Prototype Quantitative Mechanical Device for Measuring Tactile and Pressure Sense : Measurement of Movement Precision in Hand Palsy Associated with Cerebrovascular Disease.

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報　告

Prototype Quantitative Mechanical Device for Measuring Tactile and Pressure Sense : Measurement of Movement Precision in Hand Palsy Associated with Cerebrovascular Disease.

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1 Introduction

Rehabilitation training involving the adjustment of the posture of upper limb motion with sight and somatosensory feedback is used to improve functional outcome in patients with upper limb and finger movement dysfunction[1-2]. However, an index of upper limb and finger movement precision has not yet been established, and therapists must rely on their own experience to evaluate the effectiveness of training. Accurate evaluation requires the establishment of a method of measuring the changes in movement precision.

We have established an index for the precise evaluation of index finger movement control function and have analyzed the movement precision in a series of experiments[3-5]. In addition, we have performed experiments to determine the effects of multiple somatosensory input stimulation[6]. The development of an appropriate therapy program requires clarification of the ratio of somatosensory input. For this purpose, we have developed a quantitative mechanical device for determining tactile and pressure sense to allow measurement of movement precision.

2 Prototype quantitative mechanical device for measuring tactile and pressure sense

Figure. 1 show the device developed to measure the pushing force at the index finger. With this device, the amplitude of the pushing force is monitored on a display (RDT-193E ; Mitsubishi, Japan) in front of the subject. The base unit is constructed of stainless pipe having a length of 300 mm, a width of 300 mm, and a height of 500 mm that is fixed to the desk. A servomotor (KRS-786ICS ; Kondo, Japan) is fixed at the center of the wooden board on the base unit. A strain gauge is fixed to a stainless plate (length : 50 mm, width : 30 mm, and thickness : 0.3 mm) suspended from the servomotor by 100 mm of wire. The pressboard is suspended horizontally from the stainless plate by the wire. To stabilize the pressboard, a 300-g mass is suspended from the pressboard by the wire to maintain the tension of the wire.

The servomotor is controlled by a motion control board (RCB-1 ; Kondo, Japan) and dedicated software (Heart To Heart Ver 1.4 ; Kondo, Japan). A strain-measuring device (PCD300A ; Kyowa, Japan) is connected to the strain gauge for measurement of the push force, and the measurement data are analyzed on a laptop computer (CB-1 ; Sharp, Japan) using the PCD30A software package (Kyowa, Japan).

3 Calibration of the mechanical device

Figure. 2 shows the calibration of the mechanical device. The rated capacity was 1,000 g, and the rated output was 91.25 $\mu\varepsilon$. Hysteresis was defined as the

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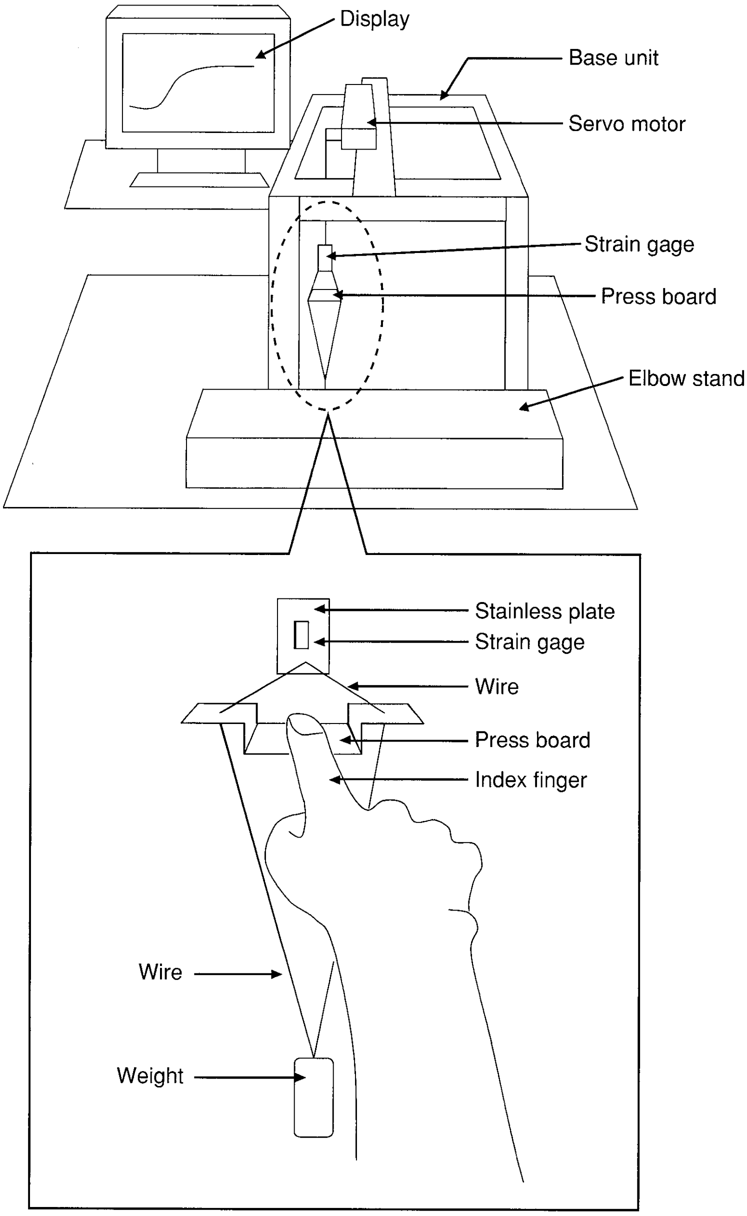

Fig. 1 Device for the measurement of tactile and pressure sense. Detail of the device around the pressboard. The subject was instructed to push on the pressboard using his/her index finger.

maximum difference between the increase and decrease divided by the rated output, as shown in the following equation:

$$Hysteresis = \frac{\text{maximum difference between increase and decrease}}{\text{Rated Output}} \times 100\ (\%RO). \quad 1)$$

The result was 4.38 (%RO), indicating that it was possible to use the device to measure the tactile and pressure sense within 1,000 g.

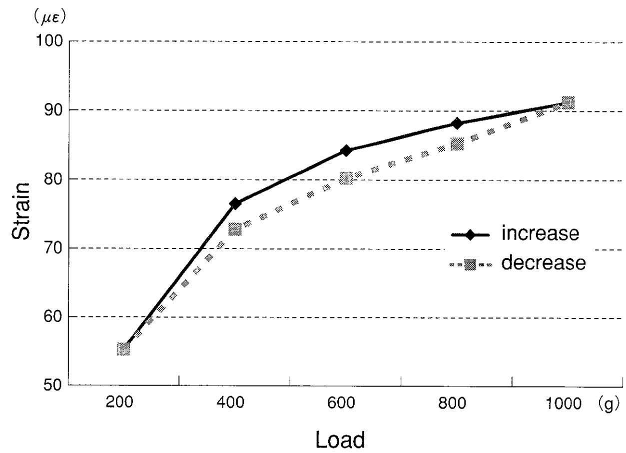

Fig. 2 Calibration of the mechanical device showing the maximum difference between increase and decrease.

4 Application of the device to research

These experimental tools are able to stimulate various input materials to represent a variety of tactile and pressure senses. This device can be used to simulate various materials used in rehabilitation. In addition, the device can be used to examine the influence of materials on movement precision.

We were able to examine the relationship between movement precision and material using the mechanical device described in this report.

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