



Original Article

Reliability and validity of the modified functional ambulation category scale in patients with hemiparalysis

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Abstract. [Purpose] This study aimed to examine the inter- and intra-rater reliability and validity of the modified functional ambulation category (mFAC) scale. [Subjects and Methods] The participants were 66 stroke patients with hemiparalysis. The inter- and intra-rater validity of the mFAC was calculated using the Spearman correlation coefficient. A score comparison of the stable or maximum gait speed with regard to mFAC and modified Rivermead Mobility Index (mRMI) performances was performed as a univariate linear regression analysis to determine how the Kruskal-Wallis test affects the mRMI and stable/maximum gait speed with regard to mFAC. [Results] The inter-rater reliability of the mFAC (intraclass coefficient [ICC]) was 0.982 (0.971–0.989), with a kappa coefficient of 0.923 and a consistency ratio of 94%. In contrast, the intra-rater reliability of the mFAC (ICC) was 0.991 (0.986–0.995), with a kappa coefficient of 0.961 and a consistency ratio of 96%, showing higher reliability. Moreover, there was a significant difference in stable/maximum gait speed between the mFAC and the mRMI. [Conclusion] Since the mFAC has sufficient inter- and intra-reliability and high validity, it can be used as an assessment tool that reflects the gait performance and mobility of stroke patients.

Key words: Ambulation, MFAC, Stroke

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INTRODUCTION

The loss of gait ability after stroke becomes a lifetime disability in addition to social activity limitations. Therefore, recovering gait ability is an important treatment objective for independent living¹⁾. Furthermore, the gait assessment must be reliable and valid to assess the gait disorder and treatment effects and establish a future treatment plan. However, few gait assessment tools have been described to date that can be used to comprehensively assess gait ability²⁾. Gait assessment tools currently range from those that use biomechanical and kinematic analyses³⁾ to those with a simple clinical design that can be easily and swiftly applied⁴⁾. However, skillful clinicians and repeated tests are required to ease the difficulty of this technological application, save time, and collect accurate data²⁾. In addition, impractical issues arise from day-to-day clinical applications due to the difficulty obtaining results and interpreting the data¹⁾.

Timed up-and-go tests and walking velocity tests (5–12 m), which are the most common methods used in clinical research, are basic tests that reflect an individual's gait ability⁵⁾. Hence, they can be used as assessment standards since they have the advantage of providing diverse therapeutic interventions by grasping the functional gait performance of patients with data that are affordable to obtain and easy to manage and interpret⁶⁾. Gait speed can be a useful assessment tool for estimating functional independence and treatment effects. Stroke patients have different gait speeds since they become stressed about their present functional status (physical and psychological), while the assessment distance may also differ (5–12 m)^{7, 8)}.

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Moreover, since speed is measured at a certain point in time, its universal application may be limited.

The inter-rater reliability (ICC) of the mFAC in patients with hip fractures is 0.96, with a construct validity of $r=0.81$ on the Elderly Mobility Scale (EMS)⁹, while the inter-rater reliability for acute stroke patients has a consistency ratio of 93% and a weighted kappa of 0.97¹⁰. Nonetheless, the inter-rater reliability of the mFAC for acute stroke patients has not yet been reported, and there is an unclear correlation between gait speed and functional mobility performance. In addition, the unmodified FAC is still being used in Korean clinical research, and the clinical application cases of mFAC have not yet been reported in this country. Therefore, the present study aimed to investigate the validity of the correlations between inter- and intra-rater reliability (ICC, kappa, standard error of the mean [SEM], and minimum detectable change [MDC]) through which the psychological characteristics of the mFAC can be reflected as well as the modified Rivermead Mobility Index (mRMI).

SUBJECTS AND METHODS

The present study was conducted from September 2014 to May 2015 on 76 chronic stroke patients (diagnosed more than 6 months earlier) who were hospitalized at Hospital M for treatment. All of the patients understood the purpose of the study and provided written informed consent prior to participating as required by the ethical standards of the Declaration of Helsinki. The subjects were selected if they scored more than 23 points on the Mini-Mental State Examination-Korean version (MMSE-K), which is designed to test cognitive function, and if they did not have neurological problems in the lower limbs (determined by the ability to safely walk on a flat surface for 10 m, regardless of the use of a cane or other aids) and orthopedic problems in either leg. Based on the aforementioned criteria, 76 chronic stroke patients were initially selected, but during the course of the study, 6 dropped out and 4 quit the study after hospital discharge or with deteriorating health. Ultimately, the data of 66 patients were obtained.

The mFAC, using a 7-point Likert scale, was used to make distinctions between the patients' gait abilities. The test and re-test reliability of the mFAC among stroke patients has been reported, with a consistency ratio of 93% and a weighted kappa coefficient of 0.97¹⁰. A gait speed test with a distance of 5 m was performed, during which the research subjects' psychological burden and stress can be minimized¹¹. An average of 3 rounds of the test was recorded. The test and re-test reliability of this assessment tool is reportedly high with an ICC of 0.88–0.97¹². In addition, mRMI was used to evaluate the stroke patients' mobility. The inter-rater reliability of mRMI for stroke patients had an ICC of 0.98¹³.

In this study, the Shapiro-Wilk test was performed using SPSS (version 18.0 for Windows 7) to test variable normality, while a frequency analysis was used to analyze the research subjects' general characteristics. The percent of total agreement and the kappa coefficient were calculated to show the consistency ratio of mFAC between the raters, while inter- and intra-rater reliability were measured using the intra-class coefficients (ICC_{2,1}). The absolute reliability (without measurement error) was assessed using SEM and MDC. In addition, the stable/maximum gait speeds regarding the mFAC and mRMI performance scores were compared using the Mann-Whitney U test and the post-hoc Kruskal-Wallis test. The validity testing of the mFAC was done with a univariate linear regression analysis, which analyzes the causal relationship between the Spearman correlation coefficient and the stable/maximum gait speed regarding functional gait ability and mRMI. Statistical significance was set at $\alpha=0.05$.

RESULTS

The research subjects were 38 males (57.6%) and 28 females (42.4%) with an average age of 59.82 years. Among these subjects, 42 had cerebral infarction (63.6%) and 24 had cerebral hemorrhage (36.4%), while 29 had right-sided paralysis (43.9%) and 37 had left-sided paralysis (56.1%). The average duration of illness was 13.27 months since onset, and the patients had an average MMSE-K score of 25.82 points. Twenty-four patients were able to walk independently (36.4%), while 25 walked with one-legged walking sticks (37.9%), 15 walked with 4-legged walking sticks (22.7%), and 2 patients used walkers (3.0%). The average mFAC was 5.39 points, and the stable and maximum gait speeds were 60 m/s and 73 m/s, respectively. The average mRMI was 29.92 points.

The inter-rater reliability of mFAC had an ICC of 0.982 (0.971–0.989), kappa coefficient of 0.923, consistency ratio of 94%, SEM of 0.174, and MDC of 0.482, while the intra-rater reliability had an ICC of 0.991 (0.986–0.995), kappa coefficient of 0.961, consistency ratio of 96%, SEM of 0.124, and MDC of 0.343, indicating high reliability.

There was a statistically significant difference between the mFAC and the stable/maximum gait speeds ($X^2=54.49$ and 54.70, respectively; $p<0.001$), and a significant difference from mRMI was found ($X^2=53.76$; $p<0.001$). In addition, mFAC validity had high correlations with the stable/maximum gait speeds ($r=0.88$ – 0.90) and mRMI ($r=0.90$).

The mFAC affected 81% and 77% of the stable and maximum gait speeds, respectively, while affecting 82% of the mRMI.

DISCUSSION

The present study's findings corroborate the high inter- and intra-rater reliability of the mFAC. Such findings are in line with those of previous studies in which the inter-rater reliability of mFAC of patients with hip fractures had an ICC of 0.96⁹, while the inter-rater reliability of the mFAC for acute stroke patients had a consistency ratio of 93% and a weighted kappa

coefficient of 0.97¹⁰). The inter- and intra-rater reliability of the present study was very high, with an ICC>0.98, kappa coefficient >0.92, and a consistency ratio >94%, all of which were measured by therapists who had worked in the field for at least 10 years. However, for this study, therapists with <5 years' experience in rehabilitation treatment for stroke patients, or even unskilled therapists, would not have had problems performing video observations and individual assessments. Moreover, the mFAC has clear standards; however, in this study, not a single subject scored 1 or 2 points on the mFAC.

Regarding assessment tools for clinical research, SEM and MDC represent absolute reliability to reflect psychological features for assessing treatment effects and determining effect size, and they offer very useful information for clinicians and therapists¹⁴). The SEM and MDC of the mFAC, which had not been explored before, were first introduced in the present study. In this study, the SEM of the mFAC was 0.17, less than 10% of the average mFAC score, while the MDC of the mFAC was 0.48, less than 10% of the maximum mFAC score, both of which fall within the acceptable range¹⁵). The MDC represents the smallest expected value of the individual treatment effect and is a very important indicator for clinicians predicting a patient's achievable recovery level after treatment¹⁵).

In the present study, a difference was noted between the stable/maximum gait speed and mRMI with regard to the mFAC groups. The 66 research subjects were divided into five groups based on the mFAC (3–7 points), and their stable/maximum gait speeds and mRMI were measured. They were all reported to be different. As the mFAC increased from 3 points (stable/maximum gait speeds of 0.16 m/s and 0.25 m/s, respectively) to 5 points (0.50 m/s and 0.58 m/s, respectively), the average gait speed increased with the mRMI performance score, representing functional mobility. What is unique is that there was a difference even between the stable and maximum gait speeds of 6 points on the mFAC (0.76 m/s and 0.89 m/s, respectively) and of 7 points (0.88 m/s and 1.12 m/s, respectively) among the independent ambulatory group.

Among the gait phase classifications that are most commonly used in clinical research, such as that of Perry, a gait speed >0.4 m/s is used for indoor walking, while 0.4–0.8 m/s is the gait speed of limited outdoor walking and >0.8 m/s is used for outdoor walking¹⁶). In addition, the cut-off value of the gait speed for outdoor walking is 0.66–1.14 m/s^{17, 18}). However, the recent definition of outdoor walking includes a cut-off value and distances of >0.73 m/s and >332 m, respectively, and includes being able to go up and down stairs and turn corners independently^{19, 20}). According to this definition, the research subjects in the present study were classified into the outdoor walking group, while the subjects whose minimum mFAC score was 6 points were expected to be assigned to the outdoor walking if their gait speed was ≥ 0.76 m/s.

The improvement in the functional gait performance of these research subjects (mFAC of 3–7 points) increased along with increased mRMI, which reflected the stable/maximum gait speeds and functional mobility. In general, healthy people can adjust their gait performance at different gait speeds. However, most patients with neurological diseases respond slowly to their surroundings because of limited outdoor walking and perform physical activities very passively²). Therefore, improvements in the functional gait performance of stroke patients with gait disability are well-reflected in their gait speed and physical activity performance.

The mFAC used in the present study can be a gait assessment tool for clinical research since its validity is proven, inter- and intra-rater reliability are high, and it is relevant to gait speed and functional mobility. In addition, it is a sophisticated method that can reflect the clinical improvement of a patient's gait ability, and it can be easily used to enhance gait speeds and clinical research designs. However, the present study has limitations; its findings cannot be generalized because the assessments are limited to a certain period in time, while an assessment to estimate the cut-off distance for outdoor walking was not performed. Future studies should include assessments to estimate the cut-offs for mFAC, distance, and other factors for outdoor walking.

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