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Contribution of Cognitive and Physical Functions to Activities of Daily Living in Hospitalized Older Patients with Stroke

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Abstract

Background: The extent to which cognitive function, muscle strength, muscle power, and balance function affect the capacity for activities of daily living (ADL) in hospitalized older patients with stroke remains unclear.

Methods: This cross-sectional study included 34 hospitalized older patients with stroke aged 65 years old and over. Cognitive function, muscle strength, muscle power, and balance were measured using the Revised Hasegawa's Dementia Scale (HDS-R), handgrip strength (HS), 5 times sit-to-stand test (FST), and Berg Balance Scale (BBS), respectively. The Barthel Index (BI) was used to assess capacity for ADL. The association of capacity for ADL with cognitive function, muscle strength, muscle power, and balance was evaluated using correlation and multiple regression analyses.

Results: Capacity for ADL (BI score) was associated with the HDS-R, HS, FST, and BBS scores by correlation analysis ($p < 0.05$). In contrast, only the BBS was significantly extracted as an independent predictor of capacity for ADL, even after adjusting for confounding factors using multiple regression analysis ($p < 0.05$).

Conclusion: These results suggest that evaluating or enhancing balance function may be effective in maintaining or improving capacity for ADL in hospitalized older patients with stroke.

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Background

According to the Ministry of Health, Labor, and Welfare in Japan, cerebrovascular disease (stroke) was reported as the second leading cause of the need for nursing care by 19.0% of persons requiring care [1]. As people age, the percentage of people who become fully independent (no problems in daily living or social life) decreases after stroke onset [2]. Therefore, it is necessary to identify the causes of the decline in capacity for activities of daily living (ADL), especially in older individuals who have experienced a stroke.

Body function predicts future capacity for ADL, grip strength, and cognitive function. [3]. Grip strength is related to upper limb strength and lower limb and trunk muscle strength, indicating overall muscle strength [4]. In contrast, muscle function includes muscle strength and power, which is involved in capacity for ADL [5, 6]. Additionally, the balance function is associated with capacity for ADL [7]. However, muscle power and balance are not included in the body functions that affect capacity for ADL, and the extent to which cognitive function, muscle strength, muscle power, and balance affect capacity for ADL remains unclear. Clarifying the extent to which cognitive function, muscle strength, muscle power, and balance function impact capacity for ADL could be useful for evaluation and treatment selection and, ultimately, lead to the maintenance and improvement of capacity for ADL in older adults with stroke.

This study aimed to clarify how cognitive function, muscle strength, muscle power, and balance function influence capacity for ADL in older adults with stroke.

Materials & Method

Patients

This cross-sectional study included 55 hospitalized patients with stroke aged 65 years and older at the Comprehensive Rehabilitation Unit of Toyoda Eisei Hospital in Japan. The exclusion criteria were as follows: 1) age < 65 years; 2) inability to obtain consent; and 3) incomplete measurement. Finally, 34 patients were included in the analysis (4 patients aged < 65 years and 17 patients with incomplete measurements were excluded). Patient diseases were obtained from medical records. The diseases of the patients were as follows: 1) cerebral infarction/cerebral embolism (n = 25), 2) cerebral hemorrhage (n = 8), and 3) subarachnoid hemorrhage (n = 1). All patients provided written informed consent, and the study was approved by the Ethics Committee of the Health Science University.

Cognitive function

The Revised Hasegawa's Dementia Scale (HDS-R) was used to assess cognitive function [8,9]. This test consists of nine items, with a

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maximum possible score of 30 points. The patients were asked the following questions: (1) their age (1 point), (2) today's date, including the year, month, day, and day of the week (4 points), (3) their current location (2 points), (4) repetition of three words (3 points), (5) serial subtraction (100−7 and 93−7) (2 points), (6) backward digit span (6-8-2 and 3-5-2-9) (2 points), (7) delayed recall of three words (6 points), (8) immediate recall of five hidden objects (5 points), and (9) listing vegetable names (scoring from 0 points for fewer than five names to 5 points for ten names). A total score of 30 indicates full cognitive function, while a score of 20 or lower suggests possible dementia [8,9].

Muscle strength

Handgrip strength (HS) was assessed using a digital hand dynamometer (Grip-D; Takei, Niigata, Japan) while the patients were seated with extended arms. Measurements were performed two times for each hand, and the highest value among the four trials was recorded as the representative value.

Muscle power

Previous studies reported that chair sit and stand times were associated with leg power [10,11]. We measured sit-to-stand tests (FST) five times for each patient (one item on a short physical performance battery). Starting from the sitting position with both hands folded in front of the arms, the time (s) to the fifth standing position was measured.

Balance function

The Berg Balance Scale (BBS) was used to evaluate balance ability and was observed to have high inter- and intra-rater reliabilities in a previous study [12]. The BBS consists of 14 items as follows: 1) sitting to standing, 2) standing unsupported, 3) sitting unsupported, 4) standing to sitting, 5) transfers, 6) standing with eyes closed, 7) standing with feet together, 8) reaching forward with an outstretched arm, 9) retrieving an object from the floor, 10) turning to look behind, 11) turning 360°, 12) placing alternate feet on the stool, 13) standing with one foot in front, and 14) standing on one foot. Each item has an ordinal scale of 0–4 points, with a maximum score of 56.

Capacity for ADL

The Barthel Index (BI) was used to assess the ability to perform ADL [13]. This scale consists of ten items, each scored based on the level of independence. The evaluated tasks included walking (0, 5, 10, or 15 points), moving from a wheelchair to a bed and back (0, 5, 10, or 15 points), getting on and off the toilet (0, 5, or 10 points), ascending and descending stairs (0, 5, or 10 points), eating (0, 5, or 10 points), dressing (0, 5, or 10 points), bladder control (0, 5, or 10 points), bowel control (0, 5, or 10 points), bathing (0 or 5 points), and grooming activity (0 or 5 points). Higher scores indicated less assistance with daily activities. The total score ranged from 0 to 100.

Statistical Analysis

Values are expressed as mean ± standard deviation. IBM SPSS Statistics (version 29.0, Mac; IBM Corp., Tokyo, Japan) was used for the data analysis. Differences were considered statistically significant at $p < 0.05$. First, the relationships between capacity for ADL and cognitive function, handgrip strength, muscle power, and balance ability were evaluated using Pearson product-moment correlation analysis. Second, multiple regression analysis (stepwise method) was used to examine the contributions of cognitive function, handgrip strength, muscle power, and balance ability to capacity for ADL, adjusted for sex, age, and body mass index (BMI), which affect capacity for ADL [14-16]. The dependent variable was the BI score, and the explanatory variables were sex, age, BMI, HDS-R score, HS, FST, and BBS in the multiple regression analysis. The BI score was normally distributed, with no significant difference observed using the Shapiro–Wilk test ($p > 0.05$).

Results

The characteristics of our patients are shown in Table 1. The capacity for ADL (BI score) was significantly associated with the HDS-R, HS, FST, and BBS scores using Pearson product-moment correlation analysis ($p < 0.05$; Table 2). In multiple regression analysis (a dependent variable was BI, and explanatory variables were sex, age, BMI, HDS-R score, HS, FST, and BBS), only BBS was significantly extracted as an independent explanatory of the capacity for ADL ($\beta = 0.82$, 95% CI 0.90–1.50, $p < 0.001$). The estimated equation for BI using BBS was as follows: BI (points) = 1.196 × BBS (points) + 15.07 ($R = 0.82$, adjusted $R^2 = 0.66$).

Discussion

Significant relationships between the BI score, HDS-R, HS, FST, and BBS were observed using Pearson product-moment correlation analysis. In contrast, in this study, only BBS was extracted as an independent explanatory factor of capacity for ADL using multiple regression analysis. These results suggest that assessing or enhancing balance may be useful for maintaining or improving capacity for ADL in hospitalized older patients with stroke.

BBS was significantly related to capacity for ADL, even after adjusting for confounding factors using multiple regression analysis, but not HDS-R, HS, or FST. A previous study reported that cognitive function is not associated with capacity for ADL in older patients with stroke [17]. Additionally, HS reflects upper and lower limb strength, and lower extremities are more affected by disuse than upper extremities [4,18]. Moreover, the HS and FST are simpler than the BBS (14 items). Thus, the BBS may have reflected more detailed body functions in this study. Balance affects capacity for ADL [7], and enhancing balance to maintain or improve capacity for ADL may be critical in hospitalized older patients with stroke.

In this study, the adjusted R^2 in multiple regression analysis was 0.66, and the adjusted R^2 should be 0.5 or greater. Balance function is associated with capacity for ADL [7]. The BBS can evaluate balance ability and was observed to have high inter-rater and intra-rater reliability in a previous study [12]. Thus, the BBS could be effective in assessing balance function, and enhancing it may be useful for maintaining or improving capacity for ADL in hospitalized older patients with stroke.

This study had certain limitations. The number of patients was small and included patients with various onset sites. The number of patients should be increased, and a more rigorous selection should be conducted in future studies. Additionally, as the severity of paralysis is not measured, the relationship with severity of paralysis should be considered in future studies. In our analysis, only the effects of gender, age and BMI were considered in the multiple regression analysis.

Table 1: Characteristics of the patients in our study.

Variables	Mean ± SD
Sex (male / female, n)	24/10
Age (year)	80.9 ± 6.5
Height (cm)	156.2 ± 10.9
Weight (kg)	53.1 ± 10.9
BMI (kg/m^2)	21.3 ± 5.8
HDS-R (points)	18.8 ± 9.1
HS (kg)	20.0 ± 7.5
FST (sec)	7.3 ± 9.1
BBS (points)	30.8 ± 18.2
BI (points)	51.9 ± 26.6

SD: Standard deviation, BMI: Body mass index
HDS-R: The Revised Hasegawa's Dementia Scale
HS: Handgrip strength, FST: Five times sit to stand test
BBS: Berg balance scale, BI: Barthel index

Table 2: Correlation coefficients between each item using Pearson product-moment correlation analysis

	Age	Height	Weight	BMI	HDS-R	HS	FST	BBS	BI
Age		0.01	-0.39*	-0.27	-0.42*	-0.27	-0.07	-0.24	-0.33
Height	0.01		0.42*	-0.27	0.20	0.74*	-0.06	0.19	0.15
Weight	-0.39*	0.42*		0.75*	0.30	0.44*	0.04	0.18	0.08
BMI	-0.27	-0.27	0.75*		0.04	-0.07	0.17	0.18	0.04
HDS-R	-0.42*	0.20	0.30	0.04		0.40*	0.34	0.50*	0.37*
HS	-0.27	0.74*	0.44*	-0.07	0.40*		0.22	0.54*	0.50*
FST	-0.07	-0.06	0.04	0.17	0.34	0.22		0.66*	0.45*
BBS	-0.24	0.19	0.18	0.18	0.50*	0.54*	0.66*		0.82*
BI	-0.33	0.15	0.08	0.04	0.37*	0.50*	0.45*	0.82*	

BMI: Body mass index, HDS-R: The Revised Hasegawa's Dementia Scale, HS: Handgrip strength, FST: Five times sit to stand test
BBS; Berg balance scale, BI: Barthel index
* $p < 0.05$

In the future, we would like to consider the influence of other confounding factors. Because the target population is limited to the Japanese population, applying the findings to other races is difficult. HS and FST were used as indicators of muscle strength and power in this study, and evaluation methods that more closely reflect muscle strength and power should be used in future studies.

Conclusions

The balance function using the BBS was associated with capacity for ADL (BI score). In addition, the balance function was extracted as an independent explanatory factor of capacity for ADL, even after adjusting for confounding factors, using multiple regression analysis. These results suggest that evaluating or enhancing balance may be effective in maintaining or improving capacity for ADL in hospitalized older patients with stroke.

Competing Interests

The authors declare that they have no competing interests.

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