The Subliminal Vibration Stimulus Makes the Improvement of the Standing Balance

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Abstract— **The fall accident of the elderly person gives serious results. One of the fall prevention methods is the improvement of the standing balance ability. We have already reported that the standing balance ability is improved by the subliminal vibration stimulus to planta pedis. The stimulus to planta pedis has the problems including the possibility of the damage of the stimulator. The aim of this study is to evaluate the influence of the subliminal vibration stimulus to the bone prominence of lower leg to the standing balance ability. The stimulus points are head of fibula, lateral malleolus, malleolus medialis, tuberosity of navicular bone and 5th metatarsal bone tuberosity. The experiments are conducted under six kinds of conditions, that is, the stimulus at five places separately and no stimulus vibration. The experiment repeats five times for each condition. The stimulus intensity is 90% of the intensity to feel vibration. Therefore, a subject does not feel the vibration even if a vibration stimulus is applied during the measurement. The subjects are five healthy males. A subject stands on one leg with closed eyes. We measured the center-of-foot-pressure (CFP) sway for 10 seconds. The standing balance was evaluated by the locus area and length of CFP sway. The stimulus to malleolus medialis or tuberosity of navicular bone or 5th metatarsal bone tuberosity significantly improved standing position balance. It became clear that the stimulus to the ankle could improve standing posture balance.**

Keywords— **fall prevention, vibration stimuli, bone prominence, standing position balance maintenance ability.**

I. Introduction

As the aging rate of Japan is 24.1%, Japan reaches a super aged society now. Therefore the injury prevention of the elderly people is considered as important. One of the injury preventive methods is the fall prevention. The fall accident of the elderly people causes the fracture of neck of femur, and it becomes the one of the causes of the nursing-care facility entrance. In an at-home elderly person 65 years or older, the yearly incidence of fall is 10-20%. It is reported that approximately 10% of people of fall result in a fracture. Furthermore, the elderly people who experienced a fall, even if their injuries are slight, are affected psychologically. And they stay indoors and their daily life is inactive. As the results, they receive various health hazards [1]

The factors of the fall accident of the elderly person include the internal factor and the external factor. The internal factor is the decrease of the physical ability by a disease and the aging. An example of the external factor is that they catch a thing including a chair or the code. It is said that the deep sensation involve in standing position balance maintenance ability.

Collins et al [1] gave the plantar entire surface the white noise vibration stimulus and showed that the elderly people's standing position balance maintenance ability was improved. In contrast, we showed that the standing position balance maintenance ability improved by single sine wave vibration stimulus to three points on planta pedis [2]. However, there were problems that a vibrator was damaged when excessive pressure hung because a vibrator was attached to planta pedis.

The aim of this study is to evaluate the influence of the subliminal vibration stimulus to the bone prominence of lower leg to the standing position balance maintenance ability.

II. Experiment

The subjects are five healthy males.

A. Stimulus

By the result of the prior study, the stimulus frequency was set 225Hz which was the most effective to center-of-foot-pressure deflection decrease. The stimulus points were head of fibula, lateral malleolus, malleolus medialis, tuberosity of navicular bone and 5th metatarsal bone tuberosity (Fig.1). The stimulus intensity is 90% of the intensity to feel weakest vibration. Therefore, a subject did not feel the vibration even if a vibration stimulus is applied during the measurement.

B. Experimental device

The stimulation device is comprised of an oscillation circuit, an amplification circuit and vibrators. Figure 1 shows the block diagram of the stimulus device.

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C. Posture of subject

Fig.3 shows the posture of a subject. The subject closed his eyes and, stood on the right leg only with the folded arms. During measurement, the knee of the support leg was extended. The hip joint and knees joint of the non- support leg were bent a little.

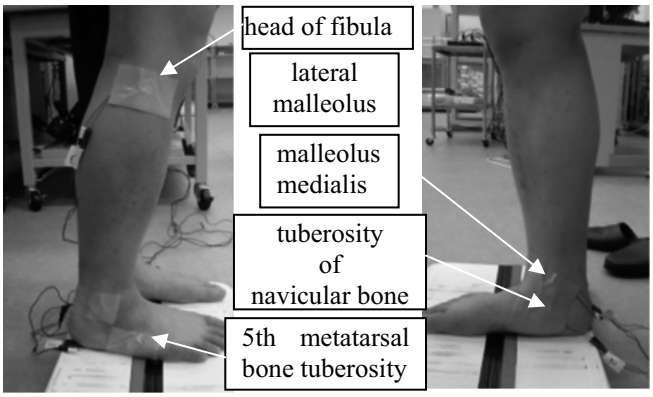

Fig. 1 Stimulus points

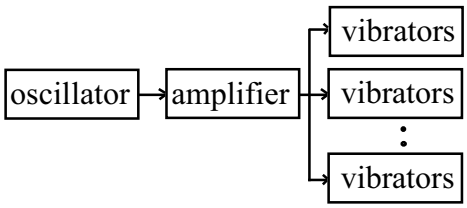

Fig. 2 Block diagram of stimulus device

Fig. 3 Posture of a subject

D. Measurement

The experiments were conducted under six kinds of conditions, that is, the stimulus at five places separately and no stimulus vibration. The experiment repeated five times for each condition. We performed the experiment of six conditions at random and chose it to be not recognized by a subject. The experiment was started according to the sign of the subject and was terminated at the time of the followings. (1)Ten seconds had passed. (2)Folded arms were separated. (3)Non-support leg touched the floor. (4)Eyes open. (5) Heel of support leg left the floor.

E. Evaluation

We measured the center-of-foot-pressure (CFP) sway. The standing balance was evaluated by the 95% effective locus area and the locus length of CFP sway.

III. RESULTS

Fig.4 shows the average of locus length. The locus length decreased at a point except the 5th metatarsal bone tuberosity. The decrease at lateral malleolus was big especially, but there was no significant difference.

Fig.5 is the average of 95% effective locus area. The 95% effective locus area decreased at a point except the tuberosity of navicular bone. Big decrease was seen at metatarsal bone tuberosity and a malleolus medialis. The significant difference was shown by the t-test.

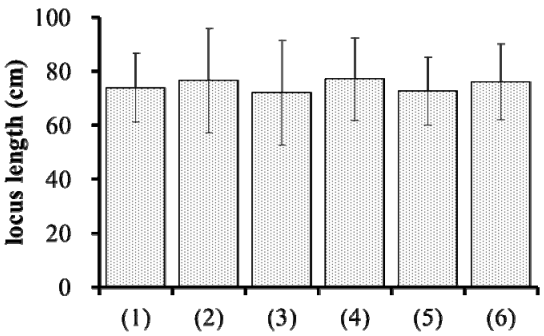

Fig. 4 Average of locus length
(1) no stimulus
(2) 5th metatarsal bone tuberosity

(3) tuberosity of navicular bone
(4) malleolus medialis
(5) lateral malleolus,
(6) head of fibula

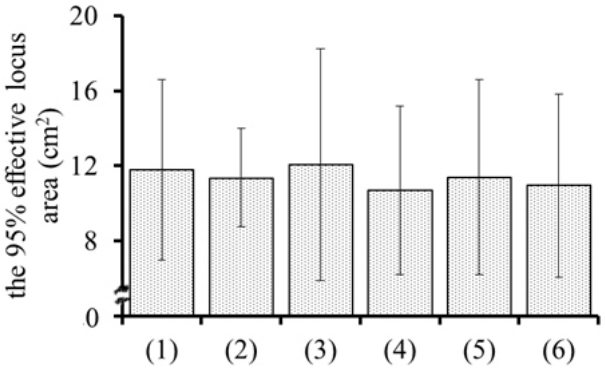

Fig. 5 Average of 95% effective locus area
(1) no stimulus
(2) 5th metatarsal bone tuberosity
(3) tuberosity of navicular bone
(4) malleolus medialis
(5) lateral malleolus,
(6) head of fibula

IV. DISCUTTION

In this study, we verified whether the vibration stimulus to bone prominences influenced the standing balance. Both decreases in the locus length and the 95% effective locus area were seen by adding vibration stimulus to a malleolus medialis, lateral malleolus and head of fibula. From these results, it is thought that standing balance maintenance ability improves. By the stimulus to the metatarsal bone tuberosity, the decrease in the 95% effective locus area decreased, but the locus length increased. As for this, it is thought that the center-of-foot-pressure moved actively within a narrow area.

The meaningful decreases in the 95% effective locus area were seen in the stimulus to metatarsal bone tuberosity and malleolus medialis. Because metatarsal bone tuberosity is closer to the planta pedis than other points, almost the same effect with our past study was shown.

About the stimulus to a malleolus medialis, the tibia which was the big bone of the volume increased direct vibration stimulus without stepping over the joint. As a result, it is thought that a vibration stimulus effect was brought more widely.

V. CONCLUSIONS

We performed the experiments to plan improvement of the standing balance maintenance ability by adding vibration stimulus to the planta pedis in our past study. However, there was a problem that vibrators were damaged, because they were attached on the planta pedis, whose pressure increased in the walking. To dissolve these problems, we chose the proximal bone protrusion where the pressure was not added at the time of walking. And we applied the subliminal vibration stimulus there and observed a change of the center-of-foot-pressure sway. As the results, the decrease in the 95% effective locus area was found by stimulus to metatarsal bone tuberosity, a malleolus medialis, lateral malleolus and head of fibula.

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