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Reliability of the Korean Version of the Trunk Impairment Scale in Patients With Stroke

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Abstract

The purpose of this study was to establish the reliability of the Trunk Impairment Scale (TIS) translated into Korea in patients with stroke. It also aims to score the quality of trunk movement and to be a tool for the treatment. The TIS consists of three subscales that static sitting balance, dynamic sitting balance and co-ordination. The TIS score ranges from a minimum of 0 to a maximum of 23. Twenty-five stroke patients (13 males, 12 females) were examined by two physiotherapists. Interrater and test-retest reliability were assessed. Kappa and weighted kappa values for the items of the trunk assessment of the TIS ranged from .67 to 1.00. Intraclass correlation coefficients for interrater and test-retest agreement were .95 and .97. Cronbach alpha coefficients for internal consistency range from .87 to .97. The TIS provide reliable assessments for the trunk and are valid scales for measuring trunk performance in patients with stroke. TIS can be used as a guideline for treatment and the assessment of quality of trunk activity.

Key Words: Reliability; Stroke; Trunk Impairment Scale.

Introduction

Balance is defined as the ability to keep the barycenter in the basal surface and to keep balance in the process of physical movement (Nashner, 1990). In the case of patients with hemiplegia caused by stroke, asymmetric postures, abnormal trunk balance, weight-movement defect and the problems of kinetic factors for daily living are observed (Bobath, 1990; Carr and Shepherd, 1985). Thus, in regards to patients with stroke, it is very important to evaluate trunk control and to cure its problem (Hsieh et al, 2002). Pope (1996) reported that a frequently occurring problem is postural incompetence and instability in sitting is related to malalignment of body segments. Karatas et al (2004) reported that the trunk muscle is impaired after stroke and also trunk paralysis and restriction arise in daily living. Bohannon et al (1995) reported that during activities of daily living, proper functioning of the trunk depends on a variety of interacting factors. Problems at the level of impairment, such as loss of muscle strength and mobility or an increase or decrease in muscle tone, can reflect in the functional performance of the trunk.

Rehabilitative factors are extensively included in tools to evaluate the function of patients with stroke. It was reported that Berg Balance Scale (BBS), Timed Up & GO (TUG) Test, Barthel Index, Functional Reach Test and Dynamic Gait Index are usually used for evaluation (An et al, 2007). However, most literature concerning motor rehabilitation after stroke focuses on the upper and lower extremity. Trunk rehabilitation receives little attention (Moreland and Thomson, 1994; Moreland et al, 1998; van der Lee JH et al, 2001b). Davies (1990) associates the loss of selective control in the trunk with problems of breathing, speech, balance, gait, arm and hand function. Sitting balance is also reported as

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a predictor of motor and functional recovery after stroke (Kwakkel et al, 1996; Loewen and Anderson, 1990; Sandin and Smith, 1990; Wade et al, 1983).

The Sitting Balance Scale developed by Nieuwboer et al (1995) showed poor reliability, especially for the items evaluating the quality of trunk activity. According to Collin and Wade (1990), The Trunk Control Test, a standardized measure with good psychometric properties, has been available since 1990 for use with people who have had a stroke. Franchignoni et al (1997) maintained that the Trunk Control Test is a quick and reliable measure with predictive validity.

The Trunk Control Test, however, does not reflect the quality of trunk movement. Because the trunk movement consists of appropriate shortening and lengthening of the trunk, selective movements of the upper and lower parts of the trunk, and moving the trunk without compensations into account (Collin and Wade, 1990). Nevertheless, there are few tools to extensively measure the post-stroke damage of the trunk.

To correct these problems, Verheyden et al (2004) developed the Trunk Impariement Scale (TIS) to evaluate trunk motor impairment for stroke patients. Fujiware et al (2004) studied the correlation with the Trunk Control Test. The result was that the TIS correlated with the Trunk Control Test (r=.91). Verheyden et al (2005) compared stroke patients and control groups to evaluate the decision of the TIS. The TIS total score was compared with both the Barthel Index (r=.86), by means of the Spearman rank correlations for determining construct validity, and the Trunk Control Test for concurrent validity. As the results, the sub-scale and total TIS scores showed significant differences between stroke patients and healthy individuals ($p<.0001$). Then, Verheyden et al (2007) studied the validity of the TIS for patients with parkinson's disease.

Winzeler-Mercay and Mudie (2002) reported that recent literature confirms the impairment of trunk muscles after stroke and shows the correlation between paretic trunk muscles and limitations in daily activities. They also reported several studies indicating trunk function us a significant predictor of motor and functional recovery after stroke.

To sum up, trunk balance is very important in the rehabilitation of patients with stroke. Thus, the necessity of tools to evaluate trunk mobility and its stability has been raised. The purpose of this study is to introduce the TIS into Korea, as well as to prove its reliability. In addition, this study is expected to be a guideline on the qualitative observation of trunk movements and the trunk alignment of patients with stroke.

Methods

Subjects

Patients were recruited through direct contact at a K university hospital and gathered stroke inpatients and outpatients on a volunteer basis with physiotherapy. Twenty-five stroke patients (13 female and 12 male) were included in study. The participants consisted of 11 patients with cerebral hemorrhage, 14 patients with ischemia with cerebral vessel's problems, 9 patients with right hemiplegia, 15 patients with left hemiplegia, 1 patient with quadriplegia. Their onset range is divided into 1 month to 6 months (14 patients), 6 months to 1 year (8 patients), and over 1 year (3 patients) and are evaluate for this lap (Table 1).

Procedures

Translation

The procedure used to produce the Korean version of the TIS was the forward translation method. This step is the translation into Korean of the original version of the TIS. English-Korean translators, two physiotherapists with years of experiences, were involved. Each translator independently translated the TIS and then, compared and discussed the result with a professor and a language expert, until a common version was reached.

Table 1. Patient characteristics of subject (N=25)

	Classification	Subject (%)
Sex	Male	13 (52)
	Female	12 (48)
Age (yrs)	40～49	4 (16)
	50～59	9 (36)
	60～69	3 (12)
	70～79	8 (32)
	80～89	1 (4)
Diagnosis	Cerebral hemorrhage	11 (44)
	Cerebral ischemic	14 (56)
Affected side	Right	9 (36)
	Left	15 (60)
	Bilateral	1 (4)
Day since stroke	From 1 month to 6 months	14 (56)
	From 6 months to 1 year	8 (32)
	Over 1 year	3 (12)

Measurement System and Measured Tasks

The TIS consist of three subscales: static sitting balance, dynamic sitting balance and co-ordination. Each subscale contains between three and ten items. The TIS total score ranges from a minimum of 0 to a maximum of 23. There are 3 subscales: static sitting balance with 3 categories and a total of 7 points, dynamic sitting balance, with 10 categories and 10 total points, and co-ordination with 4 items and 6 total points.

The subjects of study include that if patients can sitting position, they participate in this study. Further data collection to define the population consisted of patient's age, sex, height, affected side, type of stroke, days after stroke (Fugl-Meyer et al, 1975; Mahoney and Barthel, 1965). The therapist who examined the patient also explained the patient about the proceeding of this study and have taken informed consent from the patient and approval for the study was obtained with written permission to participate from a primary care physician.

For the reliability study, each patient was examined twice. On one occasion, two physiotherapists scored the TIS concurrently but independently. On another occasion, one of the therapists assessed the patient alone. The therapist who examined the patient alone also instructed the patient when both observers were scoring simultaneously. The two observations were always on the same day, separated by 1 or 2 hours of recovery time. During that time no treatment was offered. The observations were planned every half hour, so at least two different patients were evaluated before seeing the same patient again. To further minimize recall bias, the observers filled in the score sheet but did not add up the scores.

Allocation of the patients to the observers as well as the order of the two observations were randomized. Each observer examined twice time a group of 25 patients, amounting to 25 patients in total. In this study, every item of the scale was performed three times to avoid a possible scoring bias if a patient reached the maximum score after one or two attempts.

Statistical Analysis

Statistical analysis was performed using Windows SPSS version 12.0 for window. Test-retest reliability was measured by comparing the results of the therapists who examined the patient twice. To determine inter-rater reliability, the results of the both therapists who observed the patient simultaneously were compared. Test-retest and interobserver reliability were determined for all scale items. Kappa and weighted kappa values were calculated for dichotomous and ordinal scales, respectively. The agreement rate was also determined with regard to all items. In respect to the subtotal of 3 scopes and the total score of TIS, test-retest reliability and inter-rater reliability were evaluated by intraclass correlation coefficients ICC (3,1). Cronbach's alpha was calculated to check whether the subtotal is contradictory to the total.

Results

As kappa value or weighted kappa value was on the range between .67 and 1.00 in most items,

test-retest reliability showed high agreement. Also, test-retest agreement rate was on the range between 80 and 100% (Table 2). But in the item 8 in the dynamic sitting balance (.53), test-retest agreement was insufficient and also the agreement rate indicated 72%. As regards inter-rater agreement, kappa value or weighted kappa value was on the range between .60 and 1.00 and the agreement rate was 76 to 100%. In the case of the item 3 in the dynamic sitting balance (.53), inter-rater agreement was not sufficient and also the agreement rate was 72%. Intraclass Correlation Coefficient (ICC) was applied to the 3 scopes of TIC. In the case of the static sitting balance, test-retest agreement and inter-rater agreement indicated .79 and .97 respectively. In the case of the dynamic sitting balance, test-retest agreement and inter-rater agreement indicated .90 and .93 respectively. In coordination, two factors indicated .77 and .96 respectively. Likewise, ICC was applied to the total score of TIS and as a result test-retest agreement and inter-rater agreement indicated .97 and .95 respectively (Table 3). Cronbach's alpha was calculated to check whether the subtotal is contradictory to the total, and internal consistency was .87 to .99.

Table 2. Test-retest and Inter-observer agreement of scores on items of the Trunk Impairment Scale in 25 patients with stroke

Item	Test-retest agreement		Inter-observer agreement	
	Value[a]	%[b]	Value	%
Static sitting balance				
1. Keep sitting balance	1.00	100%	1.00	100%
2. Keep sitting balance with legs crossed	1.00	100%	1.00	100%
3. Keep sitting balance while legs crossed	.93[c]	96%	.53[c]	72%
Dynamic sitting balance				
1. Touch seat with right elbow (task achieved or not)	1.00	100%	.73	88%
2. Touch seat with right elbow (trunk movement)	1.00	100%	.93	96%
3. Touch seat with right elbow (compensation strategies)	.67	80%	.67	80%
4. Touch seat with left elbow (task achieved or not)	1.00	100%	1.00	100%
5. Touch seat with left elbow (trunk movement)	.93	96%	.93	96%
6. Touch seat with left elbow (compensation strategies)	.93	96%	.87	92%
7. Lift right side of pelvis from seat (task achieved or not)	1.00	100%	.93	96%
8. Lift right side of pelvis from seat (compensation strategies)	.53	72%	.73	84%
9. Lift left side of pelvis from seat (task achieved or not)	.93	96%	.93	96%
10. Lift left side of pelvis from seat (compensation strategies)	.93	96%	.73	84%
Co-ordination				
1. Rotate shoulder girdle 6 times	.93[c]	96%	.60[c]	76%
2. Rotate shoulder girdle 6 times within 6 seconds	1.00	100%	.67	80%
3. Rotate pelvic girdle 6 times	.73[c]	88%	.73[c]	88%
4. Rotate pelvic girdle 6 times within 6 seconds	1.00	100%	.93	96%

[a]Value of the calculated kappa.
[b]Percentage of agreement.
[c]Presented as weighted kappa statistic.

Table 3. Intraclass correlation coefficient (ICC) for test-retest and inter-observer agreement

	Test-retest agreement	Inter-observer agreement
Static sitting balance	.79	.97
Dynamic sitting balance	.90	.93
Co-ordination	.77	.96
Trunk Impairment Scale	.97	.95

Discussion

The purpose of this study is to prove the reliability of the TIS and its usability. In kappa value and weighted kappa value, test-retest agreement and inter-rater agreement were between .53 and 1.00 in most items. In items 1 and 2 of the static sitting balance, kappa values were 1.00 all. This value may be the result of subjects being able to sit, and so it suggested that it was very easy to perform those items. On the other hand, many subjects could not get scores in item 1 and 3 of coordination, though weighted kappa value was .60 to .93. It suggests that it is difficult for patients with stroke to perform them (Verheyden et al, 2004). Verheyden et al (2006b) who applied the TIS to patients with multiple sclerosis, reported that kappa value indicated .87~1.00 in items 1 and 2 of the static sitting balance. However, they reported that kappa value was no more than .55 to .60 in items 3 and 8 of the dynamic sitting balance. Also, in this study, kappa value showed similar results: Test-retest agreement and inter-rater agreement were .53~.73 in items 3 and 8 of the dynamic sitting balance.

Likewise, Niewboer et al (1995), who observed the post-stroke dynamic sitting balance, reported that its reliability got lower. Such results suggest the difficulty of evaluating actions and raters' experiences affect results. It is very difficult for patients with stroke to conduct symmetric trunk movement, but it is reasonable to include it in the TIS. The TIS can be a guideline for medical treatment. In addition, convalescents and patients with severe stroke need to be researched separately to evaluate the reliability of items 1 and 2 of the dynamic sitting balance and items 2, 3 and 4 of coordination (Verheyden et al, 2004). In this study, inter-rater agreement was .93 to .97, and test-retest agreement was .77 to .90 in ICC (Intraclass Correlation Coefficients) to the 3 scopes of the TIS. Accordingly, inter-rater agreement was higher than test-retest agreement. These results were similar to those reported of Verheyden et al (2004). According to their report, the TIS ICC value indicated .99 and .96, respectively, in inter-rater agreement and test-retest agreement. It also indicated .97 and .95, respectively, in two factors. Patients who suffered traumatic brain injury, the TIS ICC value indicated .95 and .88, respectively, in inter-rater agreement and test-retest agreement (Verheyden et al, 2006a).

This value can be attributed to raters simultaneously scoring patients; therefore, biases and variability could be minimized. Also, test-retest reliability might be lowered by the variability that arises in the process that patients undergo during examinations (Verheyden et al, 2004). Actually, test-retest errors were higher than inter-rater ones. ven der Lee JH et al (2001a) reported that inter-rater measurements were similar to the limitation of agreement recorded by Action Research Arm Test and Brunnstorm-Fugl-Meyer Assessment Scale. In this study, Cronbach's alpha to the TIS indicated .87~.99 and so high reliability was derived. The result was different from the report of Verheyden et al (2004) that Cronbach's alpha indicated .65~.89. Hatcher and Stepanski (1994) maintained that even an alpha coefficient less than .70 to .60 can be used. Resultantly, .97 means that it has high reliability. With regard to the TIS, test-retest kappa value was between .53 and 1.00 and inter-rater kappa value was between .67 and 1.00. Nieuwboer et al (1995)

reported that test-retest kappa value and inter-rater kappa value were between .20 and 1.00 regarding the TIS. However, the total score of the TIS is very reliable. When Motor Assessment Scale was .99 in sitting balance, the spearman rho correlation coefficient was .76 in the trunk control test (Collin, 1990). Franchignoni et al (1997) reported that Cronbach's alpha indicated .83 and .86, respectively. Benaim et al (1999) found that the internal consistency of the postural analysis scale of patents with stroke is .95. The additional purpose of the TIS is to score the quality of trunk movements as it can be a guideline for medical treatment. The 4 tasks of the dynamic sitting balance are suitable to evaluate bilateral trunk contraction or extension (Verheyden et al, 2004). In this study, trunk coordination, static sitting balance and dynamic sitting balance were considered in the TIS. Consequently, it is expected to be a guideline for medical treatment, though all trunk functions may not be evaluated.

Conclusion

The study was aimed at the clinical examination of post-stroke trunk impairment, and introducing translation. The Trunk Impairment Scale (TIS) to Korean. To do so, static sitting balance, dynamic sitting balance, and coordination were measured with regard to 25 patients from rehabilitation medicine department of a university hospital 'K,' located in Seoul. The degrees of impairment were objectified as well. In addition, the intra-rater reliability and the inter-rater reliability were ascertained in respect to every item. As a result, the kappa value was established between .67 and 1.00, and the weighted kappa value was between .60 and 1.00 in the test-retest agreement and the inter-rater agreement. Generally, they showed high agreement. The test-retest agreement rate was 80 to 100% and also the inter-rater agreement rate was 76 to 100%. In regards to every item of TIS, the test-retest ICC was between .77 and .90 and the inter-rater ICC was between .93 and .97. And in the total score of TIS, the test-retest ICC and the inter-rater ICC indicated .97 and .95, respectively. In sum, evaluating trunk impairments of patients with stroke, the static sitting balance, the reliable results were derived in the dynamic sitting balance and coordination. These results are considered to be useful for medical treatment as well as evaluating trunk movements.

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Trunk Impairment Scale (TIS)

정적인 앉기 균형

1. 시작 자세	환자가 넘어지거나, 팔을 지지 하지 않으면 10초 동안 시작 자세를 유지하지 못함.	□0
	환자가 10초 동안 시작자세를 유지 할 수 있음.	□2
	만약 이 항목에서 0점이면 TIS 총점은 0점	
2. 시작 자세 치료사는 환측 다리 위에 건측 다리를 교차시킴	환자가 넘어지거나, 팔을 지지 하지 않으면 10초 동안 앉은 자세를 유지하지 못함.	□0
	환자가 10초 동안 앉은 자세를 유지 할 수 있음.	□2
3. 시작 자세 환자는 환측 다리 위에 건측 다리를 교차시킴	환자가 넘어짐.	□0
	환자가 침대나 책상 위에서 팔의 지지 없이는 다리들을 교차시키지 못함.	□1
	환자가 다리들을 교차시키지만 몸통이 10 ㎝ 이상 뒤로 하거나, 손을 이용하여 교차시킴.	□2
	환자가 몸통을 움직이거나 손을 움직이지 않고도 다리를 교차시킴.	□3
총 정적인 앉기 균형		/7

동적인 앉기 균형

1. 시작 자세 환자는 환측 팔꿈치를 침대나 테이블에 접촉하고 (환측의 단축과 건측의 신장) 시작 자세로 되돌아옴.	환자가 넘어짐, 상지의 지지가 필요하거나 팔꿈치가 침대나 테이블에 접촉하지 못함.	□0
	환자가 도움 없이 능동적으로 움직이고, 팔꿈치가 침대나 테이블에 접촉함.	□1
	만약 이 항목에서 0점이면 2, 3 항목은 0점 처리	
2. 1번 항목을 반복	환자가 실행하지 못하거나 반대로 실행함 (환측 신장, 건측 단축)	□0
	환자가 적절한 단축/신장을 실행함	□1
	만약 이 항목에서 0점이면 3 항목은 0점 처리	
3. 1번 항목을 반복	환자가 대상 작용을 보임. (1)상지를 이용 (2)반대편 고관절 외전 (3)고관절 굴곡 (4)무릎 굴곡 (5)발이 미끄러짐	□0
	환자가 대상 작용 없이 수행함.	□1
4. 시작자세 환자는 건측 팔꿈치를 침대나 테이블에 접촉하고 (건측의 단축과 환측의 신장) 시작 자세로 되돌아옴.	환자가 넘어짐, 상지의 지지가 필요하거나 팔꿈치가 침대나 테이블에 접촉하지 못함.	□0
	환자가 도움 없이 능동적으로 움직이고, 팔꿈치가 침대나 테이블에 접촉함.	□1
	만약 이 항목에서 0점이면 5, 6 항목은 0점 처리	
5. 4번 항목을 반복	환자가 실행하지 못하거나 반대로 실행함 (건측 신장, 환측 단축)	□0
	환자가 적절한 단축/신장을 실행함	□1
6. 4번 항목을 반복	환자가 대상 작용을 보임. (1)상지를 이용 (2)반대편 고관절 외전 (3)고관절 굴곡 (4)무릎 굴곡 (5)발이 미끄러짐	□0
	환자가 대상 작용 없이 수행함.	□1

7. 시작 자세 환자는 침대나 테이블로부터 환측 골반을 올린 후(환측의 단축과 건측 신장) 시작 자세로 되돌아옴	환자가 실행하지 못하거나 반대로 실행함 (건측 신장, 환측 단축)	□0
	환자가 적절한 단축/신장을 실행함	□1
	만약 이 항목에서 0점이면 8 항목은 0점 처리	
8. 7번 항목을 반복	환자가 대상 작용을 보임. (1)상지를 이용 (2)동측 발을 밀기(뒤꿈치가 바닥에서 떨어짐)	□0
	환자가 대상 작용 없이 수행함.	□1
9. 시작 자세 환자는 침대나 테이블로부터 건측 골반을 올린 후(건측 단축과 환측 신장) 시작 자세로 되돌아옴	환자가 실행하지 못하거나 반대로 실행함 (건측 신장, 환측 단축)	□0
	환자가 적절한 단축/신장을 실행함	□1
	만약 이 항목에서 0점이면 10 항목은 0점 처리	
10. 9번 항목을 반복	환자가 대상 작용을 보임. (1)상지를 이용 (2)동측 발을 밀기(뒤꿈치가 바닥에서 떨어짐)	□0
	환자가 대상 작용 없이 수행함.	□1
총 동적인 앉기 균형		/10

협응성

1. 시작 자세 환자는 윗 몸통을 6번 회전 하며 (어깨를 앞 방향으로 3번 움직이게 함), 첫째 환측으로 움직여야 하고 시작 자세에서 머리는 고정되어야 함.	환측으로 3번 움직이지 못함.	□0
	회전시 비대칭적임.	□1
	회전시 대칭적임.	□2
	만약 이 항목에서 0점이면 2 항목은 0점 처리	
2. 1번 항목을 6초 이내 반복	회전시 비대칭적임.	□0
	회전시 대칭적임.	□1
3. 시작 자세 환자는 아랫 몸통을 6번 회전 하며 (무릎을 앞 방향으로 3번 움직이게 함), 첫째 환측으로 움직여야 하고 시작 자세에서 머리는 고정되어야 함.	환측으로 3번 움직이지 못함.	□0
	회전시 비대칭적임.	□1
	회전시 대칭적임.	□2
	만약 이 항목에서 0점이면 4번 항목은 0점 처리	
4. 3번 항목을 6초 이내 반복	회전시 비대칭적임.	□0
	회전시 대칭적임.	□1
총 협응성 점수		/6

총 체간 손상 척도	/23