Study of the Responsiveness and Minimal Clinically Important Difference of the Trunk Impairment Scale in Patients With Acute Stroke

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ABSTRACT

BACKGROUND: Trunk function is a prerequisite for functional activity; thus, it is crucial to carry out proper assessments and interventions. However, there is no clear indicator for trunk function evaluation in patients with stroke. To understand the effects of interventions over time, it is important to adopt responsive clinical indicators.

PURPOSE: To examine the Trunk Impairment Scale (TIS) (Fujiwara version) in terms of responsiveness and the minimal clinically important difference (MCID).

METHODS: In total, 55 patients who experienced an acute stroke were evaluated on the seventh day of hospitalization and the day before discharge. The responsiveness of the TIS was assessed by the effect size and standardized response mean (SRM). Additionally, an MCID study was conducted to examine the amount of change in TIS scores required to indicate a clinically meaningful change, which was determined by the presence or absence of improvement in the activities of daily living.

RESULTS: The SRM of the TIS was 1.42. Additionally, the MCID was determined to be 3 points.

CONCLUSION: The TIS score improved over time and a 3-point improvement in the TIS score was associated with improvement in the activities of daily living. Thus, this scale's clinical sensitivity and MCID have been established in patients with stroke.

KEYWORDS: Acute stroke, trunk function, TIS, responsiveness, MCID, rehabilitation

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Introduction

Stroke causes a variety of symptoms such as motor paralysis, sensory disturbance, and higher brain dysfunction, depending on the area of damage. It is necessary to facilitate the transition from bed to mobility in patients with acute stroke as early as possible, while carefully considering risk management and accurately assessing their mobility. The trunk is the central key point of the body and functions as a critical component for limb motor control, balance, and functional activity. Previous studies have shown that trunk function is strongly associated with balance, gait, and functional activity.[1] Moreover, a decline in trunk muscle performance recovery can lead to severe disabilities and reduced activities of daily living (ADLs).[2] These factors highlight the importance of appropriate assessments and interventions for trunk function.

The Trunk Control Test (TCT)[2] and Trunk Impairment Scale (Verheyden version)[3] have been used to evaluate trunk function, and their reliability and validity have been confirmed. The TCT is widely used in the clinical setting to evaluate a patient's ability to turn to either side of the bed and get up. However, the TCT has some limitations, such as the tendency toward a ceiling effect in highly capable individuals.[4] As such, this evaluation method focuses on the decline in ability, rather than functional disability. In contrast, the TIS (Verheyden version)[3] is a 17-item, 23-point scale that reflects static sitting balance, dynamic sitting balance, and trunk coordination. A score of 0 is given for difficulty in holding a sitting position.

Because of the number of items, performing the TIS (Verheyden version) in a clinical setting may be time-consuming. However, it is important to evaluate patients with stroke safely and consistently from the acute phase to the maintenance phase. Further, the TIS (Verheyden version) provides little information that can be linked to specific interventions in actual rehabilitation. The abilities that can be re-gained through stroke rehabilitation cannot be defined solely by the initial decline in ability; rather, they depend on the underlying functional disability. Thus, the measurement of functional disability is important in predicting the prognosis.

In 2004, Fujiwara et al[5] devised the TIS (Fujiwara version), a 7-item, 21-point scale that evaluates trunk function. The TIS

(Fujiwara version) has been found to be highly reliable and valid in patients recovering from stroke. This evaluation method is less burdensome than the TIS (Verheyden version) for both the examiner and examinees. Further, it is possible to identify and organize the patient's problems and evaluate the effectiveness of treatment.

The quality of the TIS (Verheyden version) as an evaluation index has been examined in terms of validity, reliability, responsiveness, and interpretability.[6] Responsiveness reflects the degree of the ability of an evaluation index to detect changes over time and refers to the validity of scores that have changed over time.[7] It is crucial to use clinical measures with good responsiveness to capture intervention effects over time. Further, intervention effects can be interpreted using the minimal clinically important difference (MCID), which was defined by Jaeschke et al,[8] and captures the minimum change in an external measure that patients or clinicians consider important as an estimate of the minimum change in other measures of interest. Understanding the MCID for assessment metrics is crucial when evaluating intervention effectiveness. The MCID goes beyond numbers, signifying changes recognized as clinically important by both patients and healthcare professionals. A thorough grasp and proper use of the MCID can significantly enhance healthcare and optimize patient care. In recent years, the MCID has been increasingly reported for balance[9] and gait assessment indices[10] in patients with stroke. However, there have been no studies on the sensitivity or MCID of the TIS (Fujiwara version).[5]

Several reasons necessitate further research regarding the TIS (Fujiwara version). Firstly, accurately assessing trunk function is essential to evaluating the effectiveness of rehabilitation. Secondly, by including items applicable to patients who struggle with maintaining a seated position, the versatility of the TIS is enhanced for broader purposes. Thirdly, identifying the sensitivity and MCID of the TIS holds great significance in clinical decision-making. These parameters aid in recognizing clinically meaningful improvements in trunk function. Lastly, this study represents the first investigation into the sensitivity of the TIS (Fujiwara version), filling the gap in previous research, and is expected to make a significant contribution to the field of stroke rehabilitation and assessment. Therefore, this study aimed to examine the characteristics of the distribution of scores, responsiveness, and MCID of the TIS (Fujiwara version) in patients who experienced acute stroke and to clarify whether the TIS (Fujiwara version) is a suitable index for evaluating trunk function in determining the effectiveness of interventions.

Materials and Methods

Participants

Patients admitted for stroke or cerebral hemorrhage between October 2019 and March 2021 were included in this study. The severity of disease at the time of admission was assessed using the National Institutes of Health Stroke Scale (NIHSS).[11] The inclusion criteria were as follows: (1) no difficulty with ADLs before disease onset, (2) diagnosis of unilateral stroke confirmed by computed tomography or magnetic resonance imaging of the brain, (3) rehabilitation within 48 hours after stroke onset, and (4) level of consciousness at "awake without stimulation." Exclusion criteria included impaired consciousness, obvious bone deformity, previous surgery, worsening stroke, and death. Stroke aggravation was defined as an increase of ⩾4 in the NIHSS score after emergency transport.[12]

Written informed consent was obtained from the patients after informing them of the purpose of the study. For those physically unable to provide their signature, written informed consent was obtained from a family member or authorized representative. Ethics approval was obtained from the Ethical Review Committee of Shioda Hospital, Chiba, Japan (Approval No.: 2018-2). This study was conducted in accordance with the principles of the Declaration of Helsinki.

Methods

We collected essential information, including age (as a continuous variable), sex, diagnosis, paralytic side, and length of stay (LOS) in days, from the electronic medical records, and the severity of stroke was determined using the NIHSS. The 7-item TIS (Fujiwara version) and TCT were used to evaluate trunk function. The motor items of the Functional Independence Measure (FIM-M)[13] were used to assess the ADLs.

Trunk function assessment

Trunk Impairment Scale (TIS) Fujiwara version. The TIS (Fujiwara version)[5] consists of 7 items with a maximum score of 21 points, where higher scores indicate better trunk ability. Two items related to the strength of the abdominal muscles and verticality were obtained from the Stroke Impairment Assessment Set (SIAS).[14] The other 5 items of the TIS (Fujiwara version), namely, perceived trunk verticality, rotational trunk strength on both the affected and unaffected sides, and righting reflex on both sides, have been shown to have high reliability, validity, and responsiveness (Table 1).

Trunk Control Test (TCT). The TCT[2] assesses 4 simple aspects related to overall trunk movement. This tool evaluates the ability to maintain a seated position, roll from supine onto affected and unaffected sides, and transfer from supine to a seated position. Each exercise is scored according to 3 assessment levels, with 0, 12, or 25 points. The maximum score is 100, with higher scores indicating better trunk function ability.

Activities of Daily Living (ADLs) assessment. The ADLs were assessed using the following exercise items of the FIM[13]: eating; dressing; wiping; changing clothes; changing clothes; using the toilet; urinating; defecating; transferring to a bed, chair, or wheelchair; transferring to the toilet; transferring to the bathtub; walking; and climbing stairs. Each item is rated on

Table 1. Trunk Impairment Scale (Fujiwara version).

ITEM	METHOD	SCORING
1. Perception of trunk verticality	While the patient is sitting on the edge of a bed or on a chair without a backrest, with the feet off the ground, the examiner holds both sides of the patient's shoulders and makes the patient's trunk deviate to the right and left. The examiner asks the patient to indicate when he or she feels the trunk is in a vertical position. The examiner then records the degree of trunk angle deviation from the vertical line drawn from the midpoint of the Jacoby line.	0: The angle is ⩾30° 1: The angle is <30° and ⩾20° 2: The angle is <20° and ⩾10° 3: The angle is <10°
2. Trunk rotation muscle strength on the affected side	The patient is asked to roll the body from the supine position to the unaffected side. The arms should be crossed in front of the chest and legs kept extended. The patient is asked to roll his or her body without pushing the floor with his or her limbs or pulling on bed clothes. Isometric contractions for stabilization and other muscles than external oblique (e.g., pectoralis major) activation during rolling are allowed.	0: No contraction is noted in external oblique muscles on the affected side 1: External oblique muscle contraction is visible on the affected side, but the patient cannot roll his or her body 2: The patient can lift the affected side scapula but cannot fully rotate the body 3: The patient can fully rotate the body
3. Trunk rotation muscle strength on the unaffected side	The patient is asked to roll the body from the supine position to the affected side.	Scoring is the same as for the trunk rotation muscle strength on the affected side.
4. Righting reflex on the affected side	The patient sits on the edge of a bed or a chair without a backrest. The examiner pushes the patient's shoulder laterally (about 30°) to the unaffected side and scores according to the degree of the reflex elicited on the affected side of the patient's trunk.	0: No reflex is elicited 1: The reflex is poorly elicited, and the patient cannot bring his or her body back to the erect position as before 2: The reflex is not strong, but the patient can bring his or her body back to the erect position almost as before 3: The reflex is strong enough, and the patient can immediately bring his or her body back to the erect position as before
5. Righting reflex on the unaffected side	The examiner pushes the patient's shoulder laterally (about 30°) to the affected side.	Scoring is the same as for the righting reflex on the affected side.
6. SIAS verticality	Instruct the patient to remain in a sitting position.	0: The patient cannot maintain a sitting position 1: A sitting position can only be maintained while tilting to one side, and the patient is unable to correct the posture to an erect position 2: The patient can sit vertically when reminded to do so 3: The patient can sit vertically in a normal manner
7. SIAS abdominal muscle strength	Stroke Impairment Assessment Set abdominal muscle strength is evaluated with the patient resting in a 45° semireclining position in either a wheelchair or a high-back chair. The patient is asked to raise the shoulders off the back of the chair and assume a sitting position.	0: Unable to sit up. 1: The patient can sit up provided there is no resistance to the movement. 2: The patient can come to a sitting position despite pressure on the sternum by the examiner 3: The patient has good strength in the abdominal muscles and is able to sit up against considerable resistance

Source: Fujiwara et al.[5]
Abbreviation: SIAS, stroke impairment assessment set.

a seven-point scale, from maximum assistance (1 point) to complete independence (7 points), with a higher score on the 91-point scale indicating greater independence in daily living. These assessments were conducted by clinicians on the seventh day of hospitalization and the day before discharge.

Statistical analysis

Characteristics of the score distribution. Histograms were used to compare the distribution of scores between the TIS (Fujiwara version) and TCT. To examine differences in the difficulty and ceiling effects of trunk function assessments, we calculated the proportions of participants who achieved perfect scores of 21 points on the TIS (Fujiwara version) and 100 points on the TCT. These proportions were defined as indicators of the difficulty of the evaluation and ceiling effects of the assessment metrics. "Ceiling effects" refer to situations in which, according to the score distribution of an assessment or test, achieving the highest possible score is very easy, indicating low precision and sensitivity of the assessment. A ceiling effect was considered to exist when the number of patients achieving a perfect score exceeded 20% of the total.[15] Furthermore, skewness in the distribution of scores was calculated. When skewness is equal to 0, the data are considered to be normally distributed; when it is greater than 0, a left-skewed distribution is indicated, and when it is less than 0, the distribution is skewed to the right.

Responsiveness analysis. To examine the responsiveness, we evaluated changes in the total scores of the TIS and TCT from the seventh day of hospitalization to the last day of intervention. The evaluated items were analyzed using the effect size (ES) and standardized response mean (SRM). The ES was calculated using measurements taken on the seventh day of hospitalization and the day before discharge. Specifically, the ES was computed by subtracting the mean measurement value on the day before discharge from the mean measurement value on the seventh day of hospitalization and then dividing this difference by the standard deviation of the measurement values on the seventh day of hospitalization. ES was employed to indicate the magnitude of differences between groups. The SRM was calculated as the difference between the mean values of the measurements on the seventh day of admission and the day before discharge, divided by the standard deviation of the difference in the measurements. The SRM was used to indicate the magnitude of between-group differences. Interpretation of the ES (i.e., the degree of responsiveness of the SRM) was as follows: small ES, <0.2; moderate ES, >0.2 and <0.8; and large ES, >0.8.[16]

MCID analysis. A previous study[17] on patients with acute stroke reported that the MCID of the FIM-M was 17 points or more; therefore, we used a change of 17 points as the criterion for determining improvement in the ADLs. Comparisons in ADL improvement (yes/no; 0/1) and background factors (Mann–Whitney U test, χ^2 test) were performed. For the investigation of MCID, the area under the curve (AUC), cutoff value, sensitivity, and specificity were calculated by receiver operating characteristic (ROC) analysis, with the presence or absence of FIM-M improvement as the dependent variable and the difference between the total scores of the TIS as the independent variable. We analyzed the TCT, as a comparative control for the TIS, in the same manner. Sensitivity represents the ability to accurately detect improvements in FIM-M, reducing the risk of missing improvements when they are present. Specificity indicates the capability to correctly identify cases where there are no improvements in FIM-M, reducing the risk of falsely identifying improvements. The ROC curve, which plots the true positive rate (sensitivity) against the false positive rate (1-specificity), aims to approach the upper-left corner, with the cutoff value chosen to minimize the distance from this corner. The AUC of the ROC curve signifies predictive ability, with values ranging from 0.5 to 0.7 indicating low predictive ability, 0.7 to 0.9 indicating moderate predictive ability, and 0.9 to 1.0 indicating high predictive ability. IBM SPSS Statistics for Windows, version 28 (IBM Corp., Armonk, NY, USA) was used for statistical analysis, with a statistical significance level of 5%.

Results

Participant attributes

The main characteristics of the participants are provided in Table 2. The mean interval between the 2 evaluations was 16.1 ± 9.3 days.

Characteristics of the TIS (Fujiwara version) and TCT score distributions

The distributions of the TIS (Fujiwara version) and TCT scores and skewness (a measure of asymmetry) are shown in Figure 1. The percentages of those with perfect scores were 0% for the TIS and 20% for the TCT on day 7, and 0% for the TIS and 52.7% for the TCT at discharge.

Responsiveness results

The ES was moderate for the TIS and small for the TCT, while the SRM was large for both the TIS and TCT (Table 3).

Comparisons between FIM-M improvement groups

The 55 included patients were divided into improved (n = 31) and non-improved (n = 24) groups on the basis of the FIM-M. Univariate analysis results are shown in Table 4; statistically significant differences in age, TCT (admission, day 7, and discharge), and TIS (admission, day 7, and discharge) were found.

Cutoff value and prediction accuracy

The cutoff value for the TIS and TCT for discriminating the MCID based on the presence or absence of improvement in the ADLs as an external index was calculated by ROC analysis. The TIS had higher sensitivity, specificity, and precision based on the AUC than the TCT (Table 5). Figure 2 shows the ROC curves for the TIS and TCT.

Discussion

In the present study, we examined the responsiveness and MCID of the TIS (Fujiwara version) in patients with acute stroke. The results further suggest the TIS as an evaluation method for determining the effects of interventions on trunk function because it easily captures changes in trunk function, has good predictive ability, and is less likely to produce a ceiling effect.

A compensatory activation role of the ipsilateral pathway is reported to accompany recovery in trunk function after stroke, associated with an increase in motor-evoked potentials of the ipsilateral trunk muscles by stimulation of the non-injured

Table 2. Participant characteristics.

SURVEY ITEM			
Total number of patients (male/female)	55 (29/26)		
Age (years, median, IQR)	76.0 (65.5-81.5)		
Length of stay (IQR)	21.0 (18.0-27.0)		
Cerebral infarction	37		
Cerebral hemorrhage	18		
Paralyzed side (Rt/Lt)	33/22		
	ADMISSION	DAY 7	DISCHARGE
NIHSS (median IQR)	9.0 (4.5-13.0)	7.0 (3.0-10.0)	4.0 (2.0-7.0)
TCT (median IQR)	49.0 (12.0-74.0)	74.0 (37.0-87.0)	100 (61.5-100)
TIS (median IQR)	10.0 (5.0-14.0)	14.0 (9.5-16.5)	16.0 (13.5-18.5)
FIM-M (median IQR)	18.0 (14.0-26.0)	31.0 (17.5-41.5)	58.0 (31.5-67.0)

Abbreviations: FIM-M, functional independence measure motor item; IQR, interquartile range; Lt, left side; NIHSS, National Institutes of Health Stroke Scale; Rt, right side; TCT, trunk control test; TIS, Trunk Impairment Scale.

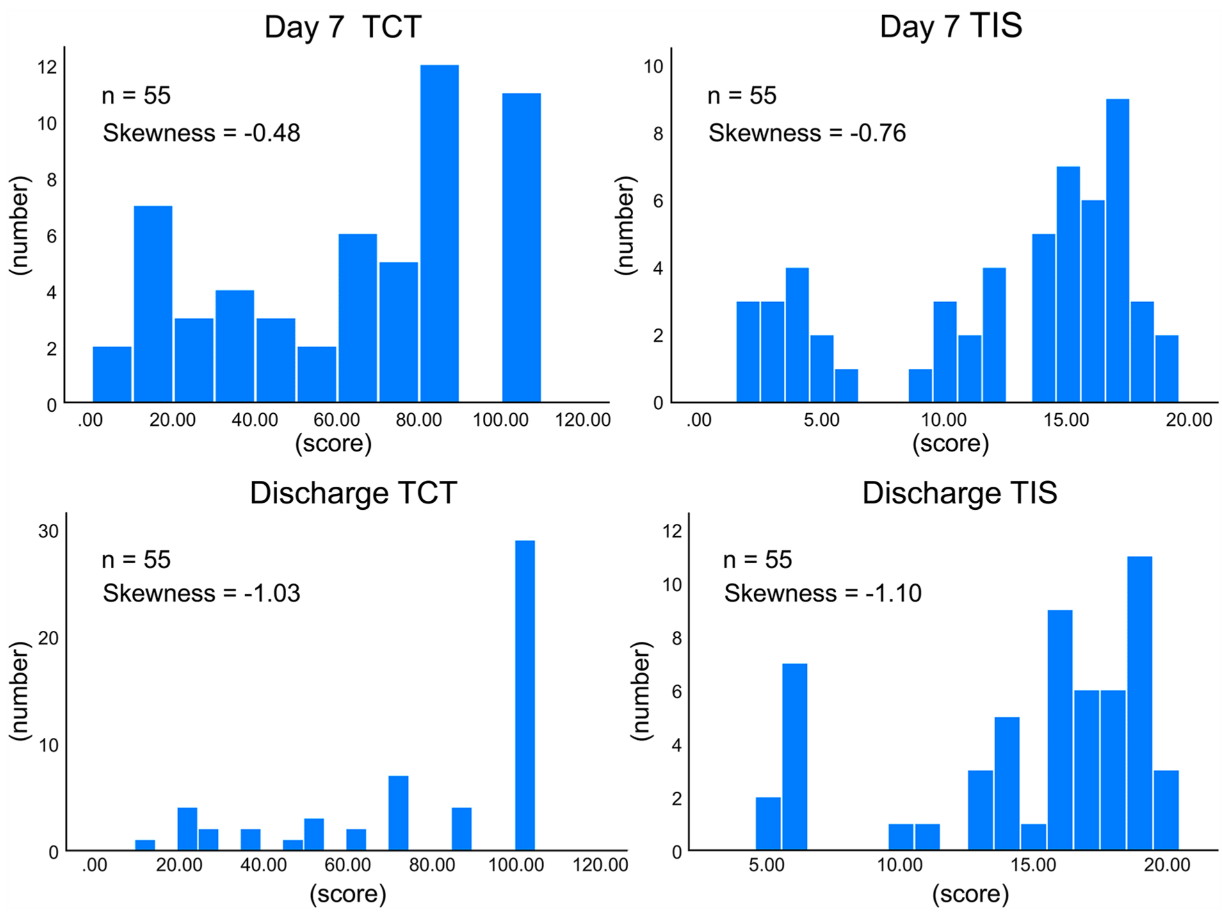

Figure 1. Distribution of scores on trunk function assessment. The skewness values, indicating asymmetry of distribution, at day 7 were as follows: TIS = −0.76, TCT = −0.48. Those at discharge were as follows: TIS = −1.10, TCT = −1.03.
Abbreviation: TCT, trunk control test; TIS, Trunk Impairment Scale.

hemisphere.[18] Trunk performance after stroke is thought to be less affected than upper- and lower-limb motor function because of bilateral innervation.[19] However, stroke often results in muscle weakness and limited coordinated movement, which determine a loss of autonomy[20]; if recovery is inadequate, the disability becomes more severe and the ADLs are reduced.[2]

Table 3. Response to intervention from day 7 of admission to the day of discharge.

	DAY 7	DISCHARGE	VARIATION	ES	SRM
TIS	12.2 ± 5.3	14.9 ± 4.6	2.7 ± 1.9	0.51	1.42
TCT	44.5 ± 31	78.5 ± 28.1	16.1 ± 15.6	0.50	1.03

Abbreviations: ES, effect size; SRM, standardized response mean; TCT, trunk control test; TIS, Trunk Impairment Scale.
Data are expressed as mean ± standard deviation.

Table 4. Comparisons between FIM-M improvement and non-improvement groups.

SURVEY ITEM	FIM-M IMPROVEMENT GROUP (N = 31)	FIM-M NON-IMPROVEMENT GROUP (N = 24)	*P*-VALUE
Cerebral hemorrhage/cerebral infarction	7/24	11/13	.07
Age (years, median, IQR)	67 (59-74)	80.5 (77-83)	<.001
Sex (male/female)	18/13	11/13	.37
Length of stay (IQR)	21 (17-26)	21.5 (19-30.8)	.47
Paralyzed side (Rt/Lt)	19/12	10/14	.82
Trunk function evaluation items			
TCT (median IQR)			
Admission	61 (36.5-74)	12 (12-40)	<.001
Day 7	87 (67.5-100)	37 (12-61.3)	<.001
Discharge	100 (100-100)	50 (25-74)	<.001
TIS (median IQR)			
Admission	14 (10-15)	4 (2-9.3)	<.001
Day 7	16 (15-17)	7.5 (3.8-12)	<.001
Discharge	18 (16.5-19)	13 (6-16)	<.001

Abbreviations: FIM-M: motor items of the functional independence measure; TCT, trunk control test; TIS, Trunk Impairment Scale.

Trunk function is a crucial component of common stroke assessment indices, such as the Fugl–Meyer assessment[21] (balance items) and SIAS[14] (verticality and abdominal muscle strength items). However, the ability to turn over and get up in a compensatory manner does not necessarily reflect the recovery of trunk function. Standardized measurements of trunk impairment are important to understand the recovery process of trunk function after stroke. For an effective treatment program for patients with impaired trunk function, an evaluation of trunk function is necessary, not only at the level of impairment, but also at the level of function.

The TIS (Fujiwara version) was designed to assess trunk function at the functional level. The rationale for TIS item selection was that vertical posture requires recognition of the verticality of the trunk, dynamic sitting requires the righting reflex ability, and abdominal muscle strength is thought to be necessary for turning from the supine position to sitting. Principal component analysis results have indicated that the 5 TIS items examine similar aspects to those of SIAS[14] trunk items (verticality and abdominal muscle strength), but differs from the SIAS in terms upper and lower extremity motor impairments and visuospatial cognition. In other words, the 5 TIS (Fujiwara version) items include disorders of the trunk as with SIAS trunk items. There is a high degree of correlation between the TIS and TCT, the standard method of assessing trunk function, and the validity of the TIS has also been acknowledged.[5] Trunk dysfunction assessed by the TIS appears to be closely related to trunk movements and the ADLs. The present study aimed to examine the responsiveness of the TIS (Fujiwara's version) for post-stroke trunk function in comparison with the TCT, for use in stroke rehabilitation studies, as well as the clinical significance of improvement in TIS in relation to the FIM-M. The results showed comparable changes in the ES, a greater degree of reactivity in the SRM for the TIS

Table 5. Cut-off values, sensitivity, specificity, and AUC.

	CUTOFF VALUE	SENSITIVITY (%)	SPECIFICITY (%)	AUC	95% CI
TIS	3.0	62.5	67.7	0.71	0.58-0.85
TCT	12.0	50.0	64.5	0.53	0.38-0.68

Abbreviations: AUC, area under the cover; CI, confidence interval; TCT, trunk control test; TIS: Trunk Impairment Scale.

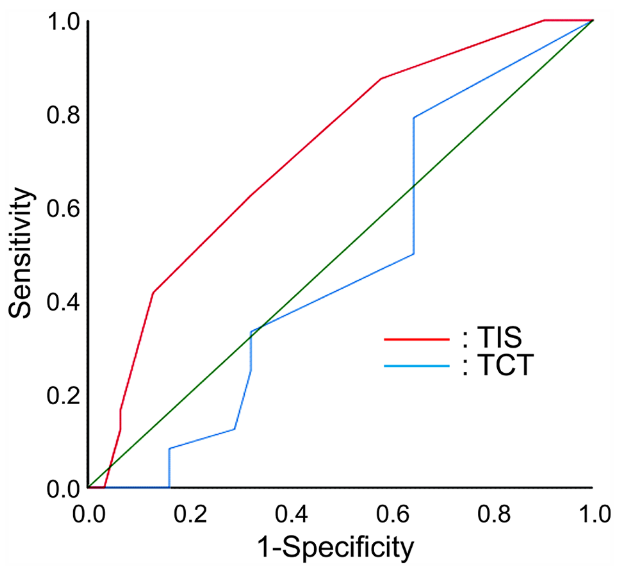

Figure 2. ROC curves for the TIS and TCT. The cutoff values were 3.0 points for the TIS (sensitivity 62.5%, specificity, 67.7%) and 12.0 points for the TCT (sensitivity 50.0%, specificity, 64.5%). The AUC was 0.71 and 0.53 for the TIS and TCT, respectively.
Abbreviations: AUC, area under the curve; ROC, receiver operating characteristic; TCT, trunk control test; TIS, Trunk Impairment Scale.

than for the TCT, and a higher predictive ability as assessed by the AUC for the TIS than for the TCT. The AUC of the TCT in the present study, at 53%, suggests that the TCT has no discriminative power (for this sample). These results suggest that the TIS can sensitively detect changes in trunk function and is useful for discriminating FIM-M improvement in patients who experienced acute stroke.

As a clinical tool for assessing trunk performance in patients who experienced stroke, the TCT and the trunk control items of the Postural Assessment Scale[22] are reportedly not suitable for use in long-term outcome studies because both tools have ceiling effects.[23-25] In the present short-term study, 20 and 52.7% of participants reached the ceiling effect for the TCT on day 7 and at discharge, respectively. In contrast, no ceiling effect was observed with the TIS, suggesting that the TIS may be useful in the evaluation of trunk function in patients who experienced acute stroke.

The quantification of the responsiveness of the TIS and TCT in terms of the ES was moderate for both evaluations. Regarding the SRM, a previous study reported that the mean change point, standard deviation of change point, and SRM of the TIS were 1.86, 1.97, and 0.94, while those of the TCT were 19.1, 18.0, and 1.06, respectively, indicating high SRM.[5] Similarly, in the present study, the mean change point and standard deviation of the change point of the TIS were 2.7 and 1.9, while those of the TCT were 16.1 and 15.6, respectively. Further, the SRM of the TIS and TCT were 1.42 and 1.03, respectively; this indicates that the TIS is capable of detecting changes sensitively, even in the acute phase.

Regarding the MCID of the TIS (Fujiwara version), a change of 3 or more points among patients who experienced acute stroke suggested that trunk function improved. In a previous study examining the MCID of the TIS (Verheyden version), the predictive ability was moderate.[26] The present study showed moderate predictive ability, with an AUC of 0.71, for the TIS (Fujiwara version). Additionally, the TIS (Fujiwara version) showed a sensitivity of 62.5% and specificity of 67.7%, indicating moderate performance. Conducting an evaluation using the TIS (Verheyden version) is difficult when the patient has difficulty holding a sitting position. We believe that trunk function should be evaluated not only at the ability level, but also at the functional level. Importantly, the TIS (Fujiwara version) includes the perception of trunk verticality, trunk rotational muscle strength, and righting reflex. The components functionally required for the sitting position can be assessed in bed from the acute stage in patients who have difficulty sitting. We recommend the TIS (Fujiwara version) as a measure of trunk function in patients with stroke because of its degree of responsiveness and predictive ability. Evaluation of trunk function using the TIS (Fujiwara version) can help discriminate ADL improvement and select an effective rehabilitation program to improve trunk function.

The present study has some limitations. The study population size was small and we had relatively small groups that differed in terms of their clinical parameters, which may have resulted in very wide confidence intervals. Additionally, there was a single evaluator. Furthermore, since we used the presence or absence of improvement in FIM-M as the external index for the calculation of the MCID, we were unable to confirm whether the patients had subjective improvement in trunk function. Future studies should evaluate the subjective improvement level and examine the MCID based on inter-rater evaluations, differences in severity, stage, and diseases of the individuals.

No previous studies have explored the sensitivity of the TIS (Fujiwara version), making this the first study of its kind. This study provides valuable insights into the sensitivity and MCID of the TIS (Fujiwara version). In the evaluation of trunk function in patients with acute stroke, the TIS (Fujiwara version) has demonstrated its sensitivity and utility as a valuable tool for assessing the effectiveness of rehabilitation programs. The findings of this research are significant for the development of rehabilitation approaches that focus on improving trunk function.

Conclusion

The responsiveness and MCID of the TIS and TCT were examined as indices for the evaluation of treatment efficacy in patients with acute stroke. The results suggest that TIS is a superior method for evaluating trunk function compared to the TCT when determining the effects of interventions on trunk function. This is because it is easier to capture changes in trunk function with the TIS than with the TCT. The TIS also has a higher predictive ability and is less likely to produce a ceiling effect. In addition, a 3-point improvement in the TIS was associated with an improvement in the ADLs, as assessed by the FIM-M.

Continuous evaluation using the TIS can detect changes associated with stroke treatment and improvement in the TIS has clinical significance.

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Data availability statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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