Prognosis and Classification of Severely Hemiplegic Stroke Patients in a Rehabilitation Hospital

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Abstract

Objective: When carrying out rehabilitation during convalescence, the prognosis must be considered before treatment, and guidance needs to be provided to patients and their families. However, predicting the prognosis and final outcomes of patients with severe hemiplegia is challenging since the condition is influenced by various factors in a complex manner. The aim of this study was to identify prognosis factors for the outcomes of severely hemiplegic stroke patients on the basis of evaluations conducted at the time of admission to rehabilitation.

Methods: The subjects were 80 first-time stroke patients presenting with severe hemiplegia. They were divided into groups by their properties and physical function on admission. The groups were compared by their properties, physical function on admission, and outcomes.

Results: According to these factors, the patients were divided into 3 groups: "good cognitive function and good muscle strength in the lower extremity on the non-paralyzed side (A group)," "poor cognitive function and poor motor function (B group)," and "good cognitive function and good motor function(C group)" by cluster analysis. At the end of the rehabilitation period, the patients in the B group had a significantly worse ability to walk and to perform ADL than the patients in the A and C groups, and only a few patients from the B group were able to return home.

Conclusion: We concluded that the classification of severely hemiplegic stroke patients is useful to predict prognosis in a rehabilitation hospital.

Keywords: Stroke; Severely hemiplegic; Cluster analysis; Classification; Prognosis; Rehabilitation hospital

Introduction

Rehabilitation programs for hemiplegic stroke patients often consist of training aimed at improving the patient's activities of daily living (ADL) and their ability to walk, which affect the patient's daily life, including the outcomes after hospital discharge [1-3]. In particular, the outcome of treatment at a rehabilitation hospital is directly linked to the prognosis, and therefore, methods for need to be established in order to design suitable training programs. For severely hemiplegic stroke patients being treated at a rehabilitation hospital, early prediction of the ultimate goals is particularly difficult to achieve. To date, prognosis prediction methods have focused on the ability to walk [4,5], ability to carry out ADL [6,7], duration of hospital stay [8] and destination [9]. However, most of these methods are aimed at predicting a single goal, and as a result, they allowed for the extraction of factors which are important for the prognosis of the concerned goals, but did not allow for determination of the patients' characteristics or overall condition. In addition, previous studies have mostly been conducted on patients in the acute phase or patients with total cerebral infarction and did not apply to prognosis prediction in severely hemiplegic stroke patients hospitalized in a rehabilitation facility.

Moreover, patients with severe hemiplegia underwent intensive training such as standing up as well as gait training using knee-ankle-foot orthosis in order to achieve early reinforcement of trunk functions and muscle strength in the non-paralyzed limb, as well as the improvement of mobility [10]. However, even if the same rehabilitation program is carried out on every patient, the final prognosis may vary depending on cognitive functions, neurological symptoms, and the amount of residual motor function. Although hemiplegic stroke patients seem to have considerable individuality with regard to the above, our experience has shown the existence of several types. For experienced therapists, assessing each patient's

type on the basis of the patient's overall picture is likely to lead to accurate treatment. Conversely, for inexperienced therapists, the treatment plan may be designed on the basis of individual evaluation results, but because of their inability to determine patients' types, deciding the course of treatment is often prolonged. If this patient classification based on empirical rules can be clarified on the basis of evaluation items measured at the time of admitting severely hemiplegic stroke patients, it will allow for the early determination of future hospitalized patients' prognosis at the time of discharge. This will also aid the provision of guidance to patients' families with regard to environmental arrangements aimed at improving the outcome and guidance concerning specific methods of assistance adjusted to patients' daily lives at home. Therefore, the purpose of this study was to determine patient characteristics by classifying participants with similar features into different types according to the patterns they showed in a cluster analysis based on the evaluation of severely hemiplegic stroke patients at the time of hospital admission. The aim of this study was to identify prognosis factors for the outcome of severely hemiplegic stroke patients on the basis of evaluations conducted at the time of admission to rehabilitation.

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Methods

Design of the study

Subjects: This study was conducted with the approval of Hanno-Seiwa Hospital's Ethical Review Board (approval number: 150118) and the approval of the Research Safety and Ethics Committee of the Arakawa Campus, Tokyo Metropolitan University (approval number: 15080).

The participants consisted of 80 out of 98 patients who were admitted to our hospital's rehabilitation ward between July 2008 and August 2015 on the first onset of stroke, who presented with severe hemiplegia, and whose paralysis of the affected lower extremity was classified as stage II or less according to the Brunnstrom recovery stage [11]. However, 18 of the 98 patients as follows were excluded from the study: 8 patients who had not been able to independently carry out ADL before disease onset, and 10 patients who could not undergo rehabilitation because of severe heart failure. We considered it better to exclude these patients, because we cannot evaluate the effect of rehabilitation. Regarding the rehabilitation program, participants underwent physiotherapy, occupational therapy, speech-language-hearing therapy and functional feeding practice in accordance with the 2009 stroke guidelines for Japan [1] daily, of achieving 9 units per day (this is the daily maximum limit according to the national system for diagnosis and treatment, in which a 20-minute session is considered as 1 unit). In physiotherapy, standing up, sitting and standing motions in daily life, transfer motions, wheelchair driving, walking, as well as stair climbing and descending practice, were performed in a stepwise manner [10]. In addition, during the initial period after admission, all patients carried out standing-up exercises, walking exercises, as well as stair-climbing-and-descending exercises while wearing a knee-ankle-foot orthosis. Depending on the patients' degree of recovery from paralysis, the knee-ankle-foot orthosis was replaced with an ankle-foot orthosis in some cases. In occupational therapy, patients performed exercises involving ADL such as toilet activities, grooming activities, dressing activities and bathing activities, and functional exercises of the upper extremities, including changing the dominant hand. In speech therapy and functional feeding practice, rehabilitation was targeted at aphasia, dysarthria, eating disorders and dysphagia.

Classification of the patients and characteristics of groups

A cluster analysis is a method in which participants' data are collected and those that are mutually similar in the absence of external criteria (objective variables) are grouped together and automatically classified.

We used this technique to determine the characteristics of the patients who participated in our study. For the selection of evaluation items, those recommended for the 2009 stroke guidelines for Japan [1] and Japanese Guidelines for the Physical Therapy (2011) [12] were used. Five evaluation items were used for classifying the types of participants: age as an indicator of patient attributes, mini-mental state examination (MMSE) as an indicator of cognitive function, the modified NIH Stroke Scale (m-NIHSS) [13] as an indicator of neurological symptoms, the trunk control test [14] as an indicator of motor function, and the "knee extensor strength on the non-paralyzed side / body weight" ratio (KES/BW-US) [15].

A cluster analysis does not allow for analysing which similarities between attributes and functions were used for the grouping of each type. For this reason, in order to determine the features of each group, a one-way analysis of variance was carried out considering each group as an independent variable and considering the evaluation items used in the cluster analysis (age, MMSE, m-NIHSS, TCT, and KES/BW-US) as dependent variables. When a significant difference was found, Bonferroni's multiple comparison tests were performed. To determine the features of each group, characterization was performed using the items that had shown significant differences between the groups in multiple comparison tests.

Comparison for prognosis of each group

Outcome measures were walking ability measured by the functional ambulation category (FAC) scores [16], ability to perform ADL measured with Barthel index score, the ability to return home.

For the statistical studies, a one-way analysis of variance was carried out using the BI and length of hospital stay as dependent variables and by considering each group as an independent variable. When significant differences were found, Bonferroni's multiple comparison tests was carried out. For the FAC and outcomes, a cross-tabulation was performed, followed by a chi-square test.

Statistical analysis was carried out using SPSS for Windows (version 24, IBM, Armonk, New York). The statistical significance level was set at 5%.

Results

Patient's characteristics

The participants' attributes were as follows: mean age was 62.7 ± 11.6 years; 50 participants were male and 30 were female; the type of stroke was cerebral infraction in 19 patients, intracerebral hemorrhage in 55 patients, and subarachnoid hemorrhage in 6 patients; and the paralyzed side was the right in 34 patients and the left in 46 patients. The time since the onset of symptoms until hospital transfer was on average 30.6 ± 15.2 days. Regarding the ability to carry out ADL at the time of hospital admission, the average BI was 15.5 ± 14.9 points. The average duration of stay at our hospital was 106.6 ± 44.5 days.

Classification of the patients and characteristics of groups

The subjects were 80 first-time stroke patients presenting with severe hemiplegia. The following data were collected on admission to the rehabilitation hospital as independent variables: the patients' age, MMSE, the m-NIHSS, TCT, and KES/BW-US by the cluster analysis, the 80 participants were classified into 3 groups: "A group", "B group" and "C group", and most of the participants were clustered in the "A group" (Figure 1).

Table 1 shows the findings pertaining to each evaluation item in the 3 groups at the time of admission, and the features of each group are shown separately as follows: the participants' age and the time since the onset of disease was not significantly different between the 3 groups. Cognitive functions were significantly greater in the "A group" and "C group" than those in the "B group". The KES/BW-US was significantly greater in the "A group" and "C group" than that in the "B group". The trunk function was significantly greater in the "A group" and "C group" than that in the "B group". In addition, trunk function was significantly greater in the "C group" than that in the "A group".

Prognosis of each group

Table 2 shows the results pertaining to each evaluation item as found in the 3 groups at the time of discharge. The ability to walk was significantly lower in the "B group" than in the "A group" and the "C group". The ability to carry out ADL was significantly higher in the "A group (the average BI was 75.9 points)" and the "C group (the average BI was 71.7 points)" than in the "B group (the average BI was 45.0
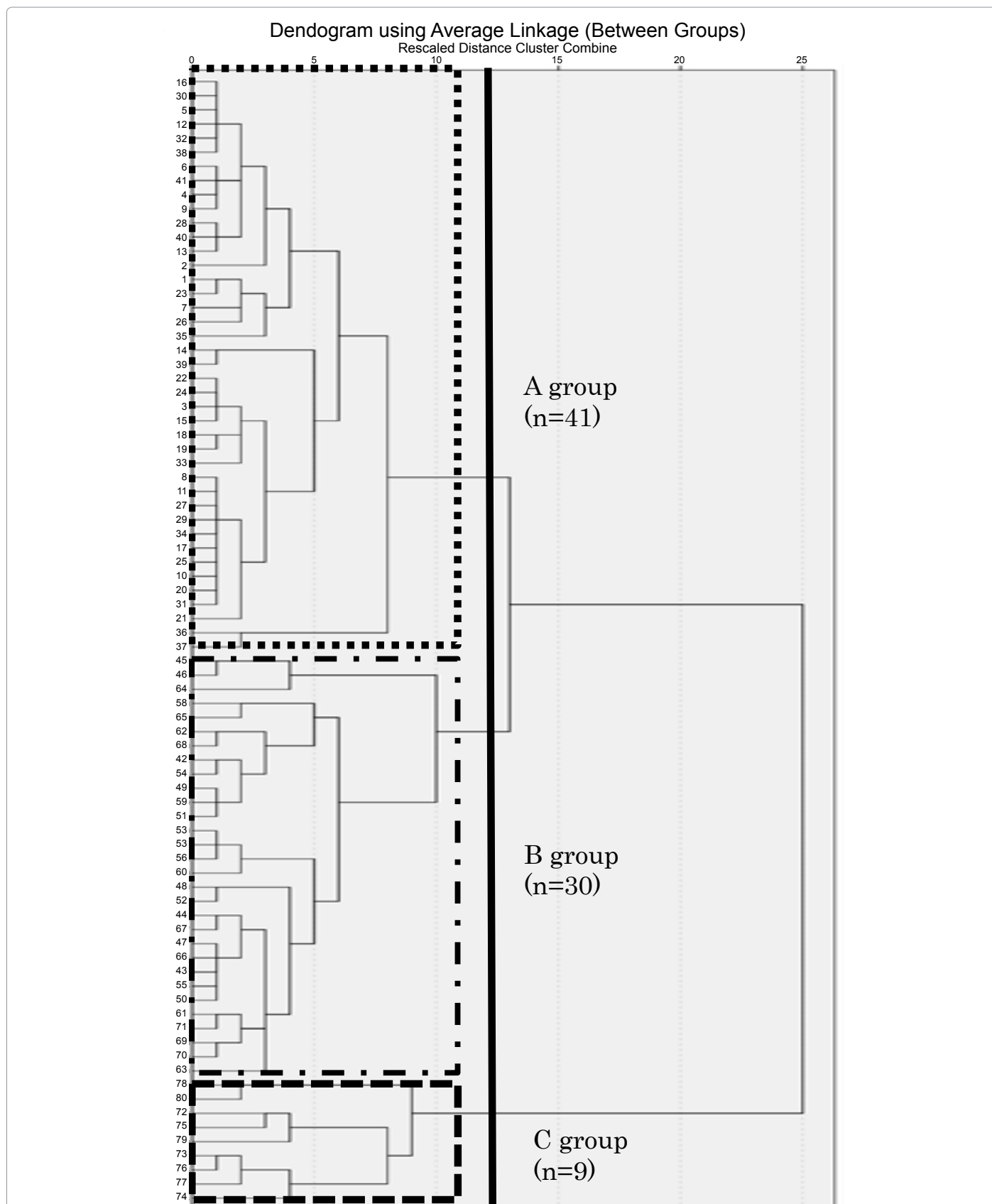
Figure 1: The number of the vertical axis indicates subjects. A transverse indicates the distance a cluster combined. The similarity of each object is tied at the nearby high location. Eighty objects were classified into 3 groups.

Items Evaluated	A group (n=41)	B group (n=30)	C group (n=9)	P value
Background factors				
Age (years)	61.4±9.7	64.2±13.4	64.0±13.6	0.588
Time from stroke onset (days)	27.5±15.9	32.9±14.5	36.9±11.5	0.141
Cognitive and neurological deficits on admission				
MMSE (points)	22.3±6.8	8.6±9.0	18.3±11.0	0.001
NIHSS (points)	9.8±1.8	12.2±2.4	10.4±2.1	0.001
Physical function on admission				
KES/BW-US (kg/kg)	0.28±0.2	0.04±0.09	0.39±0.2	0.001
TCT (points)	42.6± 12.1	10.7±11.2	80.3±12.8	0.001

Table 1: Characteristics of patients in the three groups (*p<0.05 (one-way analysis of variance, multiple comparison), KES/BW-US=Knee Extension Strength/Body Weight ratio on the Unaffected Side, MMSE=Mini-Mental State Examination, NIHSS=modified National institute of Health Stroke Scale, TCT=Trunk Control Test).

Based on the findings listed above, the features of each group were as follows: in the "A group," cognitive functions were greater, the average KES/BW-US was 0.28, and trunk function was relatively higher (enough for the patients to roll over in bed and maintain a seated posture by grasping and holding on to something). Therefore, the "A group" had "good cognitive function and good muscle strength in the lower extremity on the non-paralyzed side." In the "B group", cognitive functions were lower, the average KES/BW-US was 0.04, trunk function was poor (enough for the patients to be able to roll over in bed either towards the right or towards the left by grasping and holding on to something). Therefore, the "B group" had "poor cognitive function and poor motor function". In the "C group", cognitive functions were good, the average KES/BW-US was 0.39, trunk function was high (the patients were at least able to roll over in bed and adopt a seated posture without grasping and holding on to something). Therefore, the "C group" had "good cognitive function and good motor function".

Items evaluated	A group (n=41)	B group (n=30)	C group (n=9)	P value
Walking ability				
Walking (number)	31	6	7	0.001
Non-walking (number)	10	24	2	
ADL				
BI (points)	75.9±11.3	45.0±20.4	71.7±11.9	0.001
Destination				
Home (number)	37	18	9	0.002
Facilities (number)	4	12	0	
Length of stay (days)	91.1±36.6	122.0±46.6	102.2±45.3	0.001

Table 2: Outcomes of patients in three groups (*: p <0.05 (one-way analysis of variance, χ2test and multiple comparison) ADL=Activities of Daily Living, BI=Barthel Index).

points)", and only a few patients from the B group were able to return home.

Discussion

Findings from the cluster analysis showed that the 80 participants were classified in the "A group" with "good cognitive function and good muscle strength in the lower extremity on the non-paralyzed side, the "B group" with "poor cognitive function and poor motor function", and the "C group" with "good cognitive function and good motor function".

In severely hemiplegic stroke patients hospitalized in rehabilitation hospital, the ability to walk and carry out ADL has been reported to be greatly affected by not only patient characteristics such as age and the time since the onset of disease, but also by muscle strength in the lower extremity on the non-paralyzed side as well as trunk function at the time of admission [17,18]. However, in our study, patient characteristics such as age and the time since disease onset revealed no differences between the 3 groups. The findings revealed that when trunk function and muscle strength in the lower extremity on the non-paralyzed side were maintained at relatively high levels as in the case of the "A group", the prognoses of the abilities ultimately acquired through intensive rehabilitation programs in rehabilitation hospitals were not very different from that of the "C group" in which the trunk function and the muscle strength in the lower extremity on the non-paralyzed side were good at the time of admission. In addition, the findings also showed that even if standing and walking training using knee-ankle-foot orthosis were performed intensively in patients with the same severity of paralysis, the outcomes and the abilities at the time of hospital discharge could be different, depending on the amount of residual function in terms of muscle strength in the lower extremity on the non-paralyzed side, trunk function, and cognitive functions at the time of admission to a rehabilitation hospital. This suggests that even in stroke patients with severe paralysis, favorable outcomes may be achieved by conducting full training exercises in a rehabilitation hospital, with the aim of improving muscle strength in the lower extremity on the non-paralyzed side and in the trunk muscles.

Granger et al. [19] previously reported that the fact of whether the total BI score of a stroke patient exceeds 60 points or not, is the diverging point to whether the patient is partially independent or in need of assistance. Our findings showed that in the "A group" and the "C group", the patients were partially independent in carrying out ADL at the time of hospital discharge, whereas in the "B group", the patients

needed moderate or intensive assistance in carrying out ADL at the time of hospital discharge. Further, while most participants in the "A group" and "C group" were able to walk and went home after discharge, most of those in the "B group" were unable to walk, and only a few were eligible to return home. For hemiplegic stroke patients, the eligibility to return home after discharge from hospital is greatly influenced by their ability to carry out ADL at the time of discharge [20], family structure, number of family members living together with the patient, and social background [21]. Our study also suggested that the poor ability to walk and carry out ADL at the time of discharge were factors that caused the fewer number of patients returning home after discharge in the "B group" than in other groups.

In this study conducted on severely hemiplegic stroke patients treated in a rehabilitation hospital, we classified the participants into groups on the basis of findings at admission. We also extracted the features of each group and clarified their prognosis. The results of our study show that the features of the participants could be determined on the basis of findings at the time of admission to rehabilitation hospital, namely, cognitive functions, trunk function as well as the degree of muscle strength in the lower extremity on the non-paralyzed side, and that classifying the patients into three separate groups allowed for predicting their ability to carry out ADL as well as their ability to walk at the time of discharge. In addition, the findings of our study suggest that for patients like those who were classified as the "A group" and "C group", namely the groups with stronger cognitive function, trunk function and muscle strength in the lower extremity on the non-paralyzed side, such patients may potentially reacquire the ability to walk and carry out ADL at the time of discharge and are likely to return to living at home. In addition, it is important that the patients' family members be taught how to assist the patients with daily life at home, and that they be instructed regarding bathing, high steps and stairs associated with a risk of falls. Meanwhile, for patients with low residual function like those who were classified as the "B group", rehabilitation aimed at reducing the amount of assistance with bedside activities, toilet activities, and ambulatory activities, need to be carried out. For patients who wish to return home after recovery, home renovation and the selection of assistive devices needs to be suited to their abilities. In addition, our study also suggests that in order to avoid burdening the family with nursing care duties, it is important that the family is taught specific methods of assistance, including standing up, transfer motions, toilet activities, and walking [10]. The purpose of this is to provide the family with an understanding of the patient's medical condition from the early period of hospitalization, and also to help the family acquire skills that will allow them to provide assistance to the patient. This will allow for the setting of well-defined goals in anticipation of daily life after discharge from hospital, and will allow for designing a rehabilitation plan.

Conclusion

The classification of severely hemiplegic stroke patients is useful to predict in a rehabilitation hospital. Rehabilitation programs for severely hemiplegic stroke patients should be planned according to prognostic considerations of classification in this study. If patient's outcomes are expected to be as poor as the B group definition, then the patient will require much support by caregivers, and the rehabilitation program should include family participation.

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