shibata Y, Ogawa T: Stabilometry. Significance of locus length per unit area. Equilib Res 1995; 54: 296–306.
19. Yamamoto M: Practice of posturography. Med Technology 2001; 29: 105–110.
20. Taguchi K: Clinical application of postural sway frequency spectra. Equilibrium Res 1978; 37: 113–117.

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