Introduction

Toileting independence requires independence in activities such as manipulating lower garments and transferring to a toilet. However, these activities are some of the most challenging tasks for stroke patients [1]. Toileting independence is important for patients to maintain self-esteem and requires proper evaluation in rehabilitation settings because it is associated with patients’ likelihood of returning home [2].

In an earlier study on toileting independence in stroke patients, Sato et al. [3] reported that balance function is important for toileting independence, and is integral for acts like transferring to the toilet seat. A balance function score of approximately 42 in the Berg Balance Scale (BBS), a typical balance index, is required. The BBS cut-off value that Sato et al. calculated in the same report can serve as a target value during balance exercises directed toward toileting independence, and as an index for estimating toileting independence. If occupational therapists, physical therapists, nurses, and other medical professionals have information on BBS scores in addition to functional state of cognitive and physical activity in the early stages of post-stroke recovery, they would be better able to understand patients’ toileting assistance and other support needs beforehand, and would be able to make various preparations such as environmental adjustments. However, it takes approximately 20 min to complete the BBS, which means that the BBS...
is not easy to use as an index for determining toileting independence. Therefore, an assessment that could be completed in a short time was needed. Other factors associated with toileting independence include grip strength [4], and trunk function [5−7]. We believe that these factors can provide useful cut-off values that are capable of distinguishing patients with toileting independence from those with non-independence in a similar manner to the aforementioned BBS. The objective of this study was to explore indices that might easily and quickly estimate toileting independence in stroke patients. We hypothesized that we could achieve this by calculating cut-off values and verifying their accuracy, using unaffected grip strength and trunk functions as indices, both of which are associated with toileting independence [5−7]. Rehabilitation therapists can use this in combination of information of functional status from other assessments and observations to make more informed decisions about toileting independence.

Materials and Methods

This was a retrospective observational study in which data collected from the medical records of previously-discharged patients were analyzed. This study carried out at North-Fukushima Medical Center. The institutional Ethical Review Board of North-Fukushima Medical Center reviewed and approved the content of this study (No.56).

The subjects were stroke patients who were hospitalized in the hospital’s convalescent rehabilitation ward between October 2012 and December 2014. The inclusion criteria were having no significant cognitive dysfunction (a score of at least 21 points in the Revised Hasegawa’s Dementia Scale), and no missing records of interest variables mentioned below. We categorized the patients who scored at least 6 points for the items of “Toileting” and “Toilet transfer” in the FIM® instrument [8] as members of the independent toileting group; patients in the non-independent toileting group scored 5 points or lower for at least one of these two items. Then, the patients in these two groups were compared for background factors (age, gender, type of stroke, and affected side), unaffected grip strength, and trunk function. Unaffected grip strength and trunk function (verticality and abdominal muscle strength) were evaluated using items from the Stroke Impairment Assessment Set (SIAS) [9] as indices. In unaffected grip strength test, if the grip strength is above 25 kg in two trials, a score of 3 is given. A score of 2 means a strength of 10−25 kg, and a score of 1 is given if the unaffected grip strength is 3−10 kg [9]. SIAS was adopted because it is widely used in the rehabilitation clinical setting and can be completed in a short time. Intergroup comparisons were done using the Student’s t-test, Chi-square test, and Mann-Whitney U test. To identify factors strongly associated with the level of toileting independence, logistic regression analysis (forced-entry) was performed using the items that showed a significant difference between the two groups as independent variables, and the groups as dependent variables. In addition, logistic regression analysis (forced-entry) was also performed by adding age, gender, and affected side as independent variables to remove the confounding influence. Taking the small sample size in this study into consideration, age, gender, and affected side were entered one by one. To finish, receiver operating characteristic (ROC) analysis [10] of items that were significant in the logistic regression analysis was performed to calculate cut-off values using the Youden index [11].

Results

The subjects included 37 stroke patients (21 men and 16 women, mean age: 65.7 ± 14.5 years, mean period since the onset of stroke at the time of evaluation: 92.8 ± 38.3 days). The independent toileting group included 23 patients, and the non-independent group included 14 patients. Table 1 presents the results obtained from patients in each group. Intergroup comparisons revealed that significantly higher scores for unaffected grip strength on the SIAS in the independent group, compared to the non-independent group. However, no significant differences were found for trunk function from the SIAS (verticality and abdominal muscle strength). Logistic regression analysis identified unaffected grip
strength from the SIAS as significantly associated with toileting independence (Table 2). This significant association was also maintained after the influences of age, gender, and affected side were removed. The ROC analysis of unaffected grip strength from the SIAS provided a cut-off value of 3 points (sensitivity, 74%; specificity, 71%; ROC area under the curve, 0.730), at which independence was differentiated from non-independence.

**Discussion**

The results of this study suggest that toileting independence is associated with unaffected grip strength scored using the SIAS criteria. It has already been reported that unaffected grip strength is associated with the independence level of various ADL items including toileting and ADL prognosis in stroke patients [4, 12], and the originality of this study was to calculate the cut-off value associated with the presence or absence of toileting independence. It is assumed that the association between these two variables is attributed to the need for a certain degree of unaffected grip strength for manipulating lower garments. In addition, unaffected grip strength correlates with quadriceps muscle strength, skeletal muscle mass, one-leg standing time, and other factors in the elderly [13], and grip strength on the unaffected side has been found to correlate with the strength of other ipsilateral muscles in stroke patients [14, 15]. Therefore, there is a possibility that unaffected grip strength reflects whole body performance, and whole body performance influences toileting independence. However, these theories remain a matter of speculation. Our results agree with those of a previous study by Bae et al. [4] that describe the relationship between unaffected grip strength and toileting independence in subacute stroke patients; however, there seems to be a slight difference regarding the relationship with the affected side. Bae et al. [4] reported that this relationship is observed only in right hemiplegic patients, whereas our results suggest that the relationship is maintained even after the influences of the affected side (i.e., right and left hemiplegia) are removed. It is thought that the reason for this difference is the influence of the analysis method that the previous study [4] used bivariate analysis whereas

| Table 1. Comparison of parameters of the independent and non-independent groups |
|----------------------------------------|-----------------|-----------------|---------------|
|                                       | Independence  (N = 23) | Non-independence (N = 14) | Significant |
| Age, years                            | 62.6 ± 16.0     | 70.9 ± 10.1     | ns\(^a\)      |
| Men, %                                | 65.2            | 42.9            | ns\(^a\)      |
| Right-side hemiplegia, %              | 47.8            | 42.9            | ns\(^a\)      |
| Type of stroke                        |                 |                 |               |
| Cerebral infarction, %                | 73.9            | 64.3            | ns\(^b\)      |
| Cerebral hemorrhage, %                | 26.1            | 35.7            |               |
| Time poststroke, days                 | 86.7 ± 37.5     | 100.1 ± 39.5    |               |
| SIAS Verticality (0–3)                | 3 (0)           | 3 (0)           | ns\(^c\)      |
| SIAS Abdominal Muscle Strength (0–3)  | 3 (0)           | 3 (1)           | ns\(^c\)      |
| SIAS Unaffected Grip Strength (0–3)   | 3 (1)           | 2 (1)           | p < 0.05\(^c\) |

Mean ± SD or Median (IQR) or %

Abbreviations: SIAS, Stroke Impairment Assessment Set
\(^a\) Student’s t test; \(^b\) Chi-square test; \(^c\) Mann-Whitney test

| Table 2. Logistic regression analysis to estimate the independence of toileting |
|----------------------------------------|-----------------|-----------------|---------------|
| Model 1\(^a\)                         | Odds ratio  | P value | Odds ratio  | P value | Odds ratio  | P value | Odds ratio  | P value |
| SIAS Unaffected Grip Strength         | 7.08         | < 0.01  | 5.56        | < 0.05  | 12.83       | < 0.05  | 7.06        | < 0.05  |
| Age                                   | 0.98        | 0.496   | 0.438      | 0.487   | 0.851       | 0.832   |

Abbreviations: SIAS, Stroke Impairment Assessment Set.
\(^a\) Model 1 into which only SIAS unaffected grip strength
\(^b\) Model 2 into which SIAS unaffected grip strength along with age
\(^c\) Model 3 into which SIAS unaffected grip strength along with gender
\(^d\) Model 4 into which SIAS unaffected grip strength along with affected side
our study performed multivariate analysis. Because bivariate analysis cannot generally adjust the influence of confounding factors, the results of bivariate and multivariate analysis may be different. Further studies are needed to reveal whether the affected side influences the relationship between unaffected grip strength and toileting independence.

No association was seen between toileting independence and trunk function in the present study. Earlier studies have reported that trunk function is associated with toileting abilities [5–7]. The difference between the results of the present study and those of earlier studies can be explained by the patients in the present study who scored nearly full points for the verticality and abdominal muscle strength items in the SIAS. This could have produced a ceiling effect that prevented detecting an association with toileting independence. Therefore, the results of the present study do not rule out an association between toileting independence and trunk function. This means the relationship between unaffected grip strength and toileting independence and cut-off value indicated by this study cannot deny the possibility of being complicated by functional state of trunk. Therefore, it is necessary to keep in mind that the cut-off value shown in the present study may be applicable to only patients with good trunk function.

In the present study, the calculated SIAS cut-off value of 3 points for unaffected grip strength may be useful for easily estimating toileting independence. Grip strength can be quickly measured regardless of healthcare provider experience (in our experience, it is possible within 3 minutes.). Regarding the accuracy of the cut-off value, a previous study has calculated the cut-off value for toileting independence using BBS [3] and has reported that if 42/41 points for BBS were adapted, ROC area under the curve, sensitivity, and specificity were 0.832, 78%, and 83%, respectively. In contrast, ROC area under the curve, sensitivity, and specificity of our cut-off value were 0.730, 74%, and 71%, respectively. Therefore, the accuracy of the cut-off value calculated in this study may seem to be at a slight disadvantage compared with that of the value calculated using BBS; however, we believe that it is within a practical range and using grip strength saves valuable time over using BBS.

A limitation of this study was that we unintentionally recruited patients who did not have any marked deterioration of trunk function. Further investigations are needed to determine if the cut-off value shown in the present study is applicable to patients with reduced trunk function. Other limitations included the small sample size and limited examination of unaffected grip strength, using only the SIAS. In addition, the subjects were inpatients of a rehabilitation hospital ward. Therefore, generalization of this study’s results may be limited. Furthermore, higher brain dysfunction variables (e.g., aphasia, unilateral spatial neglect, apraxia, and attention deficit) and motor and sensory functions of the upper and lower limbs on the affected side were not addressed. Further studies are needed to expand upon these results.

Summary and Conclusions

We examined assessments that could be completed in a short time for measuring toileting independence using the grip strength of the unaffected side and trunk functions in stroke patients. In distinguishing independent and non-independent toileting groups, the cutoff value for the grip strength from the SIAS was 3 points (sensitivity, 74%; specificity, 71%; ROC area under the curve, 0.730). Grip strength can be quickly measured regardless of healthcare provider experience, and the calculated cut-off value may be useful for easily estimating toileting independence.

Conflict of interest

There are no conflicts of interest to declare.

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References


