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Original Article

Correlation between mobility assessed by the Modified Rivermead Mobility Index and physical function in stroke patients

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Abstract. [Purpose] The purpose of this study was to investigate the relationship between mobility assessed by the Modified Rivermead Mobility Index and variables associated with physical function in stroke patients. [Subjects and Methods] One hundred stroke patients (35 males and 65 females; age 58.60 ± 13.91 years) participated in this study. Modified Rivermead Mobility Index, muscle strength (manual muscle test), muscle tone (Modified Ashworth Scale), range of motion of lower extremity, sensory function (light touch and proprioception tests), and coordination (heel to shin and lower-extremity motor coordination tests) were assessed. [Results] The Modified Rivermead Mobility Index was correlated with all the physical function variables assessed, except the degree of knee extension. In addition, stepwise linear regression analysis revealed that coordination (heel to shin test) was the explanatory variable closely associated with mobility in stroke patients. [Conclusion] The Modified Rivermead Mobility Index score was significantly correlated with all the physical function variables. Coordination (heel to shin test) was closely related to mobility function. These results may be useful in developing rehabilitation programs for stroke patients.
Key words: Mobility, Modified Rivermead Mobility Index, Stroke

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INTRODUCTION

Stroke is a leading cause of death and disability worldwide[1)]. Stroke patients experience muscle weakness and sensory changes, resulting in functional disorders, such as difficulties in trunk control, balance instability, and gait dysfunction, in addition to difficulties performing activities of daily living[2)]. Mobility is essential to an independent lifestyle after a stroke and is perhaps the ability considered the most important by patients[3)]. Therefore, an important aim of rehabilitation is to improve the patient's level of mobility following a stroke[4)]. To identify mobility disabilities and manage their associated problems, clinicians need a mobility evaluation method that is simple to administer[5)]. The Modified Rivermead Mobility Index (MRMI) is recommended to assess poststroke mobility, and it is widely used, both in daily clinical practice and research on patients after stroke[4, 6, 7)].

Mobility limitations after stroke include decreased strength[8)] and range of motion[9)], in addition to spasticity[10)], impaired sensory function[11)], and impaired coordination[12)]. However, the physical function variables that have the most influence on mobility after stroke have not been clarified. Such information is important for physical therapists to develop effective treatment strategies to improve mobility function and social participation. Thus, the purpose of this study was to investigate the associations between mobility and physical variables, such as muscle strength and tone, range of motion, sensory function, and coordination in stroke patients.

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SUBJECTS AND METHODS

One hundred stroke patients were selected for inclusion in this study. All patients underwent a standardized rehabilitation program consisting of physical therapy. The objectives and requirements of the study were explained to all patients, and they all signed informed consent forms. This study was approved by the Institutional Review Board of Inje University (2-1041024-AB-N-01-20151211-HR-319). Participants with a history of dementia, significant difficulties in language expression or comprehension, presence of other neurological disease, or inability to provide informed consent were excluded. All tests were evaluated by five physical therapists.

Mobility was evaluated using the MRMI. The MRMI has high inter-rater reliability (internal consistency coefficient 0.98) and high internal consistency (Cronbach α=0.93) when administered in early-stage stroke patients[4]. The MRMI consists of eight items, including turning over, changing from lying to sitting, maintaining sitting balance, going from sitting to standing, standing, transferring, walking indoors, and climbing stairs. The MRMI score ranges from 0 to 40. Scores are assigned based on direct observations of the patient's performances in given items[4]. Muscle strength was evaluated using the Manual Muscle Test (MMT)[13]. Lower extremity range of motion was examined using a goniometer. Sensory function was evaluated using the light touch and proprioception tests[14]. Muscle tone was evaluated using the Modified Ashworth Scale (MAS). Coordination was evaluated using the heel to shin test (HTST)[15]. The HTST was performed with the patient lying in a supine position, and the tester instructed the patient to place the heel of the affected side to the shin of the less affected side just below the knee and then slide it down the shin to the top of the foot. The patient was asked to repeat this motion as quickly as possible, without making mistakes. The lower-extremity motor coordination test (LEMOCOT) was used to assess coordination[16]. The participants performed the LEMOCOT three times with their paretic lower limbs, according to previously described procedures[7]. To perform the test, the patient sat on an adjustable chair, with their feet resting flat on thin rigid foam. They placed their heels on the proximal target, with knees at 90° flexion. After a familiarization trial, patients were instructed to alternately touch the proximal and distal targets, placed 30 cm apart, with their big toe for 20 s. The number of touched targets was counted and recorded for analysis.

Data were analyzed using SPSS for Windows version 18.0 (SPSS Inc., Chicago, IL, USA). Pearson's correlation coefficients were used to evaluate the relationships among variables. Stepwise linear regression analysis was used to elucidate the explanatory factor associated with MRMI. Statistical significance was set at $p<0.05$.

RESULTS

The clinical characteristics of the patients (65 females and 35 males; mean age 58.6 years) are shown in Table 1. The correlations between the MRMI and physical function variables are summarized in Table 2. The MRMI was very strongly correlated with coordination (HTST: $r=0.846$, $p<0.01$) and MMT (hip flexor: $r=0.812$, $p<0.01$). In addition, stepwise linear regression analysis revealed that coordination (HTST: $r^2=0.855$, $F=110.816$, $p<0.05$) was the explanatory variable most closely associated with MRMI in stroke patients.

DISCUSSION

This study investigated the relationships between mobility, assessed using the MRMI, and muscle strength, range of motion, sensory function, muscle tone, and coordination in stroke patients. The MRMI score was significantly correlated with almost all these physical variables. In the stepwise linear regression analysis, the highest beta value was obtained for coordination in all the patients. The findings of the present study are in agreement with the results of a previous study, which suggested that weakness and sensation were the most significant factors affecting postural control and mobility[13]. Strength deficits in the lower extremity are closely related to functional outcomes following stroke[17]. In this study, the MRMI score was significantly correlated with muscle strength in the lower limb, particularly that of the hip flexor and knee extensor. A previous study reported that the strength of the hip flexor muscles and the knee extensor muscles of the hemiplegic limb were the most important factors determining walking speed[18]. Another study found a significant positive association between the net hip flexor moment during walking and gait speed[19]. Stroke patients were shown to have decreased passive range of motion their paretic lower limbs due to increased muscle stiffness and decreased muscle length[9]. A previous study also showed that a substantial loss of hamstring muscle length, as well as hip and toe flexion contractures, interfered with positioning and mobility in stroke patients[20].

In the current study, MRMI was negatively correlated with muscle tone, whereas the other factors were positively correlated. In an earlier study, despite improvements in lower extremity spasticity following intervention, stroke patients showed no significant improvement in mobility test[21]. MAS is one of the most commonly used clinical measures of muscle tone, despite its poor psychometric properties. However, as scores tend to cluster in the lower ranges of the six-point ordinal scale, the test's ability to discriminate between stroke patients is limited[22].

Interestingly, the stepwise linear regression analysis revealed that coordination (HTST) was the primary predictor of MRMI scores. This finding may be explained by the nature of test: the HTS test evaluates the quality of movement and

Table 1. Demographic data and characteristics of subjects

Variables	Mean ± SD
Gender	
Female/Male (%)	65/35 (65/35)
Height (cm)	166.0 ± 8.2
Weight (kg)	63.7 ± 11.4
Affected side	
Right/Left (%)	55/45 (55/45)
Type of stroke	
Infarction/Hemorrhage (%)	50/50 (50/50)
Age (years)	58.6 ± 13.9
Duration (months)	15.4 ± 11.0
MRMI score (0–40)	29.7 ± 12.0

SD: standard deviation; Duration: months between stroke onset and assessment; MRMI: Modified Rivermead Mobility Index

Table 2. Correlation coefficients between the MRMI and physical function variables (N=100)

Physical Function Variables	MRMI Scores
MMT	
Hip flex.	0.812*
Hip ext.	0.788*
Hip abd.	0.779*
Knee flex.	0.732*
Knee ext.	0.796*
Ankle DF	0.676*
Ankle PF	0.698*
ROM	
Hip flex.	0.720*
Hip ext.	0.610*
Knee flex.	0.641*
Knee ext.	0.171
Ankle DF	0.591*
Ankle PF	0.597*
Sensory function	
Light touch	0.727*
Proprioception	0.387*
MAS	
Hip add.	−0.329*
Knee ext.	−0.288*
Ankle PF	−0.266*
Coordination	
HTST	0.846*
LEMOCOT	0.635*

MMT: Manual Muscle Test; flex.: flexion; ext.: extension; abd.: abduction; add.: adduction; DF: dorsi flexion; PF: plantar flexion; ROM: range of motion; MAS: Modified Ashworth Scale; HTST: heel to shin test; LEMOCOT: lower-extremity motor coordination test
*p<0.01

requires hip and knee synergic movements[23]. In contrast, the LEMOCOT is a simple lower-extremity motor coordination test, which quantitatively assesses lower limb coordination by counting the number of touched targets[16]. Individuals with hemiparesis due to stroke typically show multiple sensorimotor impairments, which result in a lack of movement coordination[24]. This impaired coordination likely arises from dysfunction of the central command system of the brain, leading to abnormal muscle activation in both the spatial and temporal dimensions[25]. A previous study attributed an inability to fine-tune the coordination of muscles during functional tasks to impaired performance of pedaling[26]. Coordination is closely correlated with the degrees of motor recovery and rehabilitation[27]. Adequate coordination of the lower limbs is essential for performing daily tasks and purposeful locomotion[28]. Therefore, enhancing the coordination of the lower limb may improve post-stroke outcomes[29].

The present study had some limitations. First, we did not consider differences in physical function according to the mobility levels of the participants. Second, the sample size in this study was small. Thus, it was not possible to analyze the data according to the type or severity of stroke. In addition, factors other than physical variables, such as level of awareness, use of medication and lack of incontinence[30], that may influence mobility were not considered in this study.

In conclusion, the results showed that although all the physical variables assessed affected mobility, coordination was the strongest predictor of mobility in stroke patients. Therefore, we suggest that a detailed assessment of the mobility and coordination of stroke patients is necessary. To improve mobility in stroke patients, coordination training should be included as part of the stroke rehabilitation program.

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