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Original Article

The effects of hand strength on upper extremity function and activities of daily living in stroke patients, with a focus on right hemiplegia

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Abstract. [Purpose] The purpose of this study was to investigate the effects of hand strength on upper extremity function and activities of daily living in patients with right hemiplegia, as well as to provide important fundamental data for rehabilitation after stroke. [Subjects and Methods] This study was conducted from May 1 to December 30, 2013, at the Department of Rehabilitation of P Hospital in Seoul and included subjects hospitalized with a diagnosis of stroke. Patients with right hemiplegia were selected, and their hand strength, upper extremity function, and activities of daily living were evaluated. Hand strength was measured by grip, lateral pinch, and three-point pinch strength. [Results] The effects of hand strength on upper extremity function were evaluated. The results showed that all types of hand strength significantly influenced upper extremity function. However, only grip strength influenced activities of daily living. [Conclusion] In rehabilitation of stroke patients, it is necessary to first improve their general physical condition and basic activities of daily living, and then improve hand movement and hand muscle strength for instrumental activities of daily living training, which requires detailed hand movements.
Key words: Hand strength, Upper extremity, Activities of daily living

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INTRODUCTION

Stroke, one of three main causes of death in South Korea, is a general term for cerebrovascular diseases and accidents that can lead to sudden changes in consciousness and paralysis. Generally, stroke is characterized by disorders of sensory, motor, perceptive, cognitive, and language functions, as well as mobility disorders on the side of the body opposite to the stroke region[1]. In particular, muscular weakness and spasticity of the upper extremities, imbalance, hypertonia, and dysesthesia can cause a loss of motor control in the upper extremities[2]. The upper extremities, including the hands, are used for most activities in the workplace; they are a means of communication and play a critical role in many cognitive activities and motor function[3].

Upper extremity function is closely related to the performance of activities of daily living (ADLs), as well as social participation. Therefore, by reducing upper extremity damage, it is possible to facilitate independent ADLs in stroke patients[4]. Previous studies have examined the factors that influence upper extremity function after stroke. In a study of 100 stroke patients, myotonia, proprioceptive sense, and neglect were identified as factors predictive of upper extremity motor recovery[5]. It was reported that 16–17% of stroke patients had shoulder pain, more than 80% of whom had a disorder or absence of voluntary movement of the upper extremities[6]. In addition, age, eyesight, perception, understanding, cognition, depression, and motivation all have an effect on functional recovery[7]. Many studies have been conducted on individual factors related to upper extremity function after stroke. However, there is a lack of research on how hand strength, a critical factor of recovery in stroke patients, directly influences upper extremity function and ADLs. In particular, there are almost no

Table 1. General characteristics of the survey participants (n=62)

	Male (n=39)	Female (n=23)
Age (years)	59.5 ± 12.4	68.5 ± 14.5

Values are means ± SD.

Table 2. Subjective grip and pinch strengths (n=62)

	Male (n=39)	Female (n=23)
Grip strength (kg)	6.9 ± 7.4	8.1 ± 6.3
Lateral pinch strength (kg)	2.1 ± 2.1	2.5 ± 1.8
Three-point pinch strength (kg)	1.7 ± 2.1	2.0 ± 1.3

Values are means ± SD.

reports on hand strength in patients with right hemiplegia, which directly influences ADLs and determines the quality of their performance. For the most part, patients with left hemiplegia and an unaffected dominant right hand can perform self-care after stroke. However, dominant hand damage in patients with right hemiplegia directly influences their ADLs. Therefore, by investigating the effects of hand strength on upper extremity function and ADLs in patients with right hemiplegia, this study aims to provide fundamental data that can be used for rehabilitation after stroke.

SUBJECTS AND METHODS

This study was conducted from May 1 to December 30, 2013, and included 62 patients who received a diagnosis of stroke at the Department of Rehabilitation of P Hospital in Seoul and had been hospitalized. The research used surveys and assessment report measurements. All details of study procedures were submitted to the Science Research Council of Inje University, which approved the protocol.

Patients with right hemiplegia were selected, and hand strength, upper extremity function, and ADLs were evaluated. The subjects voluntarily agreed to participate in the study after obtaining information on the study's purpose and methods. Hand strength was measured by grip, lateral pinch, and three-point pinch strength. Grip strength was measured by gradations on a dynamometer, which study subjects were asked to grip as firmly as possible. Sequential measurements were carried out 3 times, and the average value was calculated. Lateral pinch strength was measured by pinching the thumb and forefinger together laterally as if gripping a key. Three-point pinch strength was measured by pressing the middle finger and forefinger down onto the thumb[8].

Upper extremity function was evaluated using the Manual Function Test (MFT), which is used to measure upper extremity function and mobility in stroke patients. The test consists of items involving motor function of the upper extremities (4 items), gripping (2 items), and finger gestures (2 items). One point is given for each successful execution. No points are given for execution failure. The total maximum score is 32 points[9].

ADLs were evaluated using the Korean version of the Modified Barthel Index (K-MBI) which comprises 7 self-care activities and 3 mobility activities. Each area is scored on a 5-points scale, and the maximum score is 100 points[10].

Research data were analyzed using the PASW Statistics ver. 18.0 software. Analysis of correlations between the 3 variables of hand strength, upper extremity function, and ADLs was conducted using Pearson's correlation coefficient. The statistical significance level in this study was $p < 0.05$.

RESULTS

The general characteristics of the study subjects are summarized in Table 1. Of the 62 subjects, 39 were male (average age, 59.3 years) and 23 were female (average age, 68.5 years). Correlation analysis was conducted for hand strength, upper extremity function, and ADLs, and the results are shown in Tables 2 and 3. There was a correlation between upper extremity function and grip strength, lateral pinch strength, and three point pinch strength. ADLs was correlated with grip strength only.

DISCUSSION

Stroke patients have difficulty recovering complete upper extremity function and therefore have limitations in ADLs and social participation. For this reason, it is important to identify the factors that influence upper extremity function and ADL performance and to apply the identified factors to rehabilitation. Therefore, this study tried to determine how hand strength, a critical factor in recovery, directly influences upper extremity function and ADLs in stroke patients.

This study showed that grip strengths of both the entire palm and fingers, including lateral pinch strength and three-point pinch strength, significantly influence upper extremity function. Heller et al. reported that hand strength reflects hand function[11]. Sunderland et al. reported that hand strength improves in proportion to the complicated motor task ability of the upper extremities and suggested that hand strength is a critical indicator of functional recovery in stroke. Their results were similar to this study's findings[12]. The effects of hand strength on ADLs were analyzed. Grip strength significantly influenced ADLs, but lateral pinch and three-point pinch strength did not. Previous studies reported that hand strength significantly influences instrumental activities of daily living (IADLs). Some studies have shown that programs to increase hand function improved

Table 3. Correlation between upper extremity function, ADLs, and grip and pinch strengths (n=62)

	MFT	K-MBI	Grip strength	Lateral pinch strength	Three-point pinch strength
MFT	1	0.3*	0.7**	0.7**	0.6**
K-MBI		1	0.3*	0.1	0.1
Grip strength			1	0.9**	0.8**
Lateral pinch strength				1	0.9**
Three-point pinch strength					1

*Significant difference ($p<0.05$). **Significant difference ($p<0.01$)

MFT: Manual Function Test (upper extremity function); MBI: Modified Barthel Index (ADLs)

hand strength and certain areas of IADL function, and that a high level of hand strength positively influenced independence in IADLs[13, 14]. In the case of IADLs that require detailed hand movement, successful function can differ depending on whether the muscular strength of the fingers has recovered. However, this study revealed that grip strength directly influenced ADLs but that pinch strength did not. The above results indicate that in the case of basic ADLs, the overall recovery of body or upper extremity movement has more influence than muscular strength in the fingers. Thus, the treatment with greater effect in the rehabilitation of stroke patients is to first increase the body conditions necessary for basic ADLs and then improve finger movement, grip strength, and pinch strength for IADL training requiring detailed hand movement.

A limitation of this study is the generalizability of its results, because the subjects were limited to a portion of stroke patients in Seoul. Therefore, further research requires participation of more sites to reflect the outcomes for a larger number of subjects, enabling use of the data for therapy of stoke patients.

REFERENCES

1) Jørgensen HS, Nakayama H, Reith J, et al.: Stroke recurrence: predictors, severity, and prognosis. The Copenhagen Stroke Study. Neurology, 1997, 48: 891–895. [Medline] [CrossRef]

2) Gracies JM, Marosszeky JE, Renton R, et al.: Short-term effects of dynamic lycra splints on upper limb in hemiplegic patients. Arch Phys Med Rehabil, 2000, 81: 1547–1555. [Medline] [CrossRef]

3) Buccino G, Solodkin A, Small SL: Functions of the mirror neuron system: implications for neurorehabilitation. Cogn Behav Neurol, 2006, 19: 55–63. [Medline] [CrossRef]

4) Whitall J, McCombe Waller S, Silver KH, et al.: Repetitive bilateral arm training with rhythmic auditory cueing improves motor function in chronic hemiparetic stroke. Stroke, 2000, 31: 2390–2395. [Medline] [CrossRef]

5) Feys H, De Weerdt W, Nuyens G, et al.: Predicting motor recovery of the upper limb after stroke rehabilitation: value of a clinical examination. Physiother Res Int, 2000, 5: 1–18. [Medline] [CrossRef]

6) Van Ouwenaller C, Laplace PM, Chantraine A: Painful shoulder in hemiplegia. Arch Phys Med Rehabil, 1986, 67: 23–26. [Medline]

7) Blanton S, Wolf SL: An application of upper-extremity constraint-induced movement therapy in a patient with subacute stroke. Phys Ther, 1999, 79: 847–853. [Medline]

8) Yoo C, Park S, Yang D, et al.: Study of the physical condition of middle-aged office and field workers aged 50 and older. J Phys Ther Sci, 2014, 26: 1575–1577. [Medline] [CrossRef]

9) Han SH, Kam KY: Effects of augmented feedback training on the upper-limb functions and ADLs of chronic stroke patients. J Kor Asso Occup Ther Policy Aged Ind, 2012, 4: 41–53.

10) Jung HY, Park BK, Sin HS, et al.: Development of the Korean Version of Modified Barthel Index (K-MBI): multi-center study for subjects with Stroke. Annals of Rehabil Med, 31: 283–297.

11) Heller A, Wade DT, Wood VA, et al.: Arm function after stroke: measurement and recovery over the first three months. J Neurol Neurosurg Psychiatry, 1987, 50: 714–719. [Medline] [CrossRef]

12) Sunderland A, Tinson D, Bradley L, et al.: Arm function after stroke. An evaluation of grip strength as a measure of recovery and a prognostic indicator. J Neurol Neurosurg Psychiatry, 1989, 52: 1267–1272. [Medline] [CrossRef]

13) Ishizaki T, Watanabe S, Suzuki T, et al.: Predictors for functional decline among nondisabled older Japanese living in a community during a 3-year follow-up. J Am Geriatr Soc, 2000, 48: 1424–1429. [Medline] [CrossRef]

14) Eng JJ: Strength training in individuals with stroke. Physiother Can, 2004, 56: 189–201. [Medline] [CrossRef]