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Original Article

Changes in the gait ability of hemiplegic patients with stroke in the subacute phase —A pattern based on their gait ability and degree of lower extremity motor paralysis on admission—

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ABSTRACT
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Purpose: To examine changes in gait ability of stroke patients in the subacute phase based on their gait ability and severity of lower extremity motor paralysis.

Methods: The subjects were 1,698 hemiplegic patients with stroke. Patients were stratified by their gait ability on admission based on the Functional Independence Measure (FIM) (scores 1 to 7), and by their severity level of lower extremity motor paralysis based on the Stroke Impairment Assessment Set (complete, severe, moderate, and mild paralysis). Then the patients were classified into 28 groups using a combination of the seven FIM walk scores and the four severity levels of motor paralysis, and the relations with gait ability at discharge and various time points were analyzed.

Results: Patients in the complete paralysis group with an admission FIM walk score of 1 or 2 showed significantly lower FIM walk scores at discharge, compared to patients in the other groups. When patients had a FIM walk score of 3 or 4 on admission, the contribution of the severity of paralysis to the FIM walk score at discharge tended to be relatively small.

Conclusion: There were diverse courses of recovery of walking ability among stroke patients depending on their gait ability and severity of motor paralysis on admission.

Key words: cerebrovascular disorders, kaifukuki rehabilitation ward, walking, hemiplegia

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Introduction

When conducting rehabilitation for stroke patients, it is important to implement a training program efficiently while predicting the level of ADL (activities of daily living) that they are expected to achieve. In particular, it is necessary to predict the gait ability of patients at discharge as accurately as possible at the time of initiation of early-stage rehabilitation, because gait ability at discharge has significant influences on their health outcomes and lifestyles after discharge [1].

Detailed information on the final level of assistance and expected duration for exercise is essential during gait exercise based on an outcome. Such information is important not only for health professionals, but also for patients and their families [2].

Previous studies have examined the changes in the gait ability of stroke patients over time, with a focus on the walking speed [1, 3, 4] and level of independence [5−7] at discharge. Since most of those studies adopted the Barthel Index in which gait was scored on a three-grade scale; “walk independently,” “walk with assistance,” and “unable to walk,” slight changes in the gait ability could not be detected. Furthermore, few previous studies focused on the conditions of patients on admission. Even if patients are considered to have the same level of assistance on admission, improvement in gait ability may vary depending on the level of motor paralysis, and different approaches should be implemented for different levels of motor paralysis. On the other hand, motor paralysis may also have different influences on changes in the gait ability over time depending on the level of assistance required.

The present study examined improvement in gait ability, length of stay, and ADL of stroke patients in the subacute phase, using the Functional Independence Measure Version 3 (FIM) [9]. Prior to the assessment, patients were stratified based on their gait ability and severity of lower extremity motor paralysis on admission.

Subjects

A total of 3,045 stroke patients who had been admitted to and later discharged from the subacute rehabilitation ward between September 2004 and March 2012 were screened. Patients were excluded from the study if any of the following applied: number of days from onset to admission was 91 days or longer; severe complications that required careful attention and could have interfered with training (a Liu Comorbidity Index score of 4 or higher); stroke was caused by lesions other than unilateral supratentorial lesions; and stroke recurred twice or more. Patients who could not complete rehabilitation due to change in health condition or other reasons and who showed ADL deterioration were also excluded from the study. Eventually, a total of 1,698 hemiplegic stroke patients who had completed inpatient rehabilitation were selected as subjects. All of the patients received treatment according to the Full-time Integrated Treatment (FIT) program [11]. The FIT program training including physical and occupational therapies was conducted seven days a week. For patients requiring speech therapy, the therapy was conducted at a maximum of five days per week. From 2004 to 2005, six sessions (2 hours) of rehabilitation were implemented, which consisted of 40 to 60 minutes of physical and occupational therapies and 40 minutes of speech therapy, only for patients requiring such rehabilitation. From 2006 onward, the permitted maximum period of training was extended to nine sessions (3 hours), which consisted of 60 to 120 minutes of physical and occupational therapies and 40 to 60 minutes of speech therapy, only for those patients requiring such rehabilitation. The rehabilitation sessions were prescribed by the physicians. Table 1 shows the demographic and clinical data of the patients. Among these patients, 236 were also the subjects of a previous study on changes in ADL on admission and at discharge [12].

Methods

Demographic and clinical data of the subjects, such as age, gender, diagnosis, side of paralysis, period from stroke onset, and length of stay, was obtained from the patient database. The FIM scale was used to assess the ADL of the patients. The sum of the FIM motor items (FIM-M), FIM-M gain ([FIM-M at discharge] − [FIM-M on admission]), FIM-M efficiency ([FIM-M gain] / length of stay), and the sum of the FIM cognitive items (FIM-C) were also calculated.

To assess the gait ability, the FIM walk item in the

Table 1. Demographic and clinical data of the subjects.

Age (years)	65.7 ± 13.0
Sex (patients)	Male: 1007 Female: 691
Diagnosis (patients)	Cerebral hemorrhage: 803 Cerebral infarction: 812 Subarachnoid hemorrhage: 83
Side of paralysis (patients)	Right: 849 Left: 849
Duration from onset to admission (days)	35.4 ± 14.9
Length of stay (days)	67.0 ± 5.4
FIM-M on admission	48.3 ± 22.8
FIM-M at discharge	68.8 ± 21.2
FIM-M gain	20.4 ± 13.6
FIM-M efficiency (/day)	0.33 ± 0.23
FIM-C on admission	24.0 ± 8.8
FIM-C at discharge	27.3 ± 7.7

FIM, Functional Independence Measure; FIM-M, FIM motor items; FIM-C, FIM cognitive items.

FIM locomotion subscore was adopted. The FIM walk item is a seven-grade scale: 1 point for less than 25% of walking effort, 2 points for 25% or higher to less than 50%, 3 points for 50% or higher to less than 75%, 4 points for 75% or higher to less than 100%, 5 points for walking under surveillance, 6 points for walking with aids, and 7 points for walking on their own. Scores were determined every two weeks starting from admission until the 12th week and at discharge. When the length of stay was shorter than twelve weeks, the score following discharge was assumed to be the same as that at discharge.

To assess lower extremity motor paralysis, the hip-flexion, knee-extension, and foot-pat tests were adopted. These methods are six-grade (0 to 5 points) scales included in the Stroke Impairment Assessment Set (SIAS) designed to assess motor functions on the paralyzed side: 0 points for no muscle contraction, 1 point for slight muscle movement, 2 points for performing tasks incompletely, 3 points for ability to perform tasks with difficulty, 4 points for ability to perform tasks with slight difficulty, and 5 points for no difficulty with tasks. The total score of the hip-flexion, knee-extension, and foot-pat tests on admission was calculated for each patient, and patients were classified based on the scores into the following four levels: complete paralysis (0 point), severe paralysis (1 to 5 points), moderate paralysis (6 to 10 points), and mild paralysis (11 to 15 points).

The patients were classified into 28 groups using a combination of the seven FIM walk scores and the four severity levels of SIAS lower extremity paralysis. The mean age, duration from onset to admission, length of stay, FIM-M on admission and discharge, FIM-M gain, FIM-M efficiency, and mean FIM-C on admission and discharge were calculated in each group. Patients' scores for each scale item were compared between the groups with different admission FIM walk scores and severity levels of SIAS lower extremity paralysis.

To examine serial changes of the FIM walk scores, the minimum, first quartile, median, third quartile, and maximum values of the FIM walk scores were calculated at eight time points (the 1st time point on admission, followed by 6 time points every two weeks until the 12th week, and the last time point at discharge) in the 28 groups. The FIM walk score at discharge was compared by the severity of SIAS lower extremity paralysis in patients with FIM walk score of 1, 2, ..., and 7 separately.

For statistical comparisons between two groups, the *t*-test was used to analyze interval scale variables, and the Mann-Whitney *U* test was adopted to analyze ordinary scale variables. Analyses of variance were conducted for comparisons among three or more groups, and Scheffe's test was used for multiple comparisons. The results were determined as significant when the risk rate was lower than 5%.

Written consent was obtained on admission for the use of patient information for academic purposes. The present study was conducted with the approval of the ethical committee of the hospital.

Results

Table 2 shows a comparison of variables stratified by the FIM walk scores and severity of SIAS lower extremity paralysis on admission. At the same admission FIM walk score, the severity of paralysis decreased as the age of the patients increased. At the same SIAS severity level, the FIM walk score on admission increased as the age of the patients decreased. The length of stay tended to be shorter in the moderate and mild paralysis groups. When the admission FIM walk score was 1, patients in the complete paralysis group showed a significantly lower FIM-M score on admission and significantly lower FIM-C scores on admission and discharge compared to the moderate and mild paralysis groups. When the admission FIM walk score was 2, patients in the complete paralysis group showed significantly lower FIM-M scores on admission compared to the other three groups, and significantly lower FIM-C scores on admission compared to severe and moderate paralysis groups. However, there were no significant differences in the FIM-C score between the complete and mild paralysis groups. There were significant differences in the FIM-C score at discharge between the complete and severe paralysis groups, but not between the complete and mild paralysis groups. When the admission FIM walk score was 3, there was a significant difference in the FIM-M score on admission between the severe and moderate paralysis groups. However, when the admission FIM walk scores were 3 to 5, there were no significant differences in the mean FIM-M and FIM-C scores on admission and at discharge between the groups, regardless of the severity of SIAS lower extremity paralysis, except for the combination mentioned in the previous sentence.

The boxplot in Figure 1 shows changes in gait ability (minimum, first quartile, median, third quartile, and maximum) according to the FIM walk score and severity levels of SIAS lower extremity paralysis on admission. The FIM walk score increased during hospitalization, except for the groups with an FIM walk score of 7. Regarding severity of SIAS lower extremity paralysis, the median FIM walk score at six weeks after admission was 2 for the complete paralysis group, and 3 or higher for the other three groups in patients with an admission FIM walk score of 1. FIM scores in the complete paralysis groups tended to be lower. Patients in the complete paralysis group with an admission FIM walk score of 2 showed lower FIM walk score compared to those in the other three groups, although the differences were smaller than when the FIM walk score on admission was 1. When the

Table 2. Comparison of variables stratified by the FIM walk scores and severity of lower extremity paralysis (SIAS).

FIM walk score of 1 on admission

	Complete paralysis $n = 138$	Severe paralysis $n = 107$	Moderate paralysis $n = 43$	Mild paralysis $n = 13$	Analysis of variance
Age (years old)	70.4 ± 11.7	68.7 ± 11.8	70.5 ± 14.3	77.2 ± 9.5	F (3,297) = 1.98, p > 0.11
Days from onset to admission (days)	38.3 ± 14.7	44.4 ± 18.3	38.3 ± 16.2	34.6 ± 22.7	F (3,297) = 3.53, p < 0.05 A*
Length of stay (days)	96.6 ± 43.1	88.5 ± 35.0	83.9 ± 39.4	68.1 ± 21.1	F (3,297) = 3.03, p < 0.05
FIM-M on admission	17.9 ± 6.2	21.3 ± 8.7	30.6 ± 17.6	35.8 ± 17.0	F (3,297) = 26.8, p < 0.01 B** C** D** E**
FIM-M at discharge	33.4 ± 19.1	44.0 ± 20.2	52.2 ± 25.0	61.7 ± 20.0	F (3,297) = 15.9, p < 0.01 A** B** C** E*
FIM-M gain	15.5 ± 15.9	22.8 ± 15.9	21.6 ± 17.4	25.8 ± 15.8	F (3,297) = 5.23, p < 0.01 A**
FIM-M efficiency (/day)	0.16 ± 0.17	0.27 ± 0.21	0.29 ± 0.26	0.38 ± 0.23	F (3,297) = 10.8, p < 0.01 A** B** C**
FIM-C on admission	13.5 ± 7.3	17.2 ± 7.5	19.1 ± 10.1	25.8 ± 7.0	F (3,297) = 14.5, p < 0.01 A** B** C** E**
FIM-C at discharge	17.8 ± 8.3	22.0 ± 7.5	23.1 ± 10.2	28.7 ± 5.0	F (3,297) = 11.9, p < 0.01 A** B** C**

FIM walk score of 2 on admission

	Complete paralysis $n = 78$	Severe paralysis $n = 133$	Moderate paralysis $n = 44$	Mild paralysis $n = 21$	Analysis of variance
Age (years old)	66.1 ± 11.0	66.4 ± 12.4	70.0 ± 12.2	75.2 ± 10.1	F (3,272) = 4.34, p < 0.01 C* E*
Days from onset to admission (days)	39.7 ± 14.1	36.3 ± 13.6	29.7 ± 12.2	36.9 ± 17.5	F (3,272) = 4.86, p < 0.01 B**
Length of stay (days)	97.3 ± 31.5	92.2 ± 26.5	78.5 ± 27.7	77.2 ± 56.4	F (3,272) = 4.78, p < 0.01 B*
FIM-M on admission	26.1 ± 8.4	31.5 ± 9.9	32.7 ± 10.9	39.0 ± 12.6	F (3,272) = 11.5, p < 0.01 A** B** C** E*
FIM-M at discharge	51.2 ± 17.1	60.4 ± 17.3	60.2 ± 20.1	63.6 ± 17.6	F (3,272) = 5.46, p < 0.01 A** C*
FIM-M gain	25.2 ± 12.8	28.9 ± 12.6	27.5 ± 15.6	24.5 ± 13.7	F (3,272) = 1.64, p > 0.18
FIM-M efficiency (/day)	0.27 ± 0.15	0.34 ± 0.21	0.37 ± 0.22	0.41 ± 0.29	F (3,272) = 4.33, p < 0.01 C*
FIM-C on admission	16.1 ± 6.4	21.9 ± 7.8	21.5 ± 7.3	19.4 ± 6.9	F (3,272) = 11.1, p < 0.01 A** B**
FIM-C at discharge	21.0 ± 6.8	25.9 ± 7.5	24.8 ± 8.2	24.1 ± 7.9	F (3,272) = 7.22, p < 0.01 A**

FIM walk score of 3 on admission

	Complete paralysis $n = 23$	Severe paralysis $n = 117$	Moderate paralysis $n = 127$	Mild paralysis $n = 66$	Analysis of variance
Age (years old)	60.1 ± 12.9	63.6 ± 11.0	64.4 ± 13.2	69.1 ± 11.9	F (3,329) = 4.22, p < 0.01 C* E*
Days from onset to admission (days)	34.0 ± 14.1	35.3 ± 14.8	33.6 ± 15.6	34.0 ± 15.1	F (3,329) = 0.28, p > 0.84
Length of stay (days)	91.0 ± 39.3	86.7 ± 25.0	70.7 ± 25.5	68.3 ± 23.7	F (3,329) = 12.5, p < 0.01 B** C** D** E**
FIM-M on admission	41.0 ± 13.1	40.6 ± 11.1	46.1 ± 12.7	44.8 ± 11.2	F (3,329) = 4.96, p < 0.01 D**
FIM-M at discharge	68.4 ± 14.8	69.6 ± 12.3	73.7 ± 12.6	70.9 ± 14.5	F (3,329) = 2.41, p > 0.06
FIM-M gain	27.3 ± 11.7	29.0 ± 10.2	27.5 ± 10.5	26.1 ± 10.3	F (3,329) = 1.15, p > 0.32
FIM-M efficiency (/day)	0.34 ± 0.17	0.35 ± 0.14	0.42 ± 0.19	0.43 ± 0.26	F (3,329) = 3.65, p < 0.05
FIM-C on admission	22.7 ± 7.6	24.2 ± 8.1	26.1 ± 7.7	25.0 ± 6.9	F (3,329) = 2.10, p > 0.09
FIM-C at discharge	27.1 ± 6.3	28.5 ± 6.3	29.8 ± 6.5	27.9 ± 6.3	F (3,329) = 2.06, p > 0.10

FIM walk score of 4 on admission

	Complete paralysis $n = 3$	Severe paralysis $n = 38$	Moderate paralysis $n = 100$	Mild paralysis $n = 156$	Analysis of variance
Age (years old)	59.7 ± 10.8	59.4 ± 12.8	62.5 ± 13.6	68.0 ± 13.2	F (3,293) = 6.34, p < 0.01 E** F*
Days from onset to admission (days)	41.7 ± 22.2	36.2 ± 14.4	36.3 ± 15.0	33.5 ± 13.7	F (3,293) = 1.11, p > 0.34
Length of stay (days)	77.3 ± 14.2	71.5 ± 20.4	64.4 ± 19.4	53.2 ± 19.0	F (3,293) = 13.4, p < 0.01 E** F**
FIM-M on admission	43.0 ± 7.5	52.1 ± 9.8	53.2 ± 12.6	55.4 ± 12.7	F (3,293) = 1.90, p > 0.12
FIM-M at discharge	67.3 ± 17.8	77.9 ± 6.6	77.9 ± 10.8	76.4 ± 12.0	F (3,293) = 1.20, p > 0.30
FIM-M gain	32.0 ± 6.2	25.9 ± 8.3	24.7 ± 10.0	21.0 ± 10.0	F (3,293) = 4.19, p < 0.01 F*
FIM-M efficiency (/day)	0.38 ± 0.06	0.39 ± 0.17	0.40 ± 0.19	0.43 ± 0.25	F (3,293) = 0.93, p > 0.42
FIM-C on admission	24.7 ± 12.9	29.4 ± 5.7	27.1 ± 6.9	26.3 ± 7.7	F (3,293) = 1.93, p > 0.12
FIM-C at discharge	26.7 ± 12.7	31.8 ± 4.5	30.7 ± 5.7	29.1 ± 6.4	F (3,293) = 2.99, p < 0.05

FIM walk score of 5 on admission

	Complete paralysis $n = 0$	Severe paralysis $n = 6$	Moderate paralysis $n = 35$	Mild paralysis $n = 209$	Analysis of variance
Age (years old)		54.2 ± 5.7	61.1 ± 15.6	66.8 ± 12.9	F (2,247) = 5.08, $p < 0.01$
Days from onset to admission (days)		34.5 ± 18.7	38.8 ± 17.2	33.4 ± 14.2	F (2,247) = 1.99, $p > 0.13$
Length of stay (days)		64.3 ± 32.8	54.8 ± 18.7	41.5 ± 18.0	F (2,247) = 11.5, $p < 0.01$ E* F**
FIM-M on admission		59.8 ± 10.2	62.0 ± 10.4	66.5 ± 11.2	F (2,247) = 3.34, $p < 0.05$
FIM-M at discharge		83.0 ± 4.0	78.9 ± 7.9	82.2 ± 8.2	F (2,247) = 2.45, $p > 0.08$
FIM-M gain		23.2 ± 11.7	16.9 ± 8.3	15.7 ± 9.2	F (2,247) = 2.16, $p > 0.11$
FIM-M efficiency (/day)		0.41 ± 0.18	0.34 ± 0.19	0.42 ± 0.24	F (2,247) = 1.50, $p > 0.22$
FIM-C on admission		30.2 ± 4.4	28.8 ± 6.6	26.4 ± 7.2	F (2,247) = 2.38, $p > 0.09$
FIM-C at discharge		33.0 ± 2.8	30.9 ± 5.4	29.0 ± 6.1	F (2,247) = 2.58, $p > 0.07$

FIM walk score of 6 on admission

	Complete paralysis $n = 0$	Severe paralysis $n = 0$	Moderate paralysis $n = 7$	Mild paralysis $n = 66$
Age (years old)			57.3 ± 10.4	63.0 ± 12.1
Days from onset to admission (days)			30.3 ± 12.6	30.9 ± 11.0
Length of stay (days)			33.3 ± 17.8	29.1 ± 15.1
FIM-M on admission			76.9 ± 8.6	79.3 ± 7.2
FIM-M at discharge			87.0 ± 3.5	87.0 ± 4.0
FIM-M gain			10.1 ± 9.5	7.7 ± 5.5
FIM-M efficiency (/day)			0.29 ± 0.25	0.33 ± 0.36
FIM-C on admission			33.9 ± 3.0	32.1 ± 4.2
FIM-C at discharge			34.6 ± 1.1	33.0 ± 3.6

FIM walk score of 7 on admission

	Complete paralysis $n = 0$	Severe paralysis $n = 0$	Moderate paralysis $n = 3$	Mild paralysis $n = 165$	
Age (years old)			43.7 ± 12.3	59.4 ± 12.6	F*
Days from onset to admission (days)			34.3 ± 12.9	31.7 ± 11.9	
Length of stay (days)			23.0 ± 11.8	30.1 ± 18.9	
FIM-M on admission			85.7 ± 1.2	84.7 ± 5.1	
FIM-M at discharge			90.7 ± 0.6	88.9 ± 2.7	
FIM-M gain			5.0 ± 1.0	4.2 ± 4.0	
FIM-M efficiency (/day)			0.27 ± 0.14	0.17 ± 0.17	
FIM-C on admission			34.3 ± 1.2	29.9 ± 5.8	
FIM-C at discharge			34.3 ± 1.2	31.3 ± 4.8	

A: Significant differences between the complete and severe paralysis groups *: $p < 0.05$
B: Significant differences between the complete and moderate paralysis groups **: $p < 0.01$
C: Significant differences between the complete and mild paralysis groups
D: Significant differences between the severe and moderate paralysis groups
E: Significant differences between the severe and mild paralysis groups
F: Significant differences between the moderate and mild paralysis groups

admission FIM walk score was 3 or 4, the pattern of recovery of gait ability was similar in the complete paralysis and other groups. When the FIM walk score at admission was 3, the median FIM walk score at six weeks after admission was 5 for all groups. For patients in the complete paralysis group with an FIM walk score of 3 or 4, the median FIM walk score at discharge was 6.

Figure 2 shows the FIM walk scores at discharge according to the FIM walk score on admission and severity of SIAS lower extremity paralysis. Analysis of variance was conducted to examine the effects of the severity of lower extremity paralysis on gait ability at discharge after stratification by the admission FIM walk score. Significant differences were noted depending on the FIM walk score on admission: score 1; F (3,297) = 9.56, $p < 0.01$, score 2; F (3,272) = 7.35, $p < 0.01$, and score 3; F (3,329) = 4.88, $p < 0.01$. Although there were no significant differences when the admission FIM walk score was 4 [F (3,293) = 0.95, $p > 0.41$], significant differences were observed when the admission score was 5, [F (2,247) = 4.50, $p < 0.05$]. Patients in the complete paralysis group with an admission FIM walk score of 1 or 2 had lower FIM walk scores at discharge compared to those in the other three groups. Patients in the severe paralysis group with an admission FIM walk score of 3 had significantly lower scores compared to the moderate

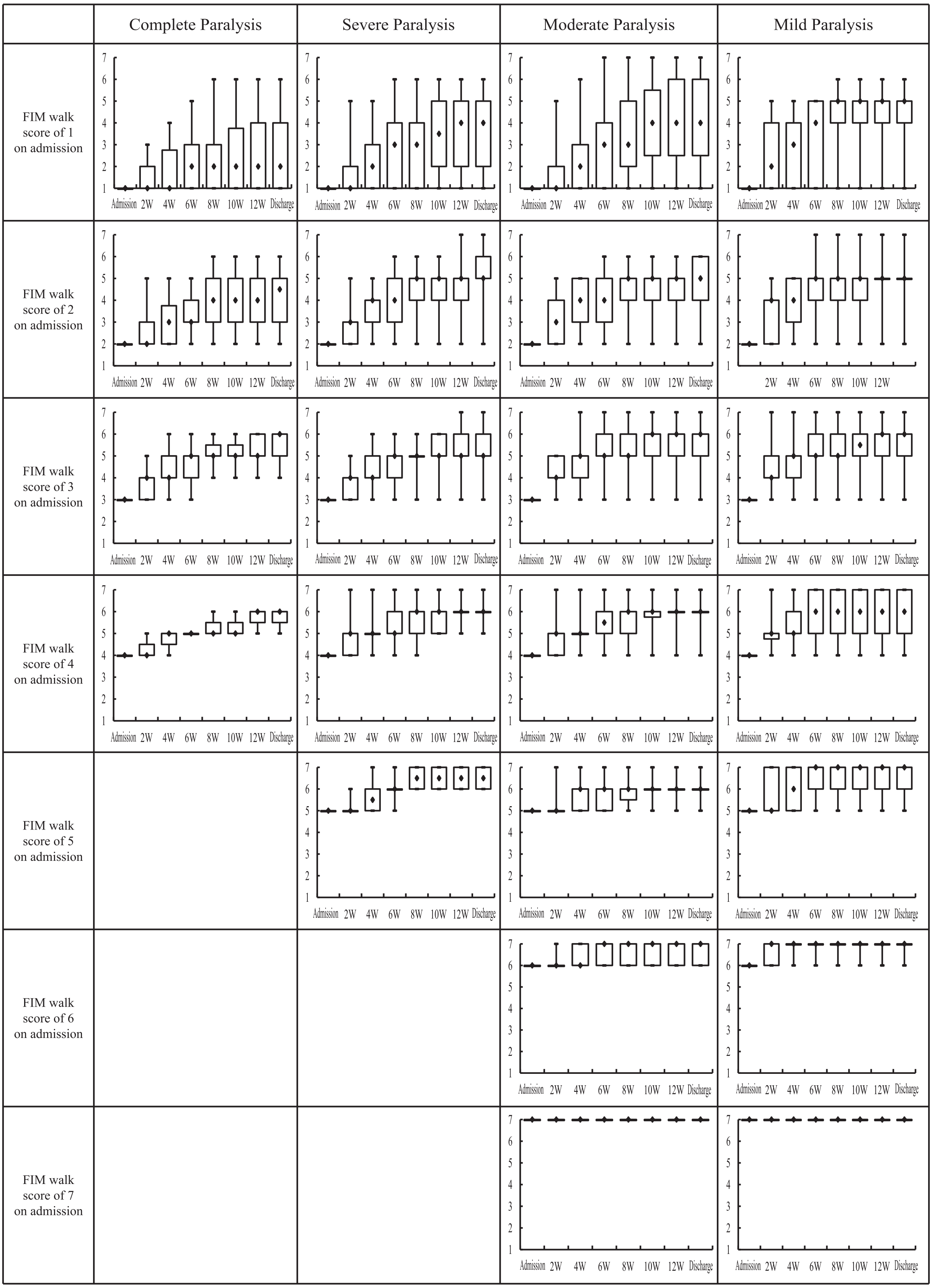

Figure 1. The trends of FIM walk abilities of patients are plotted according to the FIM walk score on admission and severity of lower extremity paralysis (SIAS).

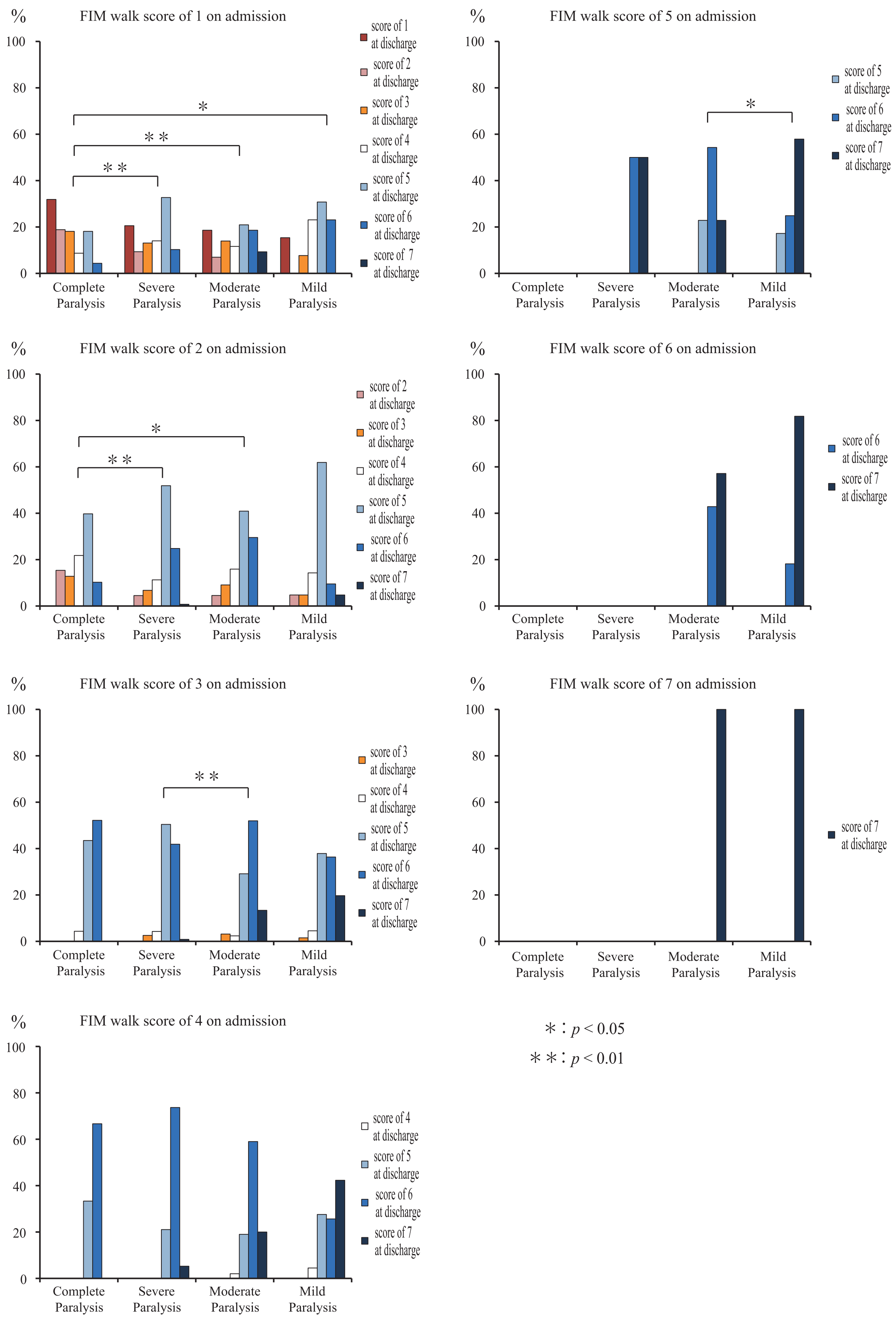

Figure 2. FIM walk scores at the time of discharge stratified by FIM scores on admission and severity of lower extremity paralysis (SIAS).

paralysis group. Patients in the mild paralysis group with an admission FIM walk score of 5 achieved higher FIM walk scores at discharge compared to the moderate paralysis group.

Discussion

This study examined the changes in gait ability of stroke patients in the subacute phase, stratified by the admission FIM walk score and severity of lower extremity motor paralysis. The subjects were patients who underwent physical and occupational therapies based on the FIT program seven days a week. According to a survey conducted by the Kaifukuki Rehabilitation Ward Association, the FIM-M score became higher when patients had greater dose of training [14]. Therefore, the results of this study are expected to provide the standard course and goal of the FIM walk score at discharge. For example, more than 70% of patients in the complete paralysis group with an admission FIM walk score of 1 had an FIM walk score of 4 or less at discharge. Only approximately 4% of patients in the complete paralysis group achieved up to an FIM walk score of 6, whereas more than 25% of patients in the moderate paralysis group accomplished a score of 6 or higher. These results provide useful information for health professionals, patients, and their families. Since this study involved a large number of subjects who underwent the same rehabilitation sessions at the same frequencies, the subjects could be classified into a total of 28 groups; a combination of seven groups according to their gait ability and four groups according to their severity level of lower extremity motor paralysis. The reliability and validity of the SIAS used to assess the level of lower extremity motor paralysis in this study have been established previously [15, 16].

Previous studies on improvement in gait ability of stroke patients suggested that recovery was notable within six months, three months in particular, after stroke onset [5−7, 17, 18]. Since the duration from stroke onset to admission in this study was 35.4 days, marked recovery could be expected in our patients, as described in the previous study. In fact, FIM walk score increased during hospitalization in all patients except those who already reached a score of 7 on admission. Jørgensen et al. [5] examined and classified changes in gait ability of stroke patients in the acute phase based on Scandinavian Stroke subscale scores to assess the functions of the legs, and suggested that the milder is the level of paralysis, the higher is the ability to walk on their own. However, since they used ambulation items of the Barthel Index, changes in the ability to walk with assistance could not be detected. On the other hand, we observed improvement of walking ability using the FIM even in patients who needed assistance. Wandel et al. [19] reported that 21% of patients with complete lower extremity hemiplegia immediately after stroke onset accomplished independent gait with or without walking aids. Different courses of recovery of walking ability were observed depending on the gait ability on admission in patients with complete paralysis in lower extremity: 4% of the patients with FIM walk score of 1 achieved modified independence, whereas 67% of the patients with FIM walk score of 4 reached modified independence in this study. When the admission FIM walk score was 1, the median FIM walk score became 2 at discharge in the complete paralysis group, and the median scores were 3 at six weeks post-admission and 4 at discharge in the severe and moderate paralysis groups. These findings imply that improvement in gait ability can be predicted more accurately by taking into account the level of paralysis combined with gait assistance required.

Regarding the combination of gait ability and the level of lower extremity motor paralysis, the predominate combinations were low gait ability with severe paralysis and high gait ability with moderate or mild paralysis. However, there were also some patients with mild paralysis and an admission FIM walk score of 1 or 2, presumably due to symptoms other than paralysis or inhibitory factors, and those with severe paralysis and an admission FIM walk score of 3 or 4, because of excellent cognitive function and also outstanding physical function of the non-paralyzed side. The mean age of patients in the mild paralysis group with an admission FIM walk score of 1 was 77.2 years, which was the highest among all the groups. This was presumably the reason why these patients had low FIM walk scores on admission despite mild paralysis. Since the mild paralysis group with an admission FIM walk score of 2 also had a high mean age and the mean FIM-C score on admission was 19.4 which was not significantly different from that of the complete paralysis group, the low mean FIM walk score on admission seems to be due to the advanced age and poor cognitive functions. The FIM walk score at discharge was significantly different between the mild and complete paralysis groups with an admission FIM walk score of 1, while no significant difference was noted between these two groups with an admission FIM walk score of 2. Patients in the mild paralysis group had low FIM walk scores at discharge because of poor cognitive functions. Although Kollen et al. [18] tried to predict gait outcome from functions of the paralyzed lower extremity, standing balance and attentional functions, only 18% of the changes were explained. They strongly suspected a significant contribution of the non-paralyzed side of the body. Since patients with complete paralysis who showed an FIM walk score of 3 or 4 on admission had a mean age of 60 years in our study, young age and good non-paralyzed side function would have contributed to gait outcome. Patients with admission FIM walk scores of 1 and 2 had admission FIM-C scores of 13.5 and 16.1, respectively, whereas patients with admission FIM walk scores of 3 and 4 had relatively excellent cognitive ability as shown by admission FIM-C scores of 22.7 and 24.7, respectively.

Since the complete hemiplegic patients with an admission FIM walk score of 3 or 4 were relatively young and had good cognitive functions, their gait exercise progressed well and they achieved a median FIM walk score at discharge of 6.

Considering the comparison between the severe paralysis group and the moderate paralysis group with an admission FIM walk score of 3 as well as the comparison between the moderate paralysis group and the mild paralysis group with an admission FIM walk score of 5, milder paralysis was related to higher FIM walk score at discharge. Since there were no significant differences in age and FIM-C score on admission, the difference in severity of paralysis probably influenced the FIM walk score. A large proportion of the patients in the mild paralysis group with an admission FIM walk score of 5 achieved an FIM walk score of 7 at discharge. For these patients, it is necessary to start training with a goal of achieving a final gait status without walking aids.

In our study on the improvement in gait ability, we classified patients based on their ability to walk and on the degree of lower extremity motor paralysis. These results can be utilized by other hospitals because information of gait ability and paralysis on admission is easily available. This study had the following limitations. The study only involved one hospital, and the influence of the duration from stroke onset to admission was not taken into account, since our analysis set the baseline of comparison to be the time of admission to the subacute rehabilitation ward. However, the influence of the duration from onset on the change in gait ability may be negligible, because the duration was around 30 to 40 days with a standard deviation of approximately 15 days in each group without any specific pattern. As the patients were diagnosed in other hospitals, the types of cerebral infarction such as atherothrombotic infarction could not be determined.

Although it is important to predict improvement in gait ability of patients who have complications that may interfere with training and patients with recurrent stroke, such patients were excluded from our analysis because the number was small and their symptoms varied greatly. Further studies are required to predict improvement in gait ability at discharge based on SIAS items other than motor paralysis and discuss the accuracy of the prediction and the contribution of different factors to gait ability.

References

1. Bland MD, Sturmoski A, Whitson M, Connor LT, Fucetola R, Huskey T, et al. Prediction of discharge walking ability from initial assessment in a stroke inpatient rehabilitation facility population. Arch Phys Med Rehabil 2012; 93: 1441−7.
2. Sonoda S. Significance of outcome study in rehabilitation. Sogo Rihabiriteshon 2008; 36: 7−10. Japanese.
3. Goldie PA, Matyas TA, Kinsella GJ, Galea MP, Evans OM, Bach TM. Prediction of gait velocity in ambulatory stroke patients during rehabilitation. Arch Phys Med Rehabil 1999; 80: 415−20.
4. Kuys SS, Bew PG, Lynch MR, Morrison G, Brauer SG. Measures of activity limitation on admission to rehabilitation after stroke predict walking speed at discharge: an observational study. Aust J Physiother 2009; 55: 265−8.
5. Jørgensen HS, Nakayama H, Raaschou HO, Olsen TS. Recovery of walking function in stroke patients: the Copenhagen Stroke Study. Arch Phys Med Rehabil 1995; 76: 27−32.
6. Wade DT, Wood VA, Langton Hewer R. Recovery after stroke- the first 3 months. J Neurol Neurosurg Psychiat 1985; 48: 7−13.
7. Wade DT, Hewer RL. Functional abilities after stroke: measurement, natural history and prognosis. J Neurol Neurosurg Psychiat 1987; 50: 177−82.
8. Mahoney FI, Barthel DW. Functional evaluation: the Barthel index. Md Med State J 1965; 14: 61−5.
9. Data management service of the Uniform Data System for Medical Rehabilitation and the Center for Functional Assessment Research: Guide for use of the uniform data set for medical rehabilitation (Ver.3.0). State University of New York at Buffalo, New York, 1990.
10. Liu M, Domen K, Chino N. Comorbidity measures for stroke outcome research: a preliminary study. Arch Phys Med Rehabil 1997; 78: 166−72.
11. Sonoda S, Saitoh E, Nagai S, Kawakita M, Kanada Y. Full-time integrated treatment program, a new system for stroke rehabilitation in Japan: comparison with conventional rehabilitation. Am J Phys Med Rehabil 2004; 83: 88−93.
12. Watanabe M, Okuyama Y, Nobotachi N, Kawahara Y, Kinoshita K, Sasaki S, et al. Relationship between increase in exercise dose and ADL improvement with stratification by age in stroke patients in the Kaifukuki rehabilitation ward. Jpn J Stroke 2012; 34: 383−90. Japanese.
13. Chino N, Sonoda S, Domen K, Saitoh E, Kimura A. Stroke Impairment Assessment Set (SIAS). In: Chino N, Melvin JL eds.: Functional evaluation of stroke patients. Springer-Verlag, Tokyo; 1996. p. 19−31.
14. Miyai I, Sonoda S, Nagai S, Takayama Y, Inoue Y, Kakehi A, et al. Results of new policies for inpatient rehabilitation coverage in Japan. Neurorehabil Neural Repair 2011; 25: 540−7.
15. Domen K. Reliability and validity of stroke impairment assessment set (SIAS) (1): items of affected-side motor function, muscle tone, deep tendon reflex, and unaffected-side function. Jpn J Rehabil Med 1995; 32: 113−22. Japanese.
16. Sonoda S. Reliability and validity of stroke impairment

assessment set (SIAS) (2): the items comprise the trunk, higher cortical function, and sensory function and effectiveness as outcome predictor. Jpn J Rehabil Med 1995; 32: 123−32. Japanese.
17. Mayo NE, Komer-Bitensky NA, Becker R. Recovery time of independent function post-stroke. Am J Phys Med Rehabil 1991; 70: 5−12.
18. Kollen B, van de Port I, Lindeman E, Twisk J, Kwakkel G. Predicting improvement in gait after stroke: a longitudinal prospective study. Stroke 2005; 36: 2676−80.
19. Wandel A, Jørgensen HS, Nakayama H, Raaschou HO, Olsen TS. Prediction of walking function in stroke patients with initial lower extremity paralysis: the Copenhagen Stroke Study. Arch Phys Med Rehabil 2000; 81: 736−8.