The Journal of Physical Therapy Science

S P T S

Original Article

Relationship among trunk control, activities of daily living, and upper extremity function during the first week after stroke in patients with acute cerebral infarction

Fumiko Iso[1], Wataru Mitsunaga[1, 2], Ryota Yamaguchi[2], Nozomi Shimizu[2], Saori Ito[2], Yuichiro Honda[2], Atsushi Okubo[2], Sumihisa Honda[3], Naoki Iso[4], Toshio Higashi[1]*, Akira Tsujino[1, 2]

[1] Unit of Medical Sciences, Nagasaki University Graduate School of Biomedical Sciences:
  1-7-1 Sakamoto, Nagasaki, Nagasaki 852-8520, Japan
[2] Nagasaki University Hospital, Japan
[3] Department of Public Health, Nagasaki University Graduate School of Biomedical Sciences, Japan
[4] Department of Occupational Therapy, Tokyo Kasei University, Japan

Abstract. [Purpose] We aimed to identify the relationship among trunk control, activities of daily living, and upper extremity function during the first week after stroke in patients with acute cerebral infarction. [Participants and Methods] Ninety-five patients with first cerebral infarction were included. Trunk control was assessed using the Postural Assessment Scale for Stroke. Additionally, activities of daily living were evaluated using the Functional Independence Measure, and upper extremity function was assessed using the upper extremity component of the Fugl-Meyer Assessment. Correlation analysis was performed to examine the relationships among these three measures. Furthermore, stepwise multiple regression analysis was performed to investigate the factors affecting activities of daily living. [Results] The total score and two subcategories of the Postural Assessment Scale for Stroke were significantly correlated with the Functional Independence Measure motor values. Stepwise multiple regression analysis revealed age and the Postural Assessment Scale for Stroke as factors influencing the Functional Independence Measure. Moreover, the Postural Assessment Scale for Stroke and upper extremity component of Fugl-Meyer Assessment showed a high correlation. [Conclusion] The trunk control ability assessed using the Postural Assessment Scale for Stroke is strongly correlated with activities of daily living estimated using the Functional Independence Measure in the first week after stroke in patients with acute cerebral infarction. The upper extremity component of Fugl-Meyer Assessment was not identified as a factor affecting the Functional Independence Measure.
Key words: Acute stroke, Stroke rehabilitation, Trunk control

INTRODUCTION

Stroke is the second leading cause of death worldwide after heart disease, and the number of stroke-related deaths is increasing[1]. With the global population aging, the number of patients with stroke is expected to further increase, along with the demand for rehabilitation. It is recommended to provide rehabilitation to stroke patients from an early stage to promote recovery. To achieve independence in daily life, patients should acquire stable and dynamic sitting abilities, which enable them to pick up and carry things from a sitting position without falling; however, this requires improvement in trunk control. Previous studies have reported that trunk control during the early stage of stroke can predict the ability to perform activities

---

of daily living (ADL) at a later stage[2–7]. A previous study reported that trunk control assessed using the "maintaining a posture" item of the Postural Assessment Scale for Stroke (PASS), age, upper extremity function assessed using the upper extremity component of the Fugl-Meyer Assessment (FMA-UE), and Barthel Index score within 14 days after stroke onset comprehensively predicted ADL ability after 6 months. Notably, the PASS-"maintaining a posture" score was a slightly stronger predictor than other factors[5]. Recently, another study reported a significant correlation between initial trunk control and ADL after 4 weeks in both initially ambulatory and non-ambulatory patients; however, a significant correlation was observed only in the non-ambulatory group after 6 months[6]. Additionally, another study reported that the ADL ability of stroke patients in the acute phase was most closely correlated with trunk control, followed by upper extremity function, but not with lower extremity function[8]. Furthermore, several studies have reported that improvement in the upper extremity was promoted by adding a trunk restraint to constraint-induced movement therapy in acute or subacute stroke patients[9, 10] or by using external trunk support in chronic stroke patients[11].

Although the association between trunk control and upper extremity function can be suggested from the study mentioned above, no study has directly compared the relationship between trunk control and upper extremity function at different phases of recovery and the role of trunk control in the acute phase as a predictor of upper extremity function. A systematic review also did not report any previous study regarding the effect of trunk exercise on upper extremity function; however, there was a study on its effect on trunk control[12]. Upper extremity function and ADL ability significantly affect the daily lives and social activities of patients, including their hobbies and work. If the relationship between trunk control, ADL ability, and upper extremity function in the early phase of stroke and during the course of long-term recovery is elaborated, it could contribute to the establishment of a more effective rehabilitation approach for trunk control in the early stage, thereby improving the ADL ability, including upper extremity function.

By predicting the prognosis of long-term functional ability using the relationship between trunk control and upper extremity function, self-help and assistive devices can be potentially used, and alternative methods for ADL independence can be considered from an early stage. Hence, it is important for occupational therapists (OTs) to provide appropriate predictive prognoses and OTs utilize the residual function in patients because even a marginal increase in the usage of patients' residual function plays a major role in preventing disuse syndrome during the acute stage after stroke.

To establish rehabilitation for the maximum usage of patients' residual function and prevention of disuse syndrome, trunk control must be directly compared with other factors, including upper extremity function, during the more acute phase. In previous studies on trunk control related to stroke, the earliest evaluation performed was 2 weeks after onset[2–7].

Hence, this prospective cohort study aimed to clarify the relationship between ADL ability and upper limb function, focusing on trunk control in patients with acute stroke within 7 days of onset.

PARTICIPANTS AND METHODS

Patients who were referred to the Nagasaki University Hospital after suffering from cerebral infarction between April 2017 and March 2018 were included in this prospective study. There were three main inclusion criteria: 1) first cerebral infarction; 2) age ≥20 years; and 3) those who had been released from rest and had started sitting by the assessment date. The exclusion criteria were diagnosis of a severe medical disease or a neurological disease other than cerebral infarction, ataxia, recurrence of stroke during admission, severe unilateral spatial neglect, vestibular organ dysfunction, more than 7 days until the start of rehabilitation, requiring total assistance even before stroke onset, or death.

All patients provided written informed consent before participation. This study was conducted in accordance with the principles embodied in the Declaration of Helsinki and was approved by the appropriate ethics committee (Approval No. 16072512-2).

Patients' characteristics including age, gender, diagnosis, classification of cerebral infarction by the National Institute of Neurological Disorders and Stroke (NINDS) III (atherothrombotic stroke, cardioembolic stroke, lacunar stroke, branch atheromatous disease [BAD], and others), number of days from onset to the start of rehabilitation, and number of days from onset to the start of sitting were registered.

The following clinical assessment was conducted to evaluate the physical and cognitive function of stroke patients.

The National Institute of Health Stroke Scale (NIHSS) was used to assess the severity of stroke.

PASS was used to assess trunk control. It is regarded that PASS provides one of the most reliable clinical assessments of postural control in stroke patients within 3 months after stroke onset[13]. PASS comprises two subcategories; five items for maintenance of posture (sitting without support, standing with support, standing without support, standing on the nonaffected leg, and standing on a paretic leg), and seven items on postural change (supine to affected side lateral, supine to nonaffected side lateral, supine to sitting up on the edge of the table, sitting on the edge of the table to supine, sitting to standing up, standing up to sitting down, standing, and picking up a pencil from the floor), which is assessed using 0–3 points. The maximum score is 36 points, and the higher the score, the higher the function.

Functional Independence Measure (FIM) was used to evaluate the ability to perform ADL. FIM consists of 13 motor items and five cognition items were assessed with 1 to 7 points; consequently, the higher the score, the higher the function (18–126 points)[14]. In this study, we focused on the relationship with physical function and used only the motor score as a clinical assessment (13–91 points).

J. Phys. Ther. Sci. Vol. 34, No. 4, 2022

316

FMA-UE was used for upper extremity assessment. FMA-UE consists of 33 items assessed using 0–2 points. The maximum score is 66 points, and the higher the score, the higher the function[15–17].

NIHSS was evaluated on admission, and PASS, FIM, and FMA-UE were evaluated in 7 days after stroke onset.

Statistical analysis was performed using IBM SPSS for Windows version 22.0 (IBM Corp., Armonk, NY, USA). The Shapiro–Wilk test was used to test data normality; subsequently, the relationship between trunk control, ADL ability, and upper extremity function was examined using Spearman correlation coefficients. Additionally, PASS was examined in each subcategory. Furthermore, to clarify the factors affecting ADL, stepwise multiple regression analysis was performed. Statistical significance was defined as p<0.05 in all cases.

RESULTS

Of 140 hospitalized patients during the target period, 108 who met the inclusion criteria were included in the evaluation. The assessment was conducted on 89 patients (48 male, 41 female patients; mean age: 76.6 ± 12.0 [median 79] years), except for 19 patients. Three were delayed in leaving the bed due to deterioration in their condition, 12 had difficulty understanding the instruction due to aphasia, dementia, or a consciousness disorder, and four were excluded for other reasons. Based on the NINDS III classification, we included 9 cases of atherothrombotic stroke, 32 cases of cardiogenic stroke, 16 cases of lacunar stroke, 3 cases of BAD, and 29 cases of others. The treatment methods included conservative treatment (47 cases), tissue plasminogen activator (tPA) therapy (29 cases), intra-arterial thrombolysis (1 case), mechanical embolectomy (1 case), tPA and intra-arterial thrombolysis (9 cases), tPA and mechanical embolectomy (1 case), and tPA and external/internal decompression (1 case). Damage to the brain occurred on the right side in 46 cases and on the left side in 43 cases. The number of days from onset to initiation of rehabilitation was 2.3 ± 0.7 days, and the number of days from onset to initiation of sitting was 3.8 ± 1.3 days. Table 1 shows the attributes of the target patients and the results of the Shapiro–Wilk test.

The NIHSS score on admission was 8.6 ± 7.7 (median 5.0). The PASS total score and scores for maintaining a posture and changing posture were 20.6 ± 11.0 (median 21.0), 7.2 ± 4.9 (median 7.0), and 13.4 ± 6.3 (median 14.0) points, respectively. The motor subtotal score of FIM were 31.2 ± 19.8 (median score 24.0) points. The FMA-UE total score was 39.4 ± 24.9 (median 48.0) points. Table 2 shows the correlation coefficient and significance level of the clinical assessments. The PASS total score and FIM motor scores were significantly correlated (ρ=0.84, p<0.01). Regarding the subcategories of PASS, the PASS scores for maintaining a posture (ρ=0.79, p<0.01) and changing postures (ρ=0.86, p<0.01) were significantly correlated with the FIM motor score, and the changing and maintaining posture scores were closely correlated. FMA-UE score and FIM motor score were significantly correlated (ρ=0.80, p<0.01). The PASS total score and FMA-UE were significantly correlated (ρ=0.89, p<0.01). Regarding the sub-items of PASS, both scores for maintaining (ρ=0.87, p<0.01) and changing posture (ρ=0.88, p<0.01) showed the same extent of correlation with FMA-UE. Table 2 shows the correlation of FIM motor score with PASS and FMA-UE.

The result of the stepwise multiple regression analysis is shown in Table 3. In the analysis, the dependent variables were FIM motor items and the independent variables were age, gender, side of the cerebral lesion, NIHSS, FMA-UE, and PASS. Age and PASS were identified as factors that significantly affect the FIM motor score (R^2=0.60, p<0.001). The standardized coefficient of the PASS score (β=0.60, p<0.001) was higher than that of age (β=−0.16, p=0.033), indicating that PASS had a stronger effect on FIM motor items.

DISCUSSION

This study investigated the relationship between trunk control, upper extremity function, and ADL ability in patients with acute cerebral infarction. The trunk control (PASS) and ADL ability (FIM) showed a strong correlation. Several previous studies have reported that trunk control is a strong predictor of overall function[2–7]. The results of this study also reveal that trunk control is considerably related to ADL ability and plays an important role in the acute phase. Performing ADL requires the ability not only to maintain a posture but also to convert the postures according to the environment and the motion intended; hence, we expected that the PASS item of change in posture had a stronger correlation with FIM motor items. However, a high correlation with FIM was observed for the overall items of PASS and each item. This result indicates that both of changing and maintaining a posture are important in ADL. Additionally, upper extremity function (FMA-UE) and ADL ability (FIM) showed a strong correlation. These results are consistent with the findings of a previous study[8], and show the possibility that upper extremity function affects ADL ability. In the results of multiple regression analysis, FMA-UE did not identified as factors affecting the FIM, which shows that these two factors are not related directly in the acute phase. Furthermore, a strong correlation between PASS and FMA-UE was identified. To date, no studies have directly compared the relationship between trunk control and upper extremity function in the early phase after stroke onset. In this study, we measured trunk and upper extremity function in our participants within 7 days of stroke onset, much earlier than the previous studies that measured it 2 weeks or more after the stroke onset[2–8]. As the main result of our stepwise multiple regression analysis, age and PASS were included as factors related to ADL in the acute stage. A previous study reported that age at onset was a factor related to ADL at 6 months after onset of stroke[5]. In the acute phase, as rest for a certain period was instructed, age, which is related to physical durability, may have been strongly related to ADL ability. In this study, we showed that PASS

Table 1. Attributes of patients and results of the Shapiro–Wilk test

Characteristics		n=89	Shapiro–Wilk test
Age (years)		76.6 ± 12.0	**
Gender	Male	48 (54%)	
	Female	41 (46%)	
NINDS	Atherothrombotic stroke	9 (10.0%)	
	Cardiogenic stroke	32 (36.0%)	
	Lacunar	16 (18.0%)	
	Branch atheromatous disease	3 (3.4%)	
	Others	32 (32.6%)	
Treatment	Conservative treatment	47 (52.9%)	
	tPA	29 (32.6%)	
	Intra-arterial thrombolysis	1 (1.1%)	
	Mechanical embolectomy	1 (1.1%)	
	tPA and intra-arterial thrombolysis	9 (10.1%)	
	tPA and mechanical embolectomy	1 (1.1%)	
	tPA and external/internal decompression	1 (1.1%)	
Lesion side	Right	46 (51.7%)	
	Left	43 (48.3%)	
Initiation of rehabilitation (days)		2.3 ± 0.7	
Initiation of sitting (days)		3.8 ± 1.3	
NIHSS		8.6 ± 7.7	***
PASS total		20.6 ± 11.0	***
PASS posture		7.2 ± 4.9	***
PASS posture change		13.4 ± 6.3	***
FIM total		57.4 ± 27.1	**
FIM motor		31.2 ± 19.8	***
FIM cognition		26.2 ± 10.9	***
FMA-UE		39.4 ± 24.9	***

NINDS: National Institute of Neurological Disorders and Stroke III; NIHSS: National Institute of Health Stroke Scale; PASS: Postural Assessment Scale for Stroke Patients; FMA-UE: Upper Extremity of the Fugl-Meyer Assessment; FIM: Functional Independent Measure.
Age, initiation of rehabilitation, initiation of sitting, NIHSS, PASS, FMA, and FIM are presented as average ± SD. Gender, NINDS, treatment, and lesion side are presented as n (%). **$p<0.01$, ***$p<0.001$.

Table 2. Correlation of FIM with PASS and FMA-UE

	FIM motor	PASS posture	PASS change	PASS total	FMA-UE
FIM motor					
PASS posture	0.79**				
PASS change	0.86**	0.93**			
PASS total	0.84**	0.99**	0.97**		
FMA-UE	0.80**	0.87**	0.88**	0.89**	

FMA-UE: Upper Extremity of the Fugl-Meyer Assessment; FIM: Functional Independent Measure; PASS: Postural Assessment Scale for Stroke Patients.
**$p<0.01$.

Table 3. Stepwise multiple linear regression analysis of variables for activities of daily living ability during the acute phase

	Variable	B	p-value
Pattern 1	PASS total score	0.60	**
	Age	−0.16	*
	R	0.78	**
	R^2	0.60	

PASS: Postural Assessment Scale for Stroke Patients.
*$p<0.05$, **$p<0.001$.

J. Phys. Ther. Sci. Vol. 34, No. 4, 2022

318

had a stronger relationship with ADL ability. Additionally, several researchers have reported the influence of early trunk control on ADL ability in the later phase[2–8]. This study also showed that trunk control plays an important role in the acute phase even within 7 days after the onset of stroke. Therefore, preceding the approach to trunk control from immediately after onset may greatly assist in the recovery of ADL.

The present study has some limitations. Our cross-sectional study could demonstrate the relationship between trunk control, ADL ability, and upper extremity function in the acute phase of cerebral infarction; however, we could not conduct investigation on future progress or prognosis prediction. Additionally, the assessment items were limited because our study was conducted in the acute phase. Therefore, a longitudinal study is necessary to re-verify these evaluation items.

In conclusion, trunk control and age were shown as factors related to ADL. Trunk control is strongly correlated with ADL ability and upper extremity. Therapists should focus on patients' ability of trunk control during the acute phase of stroke.

Funding

Conflicts of interest

The authors declare no conflict of interest regarding the publication of this paper.

REFERENCES

1) World Health Organization: Global health estimates. 2016 https://www.who.int/healthinfo/global_burden_disease/en/ (Accessed Jun. 24, 2019)

2) Di Monaco M, Trucco M, Di Monaco R, et al.: The relationship between initial trunk control or postural balance and inpatient rehabilitation outcome after stroke: a prospective comparative study. Clin Rehabil, 2010, 24: 543–554. [Medline] [CrossRef]

3) Duarte E, Marco E, Muniesa JM, et al.: Trunk control test as a functional predictor in stroke patients. J Rehabil Med, 2002, 34: 267–272. [Medline] [CrossRef]

4) Franchignoni FP, Tesio L, Ricupero C, et al.: Trunk control test as an early predictor of stroke rehabilitation outcome. Stroke, 1997, 28: 1382–1385. [Medline] [CrossRef]

5) Hsieh CL, Sheu CF, Hsueh IP, et al.: Trunk control as an early predictor of comprehensive activities of daily living function in stroke patients. Stroke, 2002, 33: 2626–2630. [Medline] [CrossRef]

6) Kim TJ, Seo KM, Kim DK, et al.: The relationship between initial trunk performances and functional prognosis in patients with stroke. Ann Rehabil Med, 2015, 39: 66–73. [Medline] [CrossRef]

7) Verheyden G, Nieuwboer A, De Wit L, et al.: Trunk performance after stroke: an eye catching predictor of functional outcome. J Neurol Neurosurg Psychiatry, 2007, 78: 694–698. [Medline] [CrossRef]

8) Likhi M, Jidesh VV, Kanagaraj R, et al.: Does trunk, arm, or leg control correlate best with overall function in stroke subjects? Top Stroke Rehabil, 2013, 20: 62–67. [Medline] [CrossRef]

9) Bang DH, Shin WS, Choi SJ: The effects of modified constraint-induced movement therapy combined with trunk restraint in subacute stroke: a double-blinded randomized controlled trial. Clin Rehabil, 2015, 29: 561–569. [Medline] [CrossRef]

10) Bang DH, Shin WS, Choi HS: Effects of modified constraint-induced movement therapy with trunk restraint in early stroke patients: a single-blinded, randomized, controlled, pilot trial. NeuroRehabilitation, 2018, 42: 29–35. [Medline] [CrossRef]

11) Wee SK, Hughes AM, Warner MB, et al.: Effect of trunk support on upper extremity function in people with chronic stroke and people who are healthy. Phys Ther, 2015, 95: 1163–1171. [Medline] [CrossRef]

12) Alhwoaimel N, Turk R, Warner M, et al.: Do trunk exercises improve trunk and upper extremity performance, post stroke? A systematic review and meta-analysis. NeuroRehabilitation, 2018, 43: 395–412. [Medline] [CrossRef]

13) Benaim C, Pérennou DA, Villy J, et al.: Validation of a standardized assessment of postural control in stroke patients: the Postural Assessment Scale for Stroke Patients (PASS). Stroke, 1999, 30: 1862–1868. [Medline] [CrossRef]

14) Hsueh IP, Lin JH, Jeng JS, et al.: Comparison of the psychometric characteristics of the functional independence measure, 5 item Barthel index, and 10 item Barthel index in patients with stroke. J Neurol Neurosurg Psychiatry, 2002, 73: 188–190. [Medline] [CrossRef]

15) Duncan PW, Propst M, Nelson SG: Reliability of the Fugl-Meyer assessment of sensorimotor recovery following cerebrovascular accident. Phys Ther, 1983, 63: 1606–1610. [Medline] [CrossRef]

16) Fugl-Meyer AR, Jääskö L, Leyman I, et al.: The post-stroke hemiplegic patient. 1. a method for evaluation of physical performance. Scand J Rehabil Med, 1975, 7: 13–31. [Medline]

17) Poole JL, Whitney SL: Motor assessment scale for stroke patients: concurrent validity and interrater reliability. Arch Phys Med Rehabil, 1988, 69: 195–197. [Medline]