

# Prediction of Independent Walking Ability for Severely Hemiplegic Stroke Patients at Discharge from a Rehabilitation Hospital

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*Background:* It is important to predict walking ability for stroke patients, because rehabilitation programs are planned on such predictions. We therefore examined predictive factors that are available before discharge from a rehabilitation hospital. *Methods:* Seventy-two consecutive patients with a first attack of stroke with severe hemiplegia were included in this study. We retrospectively evaluated background factors (age, gender, time from stroke onset, paresis side, and stroke type). Other neurological and physical parameters were collected by means of the modified National Institutes of Health Stroke Scale, the Mini-Mental State Examination, the Trunk Control Test (TCT), and the knee extension strength/body weight ratio on the unaffected side (KES/BW-US) at the time of admission. We divided the patients into 2 groups, the independent group (n = 49) and the dependent group (n = 23), on the basis of the Barthel Index of mobility at the time of discharge. We then compared the 2 groups with respect to the aforementioned parameters. We also performed stepwise discriminant analyses to ascertain which parameters are the best predictors of walking ability at the time of discharge. *Results:* Age, TCT score, and the KES/BW-US ratio were significantly different between the groups. Discriminant analysis revealed that younger age and a higher KES/BW-US ratio were significantly associated with walking ability at discharge, which could be precisely predicted using the following formula:  $Y = .093 \times (\text{age}) - 4.316 \times (\text{KES/BW-US}) - 4.984$ . *Conclusions:* At the time of admission, age and the KES/BW-US ratio permit the prediction of independent walking ability at the time of discharge. Our formula predicts walking ability with an accuracy of more than 91%. **Key Words:** Prediction—rehabilitation—walking ability—severely hemiplegic stroke patients.

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## Introduction

Following strokes, rehabilitation programs for patients should be planned according to prognostic considerations.<sup>1</sup> For example, if the functional outcome is expected to be poor and will require much support by caregivers, the rehabilitation program should include family participation. The ability to walk is a decisive factor in determining the activities of daily living (ADL), and regaining the ability to walk is a pivotal goal in the rehabilitation of patients after hemiplegic strokes.<sup>2-4</sup> An ankle foot orthosis (AFO) is commonly used to provide better balance and walking quality,<sup>5-8</sup> but severe hemiplegia prevents voluntary knee control during standing. A knee-ankle foot orthosis (KAFO) is therefore an aid to ambulation in the event of severe hemiplegia.<sup>9-12</sup> In previous studies in which AFO was used in rehabilitation, the likelihoods of independent walking ability were predicted from the criteria of sitting balance, trunk ability, and muscle strength of the lower extremities.<sup>13-18</sup> However, predictors of walking ability have not been established for patients who suffer severe hemiplegia and may require a KAFO. The ability to predict walking ability at discharge for patients with severe hemiplegia would become an important indication for the application of a KAFO. Therefore, we aimed to identify the predictors of walking ability that would be available at the time of admission to rehabilitation hospital.

## Methods

### *Design of the Study*

This study was approved by the Ethics Committee of Hanno-Seiwa Hospital (Approval No. 140109). All of the patients who were admitted to our rehabilitation hospital from August 2008 to April 2015 with sequela of stroke were retrospectively assessed, and the patients with severe hemiplegia at admission were included in this study. Severe hemiplegia was defined as having a Brunnstrom Recovery Stage<sup>19</sup> of II or I in the lower extremity. Patients who required assistance in walking before the index stroke episode were excluded. In all of the patients, demographic information (age, gender, time from stroke onset, and paresis side) and stroke type (cerebral infarction [CI], intracerebral hemorrhage [ICH], and subarachnoid hemorrhage [SAH]) were reviewed. Cognitive function and neurological deficits at admission were evaluated using the Mini-Mental State Examination (MMSE) and the modified National Institutes of Health Stroke Scale (m-NIHSS),<sup>20</sup> respectively. Physical function was evaluated by the Trunk Control Test (TCT)<sup>21</sup> and by the knee extension strength/body weight ratio on the unaffected side (KES/BW-US), for which the measurement method was reported previously.<sup>22</sup> At discharge, we evaluated the Barthel Index (BI) for all patients and used it to gauge walking ability. When a patient could walk for 50 yards or more without

the help of another person, regardless of aid by cane or leg brace, the patient was considered to be capable of walking independently (BI subscore of 15 points). Patients who could not walk independently for 50 yards (BI subscore of 10 points or lower) were regarded to be incapable of walking independently. We then compared the aforementioned variables between the 2 groups. Furthermore, stepwise discriminant analysis was performed to reveal which parameters significantly contributed to walking ability.

### *Statistical Analysis*

The *t*-test was used for age, time from stroke onset, MMSE, m-NIHSS, TCT, and KES/BW-US. The  $\chi^2$  test was used for gender, stroke subtype, and paresis side. In addition, for the variables showing significant differences, a discriminant analysis was conducted using walking ability at discharge as the dependent variable. All statistical analyses were performed using SPSS for Windows (version 23.0; IBM Corp., Armonk, NY), and *P* values less than .05 were considered statistically significant.

### *Rehabilitation Program*

All the patients received a KAFO and conventional rehabilitation including physical therapy (PT), occupational therapy (OT), and speech therapy (ST). They underwent 2-3 hours of these therapies daily. PT, OT, and ST were conducted each day as necessary for 1-3 units each (1 unit is 20 minutes; total of 6-9 units). In cases in which the general condition of the patient was unstable, PT began from the bedside and included range of motion exercises, positioning, sitting exercises, and standing exercises. If permitted by the general condition, the exercises of standing, mat work, transfer maneuvers, wheelchair use, walking, and stair climbing were performed incrementally in the training room (gym). OT included ADL training, such as using the bathroom, grooming, dressing, and bathing. OT also involved arm exercises, including changing hand dominance. ST included exercises for dysphagia and for aphasia.<sup>23</sup>

## Results

Seventy-two patients were included in the study. The ages ranged from 39 to 87 years old ( $63.2 \pm 11.3$  years old), and there were 45 men and 27 women. There were 15 CI, 51 ICH, and 6 SAH. The length of stay ranged from 29 to 178 days (mean  $\pm$  SD:  $100.7 \pm 41.9$ ); 62 patients were discharged to their homes, and 10 patients required transfer to a care facility.

Of the 72 patients, 49 were categorized as able to walk independently, and 23 were judged to be in the dependent group. The background factors and the neurological and physical findings are shown for each group in [Table 1](#). The mean age of the independent group was significantly

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