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Original Article

The Influence of Age-related Changes in Tactile Sensibility and Muscular Strength on Hand Function in Older Adult Females☆

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SUMMARY

Background: Aging affects the human hand function. For example, a decline in manual dexterity often accompanies old age. This decline corresponds to age-related changes in muscle and/or tactile functions. This study investigated whether age-related changes in muscular strength and tactile sensibility are related to the hand function.

Methods: The subjects consisted of 64 older adult females. The hand function was assessed using Perdue pegboard test. The handgrip strength was measured using a handgrip dynamometer. Tactile-pressure threshold was evaluated using Semmes-Weinstein monofilaments. These tests were performed on the dominant hand. All data items were compared among the four age groups (65–69 years, $n = 17$; 70–74 years, $n = 16$; 75–79 years, $n = 15$; 80–85 years, $n = 16$).

Results: The scores on Perdue pegboard test showed significant differences among the four age groups, and they decreased with age. The tactile-pressure threshold was augmented with increasing age, whereas handgrip strength did not differ among the four age groups. A significant relationship was observed between the Perdue pegboard test score and tactile-pressure threshold ($r = -0.61$), but not the handgrip strength ($r = 0.18$).

Conclusion: These results suggested that the manual dexterity in the hand function was attenuated with increasing age. We considered that this attenuating effect was associated with a decline in tactile sensibility rather than a change in the muscular strength of the hand.

1. Introduction

The changes in motor function that accompany aging include a marked decline in strength and muscle mass, leading to impairments in mobility and the activities of daily living (ADL). Regarding the decrease in lower extremity strength, a prior study reported that the decline in lower extremity strength begins after the fifth decade of life.[1] This decline in strength associated with aging impairs individual's ability to respond quickly and forcefully to prevent a fall after a postural disturbance, thus leading to increased falling by elderly individuals.[2–5] These previous results suggested a close relationship between motor function and lower extremity strength.

Aging also affects human manual function, as reflected by the skillful use of the fingers in grasping, lifting, and manipulating objects. A previous study reported that a 15% loss in strength per decade occurs in individuals of 50–70 years old.[3] This age-related change in strength corresponds to a decrease in skeletal muscle mass.[6] On the other hand, human hands show excellent sensory function and motor function. For example, the human hand can discriminate the texture, shape, and temperature of surfaces by touching them with the fingers. However, this sensory perception gradually weakens with aging, resulting in worsening performance in ADL, such as fastening buttons, tying shoelaces, writing a note, and others[7] because of age-related changes in muscular strength and sensation in the hand as described above. However, regarding hand motor function, which requires highly skilled motor control, age-related changes in hand sensation may be more important as a determinant of the decrease in manual function than muscular strength in the elderly, in contrast to lower limb motor function, which involves

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an element of gross motor function. This study, therefore, investigated whether age-related changes in muscular strength and tactile sensibility are related to manual function in older adults.

2. Materials and Methods

2.1. Subjects

Sixty-four adult females aged 65–84 years (mean age, 74.4 ± 5.8 years) participated in this study. All the subjects professed to be in good health on a standard medical examination questionnaire and lived independently in the community. None of the subjects had the common diseases, which are known to influence neuromuscular function of the hand, such as carpal tunnel syndrome, osteoarthritis of hand joints, diabetic polyneuropathy, or cervical spondylosis-related cervical radiculopathy. However, three subjects indicated diet-controlled diabetes. Another 39 subjects were on regular medication for cardiovascular problems and/or osteoarthritis of knee joints and/or low back pain. The remaining 22 elderly individuals did not take regular medication. Moreover, before the study, we administered the Mini-Mental State Examination, and all subjects passed (borderline passing score of 25). To clarify the age-related changes in hand function, the participants were divided into four age groups (65–69 years, $n = 17$; 70–74 years, $n = 16$; 75–79 years, $n = 15$; and 80–85 years, $n = 16$). Each subject was informed in advance of the purpose of the study and of the procedures involved, and their consent was obtained. This study was performed in accordance with the Declaration of Helsinki and approved by the Institutional Ethical Committee of Nagasaki University.

2.2. Measurements

Manual function was assessed using the Perdue pegboard test (Lafayette Instrument, Lafayette, IN, USA). This standardized reliable[8] means of evaluating hand and finger function involves retrieving small metal pegs (length, 25 mm; diameter, 3 mm) from a cup and placing them in a line of holes. The number of pegs placed in the holes within 30 seconds was recorded. Handgrip strength was measured using a digital handgrip dynamometer (TKK5401; Takei Kiki Kogyo, Japan). These tests were repeated twice with the dominant hand, and the maximum value was determined. The tactile-pressure threshold on the distal palmar pad of the index finger was evaluated using Semmes-Weinstein monofilaments (North Coast Medical, Morgan Hill, CA, USA). We used 20 kinds of filaments ranging in weight from 0.004 to 447 g. For each filament, the aesthesiometer pressure in grams was converted to $\log_{10}$0.1 mg, yielding a scale composed of intervals of approximately equal intensity between filaments. The subjects were tested with their eyes closed after receiving clear instructions. The target area was marked on the volar side of the distal phalanx of the dominant index finger. Each filament was pushed into the target area until it bent about 90° for about a second. The threshold was recorded as the smallest filament diameter that could be perceived in at least 80% of its applications (five trials).

2.3. Statistical analysis

Differences because of age were examined using one-way analysis of variance. If a significant F value was found for a main effect, Tukey post hoc test was performed to detect significant differences in mean values among the four age groups. Furthermore, Pearson's correlation was performed to determine the relationships between the pegboard test score and handgrip strength or tactile-pressure threshold. The level of statistical significance was defined as $p < 0.05$. The data are expressed as the mean ± standard error.

3. Results

3.1. Age-related changes in the Purdue pegboard score, handgrip strength, and tactile-pressure threshold

The pegboard test scores for the four age groups (65–69 years, 70–74 years, 75–79 years, and 80–85 years) were 15.9 ± 1.7, 14.0 ± 2.6, 12.8 ± 2.7, and 12.6 ± 1.5, respectively. This age-related change in the functional test scores (pegs placement) showed significant differences among the four age groups ($p < 0.01$; Fig. 1A). However, handgrip strength did not differ among the four age groups (65–69 years, 22.1 ± 3.8 kg; 70–74 years, 20.6 ± 3.2 kg; 75–79 years, 20.8 ± 2.6 kg; 80–85 years, 19.7 ± 4.3 kg, $p = 0.29$; Fig. 1B). In contrast to the results for handgrip strength, the tactile-pressure threshold increased with age (65–69 years, 2.8 ± 0.3 $\log_{10}$0.1 mg; 70–74 years, 3.0 ± 0.4 $\log_{10}$0.1 mg; 75–79 years, 3.1 ± 0.3 $\log_{10}$0.1 mg; 80–85 years, 3.2 ± 0.3 $\log_{10}$0.1 mg, $p < 0.01$; Fig. 1C)

3.2. Relationships between the Purdue pegboard score and the tactile-pressure threshold or handgrip strength

The Perdue pegboard test score showed no relationship with handgrip strength ($r = 0.18$, $p = 0.17$; Fig. 2A) and a negative relationship with the tactile-pressure threshold ($r = -0.61$, $p < 0.01$; Fig. 2B).

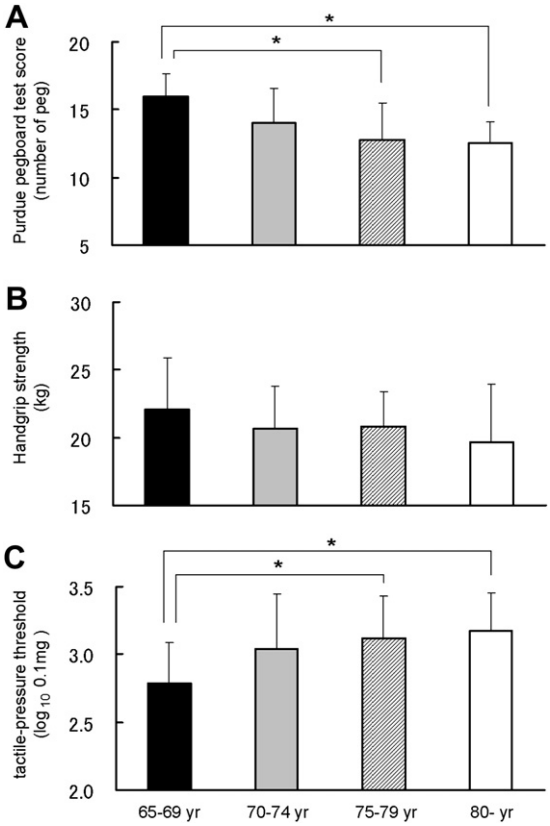

Fig. 1. The age-related changes in pegboard test scores (A), handgrip strength (B), and tactile-pressure threshold (C). The data were compared among the four age groups (65–69 years: ■, 70–74 years: ▒, 75–79 years: ▨, 80–85 years: □). *$p < 0.05$.