Spinal Cord (2011) 49, 1198–1202

www.nature.com/sc

ORIGINAL ARTICLE

Validation of the Brazilian version in Portuguese of the Thoracic-Lumbar Control Scale for spinal cord injury

CB Pastre[1], AM Lobo[2], TD Oberg[3], KR Pithon[4], SM Yoneyama[5] and NMFV Lima[6]

[1]Neurology Physical Therapy/State University of Campinas (UNICAMP), Campinas, Brazil; [2]Neuroscience and Behavior from the Institute of Psychology/University of Sao Paulo (USP), São Paulo, Brazil; [3]Biomedical Sciences by UNICAMP, Campinas, Brazil; [4]Experimental Surgery/Faculty of Medical Sciences/UNICAMP, Campinas, Brazil; [5]Sciences of Rehabilitation/USP, Sao Paulo, Brazil and [6]Biomedical Sciences/UNICAMP, Campinas, Brazil

Study design: Prospective clinical study.
Objectives: This study aimed to translate, adapting to Brazilian version in Portuguese, validate and measure inter and intra-examinator reliability and internal consistency of the Thoracic-Lumbar Control Scale instrument.
Setting: State University of Campinas, São Paulo, Brazil.
Methods: This instrument was translated to Brazilian Portuguese by a bilingual translator, and it was retranslated to English for conflict correction and cultural adaptation. Two physiotherapists were previously trained to standardize the scale administration. In all, 22 patients were selected and initially assessed through FIM and American Spinal Injury Association (ASIA) instruments. Furthermore, they were evaluated through the Thoracic-Lumbar Control Scale by two examiners and revaluated 1 week after by only one examinator.
Results: The Brazilian Portuguese version of Thoracic-Lumbar Control Scale showed excellent intra and inter-examinator reliability (0.961 and 0.986), high value of internal consistence (0.934) and significant correlation with ASIA sensory score ($r = 0.83$, $P = 0.001$).
Conclusions: The Brazilian Portuguese version of Thoracic-Lumbar Control Scale is a valid and efficient instrument to assess trunk control of after-spinal cord injury patients, which certifies its replicability by other neurology professionals.
Spinal Cord (2011) **49**, 1198–1202; doi:10.1038/sc.2011.86; published online 18 October 2011

Keywords: spinal cord injury; postural balance; validity of tests; reproducibility of results

Introduction

Postural control refers to the ability of maintaining balance against internal and external perturbances, with the goal of keeping the body center of mass within the base of support.[1,2] After the spinal cord injury (SCI), the balance automatism may be affected and these individuals begin to adopt new patterns of postural control.[1,2] The decrease of sitting balance and postural control cannot be fully compensated by the use of non-postural muscles, which only reduces functional disability partially. Thus, it is difficult to perform the trunk and upper limbs movements due to a lack of adequate postural stability after SCI.[1]

Despite the trunk impairment clinical importance in SCI victims, there is a lack of scales in literature addressing trunk disfunction. There are no validated scales in Brazil that specifically assess trunk after SCI, as well as studies about profile and treatment of trunk control dysfunction in this population. The scales used to characterize the trunk function and that have a Brazilian version, address post-stroke patients with hemiparesis, in quantitative[3,4] and qualitative[5] ways. For post-SCI patients, there are reports using functional measures that evaluate the trunk function indirectly, even though they do not allow a quantitative assessment of this function level such as Spinal Cord Independence Measure,[6] Modified Functional Reach Test[7] and Quadriplegia Index of Function[8] instruments. With the purpose of assessing specific function and motor ability of the thoracic and lumbar regions, the Thoracic-Lumbar Control Scale or Graves-Atkinson Scale, a specific instrument for patients after SCI, was developed by Atkinson *et al.*[9] in 2007 at Baylor College of Medicine, Houston, TX, USA.

This instrument assesses 10 tasks in the supine, prone, sitting and standing positions and the ability of patients to perform activities in these positions. This scale has not yet been used in clinical trials; however, it is specific for

Correspondence: CB Pastre, Rua Doutor Delfim Moreira, 112, Jardim Mantiqueira. CEP: 37795-000, Andradas, Brazil.
E-mail: karolbpastre@hotmail.com
Received 22 June 2010; revised 17 May 2011; accepted 11 July 2011; published online 18 October 2011

measuring trunk disfunction level of patients post-SCI, which demands its validation, so it can be used in new studies involving this population.

Thus, this study aimed to translate, adapt to Brazilian Portuguese, validate and measure the reliability of inter and intra-rater and internal consistency of the Thoracic-Lumbar Control Scale and its correlation with ASIA[10] sensory score, the oficial instrument (gold standard) to evaluate post-SCI patients. Furthermore, to correlate functionality and trunk function, the Thoracic-Lumbar Control Scale was compared with FIM,[11] an instrument not specific for SCI patients, however, highly used in this population in Brazil to evaluate functional abilities.

Materials and methods

This is a prospective clinical study performed at the Outpatient Physical and Occupational Therapy, Clinical Hospital, University of Campinas (UNICAMP) in the period from March to December 2009. The study was approved by the Ethics in Research of the Faculty of Medical Sciences, UNICAMP (protocol number 403/2009) and all subjects signed a consent form.

Instruments of measuring

The Thoracic-Lumbar Control Scale[9] includes 10 items that assess: trunk extension in prone, elevation of the pelvis, trunk flexion in supine, trunk rotation, sit to supine, supine to sit, sitting posture, trunk extension in sitting, sitting balance and standing balance. The tasks are scored according to the ability of the patient to perform it with minimum effort, ranging 0–5 points. Scores decrease as the use of compensatory strategies increase.

On the first seven tasks, to obtain five points, the patient must be able to perform the task on the position proposed without evidenced effort and no assistance; he grades 4, if when performing the task it is observed some sign of effort. If it is necessary for the patient to change the position for him to perform the task, grades vary 3–0. In case some contractile activity is detected or assistance is given from the therapist in most part of the movement, the task is graded 1. In the absence of movement and muscle contraction, or assistance given to perform the task fully, the patient score is 0.

The Functional Independence Measure (FIM)[11] assesses 18 categories graded 1–7 and ranked according to the dependence level required to perform the tasks. This scale was used as a complementary correlation instrument of the Brazilian Portuguese version of the Thoracic-Lumbar Control Scale. The American Spinal Injury Association (ASIA)[10] was used to determine the neurological level and type of SCI. The ASIA sensory score was used as gold standards for the validation study of the Thoracic-Lumbar Control Scale.

Subjects

We included individuals of both sexes, aged between 18 and 65 years, with clinical diagnosis of the SCI for more than 6 months, complete or incomplete paraplegia or tetraplegia, according to the classification adopted by the American Association of SCI. Individuals with ASIA E type, medullary syndrome, with standing capability, other neurological comorbidities and pressure ulcers with sitting restrain were excluded.

Procedures

Translation. The original instrument was translated by two independent bilingual translators, who are native in Brazilian Portuguese language, and two different versions of the instrument were obtained. These versions were reviewed by two expert physiotherapists, obtaining a single version in Brazilian Portuguese language. The version in Brazilian Portuguese was submitted to retroversion by a third translator who did not know the original instrument. The original version, the version in Portuguese and retroversion were compared by the physiotherapists and specialists to eliminate errors of interpretation and cultural conflicts. The translation, validation and reliability analysis in Brazil were permitted by the scale authors after contact by e-mail.

Examiner's training and pre-test. Two physiotherapists, post-graduating students, were previously trained by an experienced physiotherapist to explain the instructions and standardize the scale administration, through a demonstrative video released by the author of the instrument. The pre-test consisted in administering the instrument in an individual diagnosed with SCI, but he was not included in the sample.

Assessment. The selection of patients included clinical history, and those that met inclusion criteria were evaluated by the FIM and ASIA scales. Then, patients were transferred to another room where two examiners assessed them with the Brazilian Portuguese version of the Thoracic-Lumbar Control Scale, and one of them led tasks and both scored the instrument. Communication was not allowed between investigators during the scale execution. Reassessment of the Thoracic-Lumbar Control scale was performed within 1 week (retest) by a single examiner.

Statistical analysis

For data analysis the SPSS 15.0 (IBM SPSS) was used. The reliability of the Thoracic-Lumbar Control Scale—Brazilian Portuguese version was determined through: inter- and intra-observers reliability, internal consistency of the scale, and correlation between the ASIA sensory score and this version of the Thoracic-Lumbar Control Scale (construct validity). Intra-observer and inter-observer agreement was verified in the items of the Thoracic-Lumbar Control Scale and its total score, using the intra-class correlation coefficient, to measure the replicability of the scores, and the following classification was adopted: intra-class correlation coefficient <0.40—weak agreement, intra-class correlation coefficient <0.75—moderate agreement and intra-class correlation coefficient >0.75—high agreement.[12] The internal consistency, which shows the correlation between items in the instrument, was evaluated by alpha Cronbach.[13]

The item-total correlation of Thoracic-Lumbar Control Scale was calculated and scores higher than 0.4 are

considered satisfactory.[14] The correlation between ASIA sensory score, FIM score and Thoracic-Lumbar Control Scale was determined by the Spearman correlation coefficient (r). The level of significance for analysis was 5%.

We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research.

Results

From 60 patients with SCI of outpatient list, 22 met the inclusion criteria and were recruited for the study after signing the consent term. Sample characteristics are summarized in Table 1. The neurological level, FIM and Brazilian version in Portuguese of Thoracic-Lumbar Control Scale total scores registered by the standard examiner are presented in Table 2. The majority of the evaluated patients were male, with age ranging 21–61 years with injury time between 6 months and 22 years and type A ASIA.

All items in the Thoracic-Lumbar control scale showed item-total correlation coefficient greater than 0.4. The internal consistency of the scale by Cronbach's alpha value, based on their total score was 0.934, considered a high value of internal consistency. Table 3 shows the reliability coefficient of inter- and intra-observers. The Portuguese version of Thoracic-Lumbar control scale was correlated with ASIA sensory score ($r = 0.83$, $P = 0.001$) and was moderatly correlated with total FIM ($r = 0.64$, $P = 0.001$).

Table 1 Demographic characteristics ($n = 22$)

Variables	*Mean ± s.d.*
Age (y)	33.64 ± 11.04
Sex (female/male)	2/20
Height (cm)	1.74 ± 0.07
Weight (kg)	72.88 ± 11.49
Etiology of SCI	
Automobilist accident	8
Motorcycle accident	6
Dive in shallow water	5
Fire gun injury	3
Time of lesion (y)	6.93 ± 5.67
Assistance device	
Wheelchair	22
Total FIM	81 ± 24.99
Neurologic level (ASIA)	
C2 – T1	13
T2 – L2	9
ASIA type	
A	14
B	3
C	2
D	3

Abbreviations: ASIA, American Spinal Injury Association; FIM, Functional Independence Measure.

Discussion

The Brazilian version in Portuguese of Thoracic-Lumbar Control Scale presented excellent inter-rater and intra-rater reliability and good internal consistency, thus showing a valid and effective evaluation of trunk control in patients post-SCI. The original authors of the scale also found a high level of internal consistency (0.91) for the instrument and high coefficients within and between examiners (0.943 and 0.962).[9]

Seelen *et al.*[1] reported that individuals with high thoracic SCI (T2-T8) use non-postural muscles like the latissimus dorsi and upper trapezius to restore sitting stability after balance disturbance. Unlike, in individuals with low thoracic SCI (T9-T12), the use of this alternative is less required, as the erector spinal muscle is less compromised. Thus, it is evident the need of a specific measuring instrument for the trunk and its compensatory strategies in this population. The Brazilian version in Portuguese of Thoracic-Lumbar Control Scale evaluates main activities that require a good trunk control in prone/supine, sitting and standing postures. It is ideal for administrating in studies involving SCI trunk, for providing results that are visualized and discussed reliably.

Table 2 Neurological level, ASIA type, ASIA sensory score, FIM and Thoracic-Lumbar Control Scale total scores for each patient ($n = 22$)

Patient	*Neurological level (ASIA)*	*ASIA type*	*Total score trunk scale*	*Total FIM*
1	C6	A	14	72
2	C6	A	13	68
3	C4	A	11	56
4	T5	A	15	112
5	L2	B	49	121
6	T2	A	15	71
7	C6	A	11	73
8	C3	D	29	104
9	C3	D	35	49
10	C5	D	16	68
11	T5	C	14	114
12	C4	A	7	53
13	C3	A	13	81
14	T1	A	11	97
15	C5	A	15	58
16	C4	A	7	49
17	T9	C	38	113
18	T5	A	17	81
19	T6	B	40	111
20	T5	B	24	113
21	T6	A	12	69
22	C2	A	5	49

Abbreviations: ASIA, American Spinal Injury Association; FIM, Functional Independence Measure.

Table 3 Intra and inter-rater reliability: intra-class correlation coefficient ($n = 22$)

Item	*ICC*	*CI 95%*	P-*value*
Inter-rater reliability	0.986	0.967; 0.994	0.001
Intra-rater reliability	0.961	0.905; 0.984	0.001

Abbreviations: CI, confidence interval; ICC, intra-class correlation coefficient.

Due to the scarcity of specific instruments for this condition in Brazil, this scale translation and validation is of fundamental importance, so new studies can be proposed in this population, considering that most of the validated trunk scales address the post-stroke population.

It is postulated that a proper sitting stability and trunk control in post-SCI patients are required to perform the upper limb movements in essential Activities of Daily Living (ADL).[15] Sprigle *et al*.[15] reported that postural stability tests, that measure the performance of individuals with SCI in ADL and which can be applied quickly in clinical environment, assist therapists in prescribing the correct wheelchair and an efficient postural support. The sitting balance task, assessed by the patient's ability in frontal and lateral reaching, had a high-value item-total correlation. According to Verheyden *et al*.,[16] the trunk has a critical role in the organization of postural reactions, and its displacement without the loss of balance is extremely important in carrying out ADL.

According to Atkinson *et al*.,[9] the muscles innervated by the thoracic and lumbar spine perform an essential role in the body and posture positioning, which are important for functional activities, such as walking and daily life activities. The motor scoring of ASIA is the only clinical grading used to assess motor function in SCI; however, as the trunk muscles are innervated by a large quantity of nerve roots, the quantitative determination of trunk function would be impracticable. Thus, the Thoracic-Lumbar Control Scale is the instrument elected to measure motor abilities of the thoracic and lumbar regions.

The most currently used instrument in assessing the functionality of the post-SCI patient is the FIM. According to Anderson *et al*.,[17] the FIM and other measures of functionality share common components in their structure, and therefore is widely used in this population. Therefore, the FIM evaluates the trunk qualitatively on self-care, transfers and locomotes tasks, and we recommend its use associated with The Brazilian version in Portuguese of Thoracic-Lumbar Control Scale to assess quantitatively and qualitatively the impact of the trunk control treatment protocol in patients after SCI.

There is scarcity of Brazilian versions of scales that address trunk performance after SCI. These patients characterizations are made through scales validated in Brazil for another group of patients, such as Trunk Impairment Scale,[18] which was developed to assess stroke patients, thus they are unable to measure the impairment of patients after SCI for not approaching specific deficits of this condition. Therefore, the importance of validating instruments in Brazil, which are sensitive to detect trunk impairments in this group of patients.

The functional reach test reflects the ability of the post-SCI patient of using the upper limbs in tasks while maintaining an adequate trunk control. Lynch *et al*.[7] assessed the reliability of the Modified Functional Reach Test, which measures sitting balance in subjects after SCI, and its correlation with the neurological level and dysfunctional framework. There was high test-retest reliability and the results reflected changes related to the level of injury. The Thoracic-Lumbar control scale approaches trunk motor functions, functional reaching on 'sitting balance' and 'standing balance' items, and also includes in these items postural compensation aspects and the use or not of the upper limbs to maintain trunk control.

The validation of the Thoracic-Lumbar control scale to Portuguese will allow a better characterization of SCI patients and monitor rehabilitation outcomes. The scale can be used in future studies for validating and comparing with other instruments approaching this population, such as Spinal Cord Independence Measure (SCIM)[6] and Quadriplegia Index of Function (QIF),[8] which do not have a translated version in Brazil. The SCIM[6] was developed in 1997 and assesses the independence during ADL. It showed high interrater reliability and was more sensitive than the FIM to functional changes found in subjects with paraplegia. The Quadriplegia Index of Function (QIF)[8] was specifically developed for tetraplegic patients. The instrument showed good correlation with FIM ($r=0.97$ and 0.93), with ASIA motor score ($r=0.91$ and $r=0.91$) and moderate correlation with ASIA sensory score ($r=0.64$ for touch, $r=0.65$ for painful stimuli).[19,20]

The sensory capacity, determined by ASIA, presented correlation with the Brazilian Portuguese version of the Thoracic-Lumbar Control Scale. The SCIM and QIF instruments measure the level of the offered assistance during the task and they do not evaluate the trunk in a straight and quantitative manner, thus, highlighting the clinical relevance of the Thoracic-Lumbar control scale for SCI. This version of the scale also assess the trunk performance through the therapist level of assistance, but scoring are mainly given considering the motor control during the task (muscle contraction, range of motion, reached excursion, posture maintenance and alignment and compensatory strategies use).

Among the benefits of Thoracic-Lumbar control scale for SCI are: short time of application (15 min), and its easy understanding by patients, because assessed postures are adopted during ADL. Moreover, its application requires only one equipment—a ruler to measure the extent of frontal and lateral reach—which does not confer a high-cost application. Other advantages of the scales are: selective evaluation of the thoracic and lumbar portions (trunk extension), trunk analysis on supine, sitting and standing positions and a wider grading for each task compared with other trunk-measuring instruments. The Thoracic-Lumbar control scale for SCI meets the necessary aspects for an objective measurement of trunk action in patients post-SCI, considering that its tasks encompass trunk selective activities (trunk flexion, extension and rotation and elevation of the pelvis) and functional activities aiming transfers and adequate repositioning of the trunk (sit to supine, supine to sit, sitting posture, trunk extension in sitting, sitting balance and standing balance), with the indication of possible compensatory strategies.

The difficulty found during use of this scale was to understand the elevation of the pelvis item, whereas this is a movement rarely performed along the day and it is severely impaired due to the muscle weakness in these patients. The

study limitations were: small sample, gender imbalance and the different levels of impairment after SCI. The findings limit generalization to ambulatory patients.

The Brazilian version in Portuguese of Thoracic-Lumbar control scale for SCI has proved to be valid and effective to quantify the trunk-control deficits. Moreover, the scale was easy to apply and showed excellent inter-rater and intra-rater reliability, ensuring the replicability by other professionals. The scale presented a high correlation with the ASIA sensory score, revealing the relationship between the sensory and functional capacity of trunk. Furthermore, we suggest the development of treatment protocols directed to trunk dysfunction in post-SCI and outcomes follow-up with specific scales. The manual scale is available through authors: karolbpastre@hotmail.com.

Conflict of interest

The authors declare no conflict of interest.

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