Construct Validity and Clinical Utility of the Argentine Version of the Trunk Control Test in Subjects With Spinal Cord Injury Sequelae

Gerardo Candoni[1], Elizabeth Coronel[2], Marcos Valdez[1] and Federico Scaminaci-Russo[3]

1. Hospital de Rehabilitación Manuel Rocca. Argentina
2. Servicio de Kinesiología, Hospital "Prof. Dr. Juan P. Garrahan". Argentina
3. Profesional independiente. Argentina

ABSTRACT

Introduction: Individuals with adequate trunk control have a greater likelihood of independently performing activities of daily living, regardless of the level or severity of their injury. However, there are currently no valid and reliable tools in Argentina to assess trunk control in this population. This study aimed to determine the construct validity and clinical utility of the Argentine version of the Trunk Control Test (TCT).

Materials and Methods: Participants were enrolled through non-probabilistic convenience sampling until the target sample size was reached or up to two years after approval. The required sample size was 50 participants. Inclusion criteria were: individuals aged 15 to 75 years with a diagnosis of spinal cord injury. Exclusion criteria included: other neurological diagnoses, sensory organ impairments, conditions preventing test administration, and/or psychiatric disorders.

Results: The sample consisted of 50 individuals, with the median total TCT score approaching the maximum value. Regarding hypothesis testing for construct validity, six moderate, one weak, and four low correlations were found; no differences were observed between known groups.

Conclusion: The Argentine version of the TCT showed a moderate correlation with independence and gait. It does not discriminate between individuals with paraplegia or tetraplegia, or between those with complete and incomplete injuries. The administration time was 8 minutes.

Keywords: injury, reproducibility of results, health outcomes research, rehabilitation.

Validez de constructo y utilidad clínica del *Trunk* control test versión argentina en sujetos con secuela de lesión medular espinal

RESUMEN

Introducción: aquellas personas con buen control de tronco poseen una mayor probabilidad de realizar por sí mismas actividades de la vida diaria independientemente del nivel de lesión y del grado de lesión; pero hasta el momento no contamos en la Argentina con herramientas válidas y fiables que evalúen el control de tronco en estos sujetos. El objetivo fue establecer la validez de constructo y utilidad clínica de la versión argentina del *Trunk Control Test* (TCT).

Materiales y métodos: los sujetos fueron ingresados mediante un muestreo no probabilístico por conveniencia hasta alcanzar el tamaño muestral o hasta 2 años de aprobado. El tamaño muestral requerido fue de 50 sujetos. Se incluyeron sujetos que poseyeran entre 15 años a 75 años y tuvieran diagnóstico de lesión medular espinal. Se excluyeron sujetos que poseyeran: otro diagnóstico neurológico, alteración

Author for correspondence: gerardocandoni@gmail.com, Candoni G.

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en los órganos sensoriales, condiciones que impidieran la realización de la prueba y/o enfermedad psiquiátrica.
Resultados: la muestra se compuso de 50 sujetos en los cuales la mediana del puntaje total del TCT fue cercana a su valor máximo. En cuanto a la prueba de hipótesis para la validez de constructo se hallaron 6 correlaciones moderadas, 1 escasa y 4 débiles, mientras que para grupos conocidos no se encontraron diferencias.
Conclusión: la versión argentina del TCT mostró una correlación moderada con la independencia y la marcha, no discrimina entre personas con paraplejía y tetraplejía, y/o personas con lesiones completas e incompletas. El tiempo de administración fue de 8 minutos.

Palabras clave: lesión, reproductibilidad de los resultados, investigación sobre los resultados de salud, rehabilitación.

INTRODUCTION

Spinal cord injury (SCI) refers to damage to the spinal cord due to trauma or degenerative disease and can cause caudal motor, sensory, or autonomic dysfunction at the level of injury[1,2]. Worldwide, between 250,000 and 500,000 people suffer from SCI each year[1,2]. In Argentina, Peralta et al. described a population of subjects with SCI[3]. Male gender, traumatic etiology, and traffic accidents were the most frequent causes. Thoracic neurological level (NL) and injury rated as A by ASIA Impairment Scale (AIS) were the most prevalent[3]. Any upper limb reaching task will result in a challenge for seated-standing postural control in individuals with partial or complete trunk and arm motor deficits; however, subjects with low paraplegia (thoracic NL 10-12) achieve a greater distance in their reaches due to the preservation of the spinal extensor muscles[4]. Motor performance may be affected by weakness and deterioration of somatosensory information, resulting in impaired postural stability, even in a sitting position5. These subjects need a comfortable and stable posture to perform activities of daily living (ADLs) while seated[6]. Trunk control is the ability to control the trunk by influencing sitting balance7. Subjects with SCI, who have good trunk control, are more likely to achieve the ability to perform ADLs without the assistance of another person, irrespective of NL and degree of AIS8.

Faced with the need to evaluate this construct, we found two tools designed for this purpose: the Trunk Control Test for subjects with SCI (TCT-SCI) and the Trunk Assessment Scale for the same population (TASS). The former is considered the gold standard for assessing sitting balance performance[9,10] without subsequent support. Additionally, this test allows for assessing activities, body structures, and functions, consistent with the conceptual framework of the International Classification of Functioning, Disability, and Health (ICF)11. The TCT-LME was developed by Quinzaños et al. in Mexico in 2014 and proved valid, reliable, and of good clinical applicability in subjects with SCI, regardless of the type and level of injury[12]. On the other hand, it also showed that it predicts gait and independence at one year of evolution[8].

However, to date, we do not know if it is a valid and helpful tool to assess trunk control in the Argentine population with SCI sequelae. Therefore, the authors of this study considered that validation of the test would facilitate the selection of treatment strategies aimed at achieving the highest level of functioning in people with SCI. Such validation was carried out based on the cross-cultural adaptation of the TCT-LME[13].

Research question

Is the Argentine version of the TCT valid and useful in subjects with SCI sequelae?

Answering this question would allow us to determine whether the Argentine version correlates positively with walking ability and functional independence and whether its application is complex. It would also let us know the differentiation between individuals with paraplegia and tetraplegia and between complete and incomplete SCI, in order to propose future treatment strategies based on the body impairments and/or limitations in the activities evaluated.

Objective

The primary objective of the present study was to establish the construct validity and clinical utility of the TCT-SCI scale for spinal cord-injured subjects in Argentina.

The secondary objective was to confirm or reject the correlation hypotheses of the tool, which are presented below.

Hypothesis

1. Higher TCT-SCI scores positively correlate with the ability to walk indoors for 10 meters and with functional independence.

2. Subjects with paraplegia have higher scores than subjects with tetraplegia.

3. Subjects with complete SCI have lower scores than those with incomplete SCI.

MATERIALS AND METHODS

The protocol of the present study was approved by the Ethics Committee of the Institute of Psycho-physical Rehabilitation (protocol number: 12751); it was conducted according to the guidelines established by the modified declaration of Helsinki.

The development of the following protocol complied with the recommendations of the COSMIN guide (COnsensus-based Standards for the selection of health status Measurement INstruments)[14] and we followed the COSMIN recommendations[15] for its report.

Design

The design of this study was observational, analytical, and cross-sectional.

Participants

We included subjects who:

1. Were between 15 and 75 years of age.
2. Had a diagnosis of SCI, regardless of the type of SCI, its NL, or the time of evolution[12].
3. Agreed to sign the informed consent form (Appendix A).

(Appendix A).

We excluded subjects who had:

1. Another neurological diagnosis[12].
2. Impaired sensory organs (i.e. deafness, blindness)[12].
3. Orthopedic, metabolic, or cardio-vascular conditions that would prevent performance of the test[12].
4. Psychiatric illness as it may hinder the patient's collaboration and influence the functional level[16].

Data collection process

Clinical-demographic data:

- Age
- Sex
- Type of injury
- Time since injury
-NLI (Neurological Level of Injury)
- Etiology
-- Tetraplegia/Paraplegia

Primary outcome variable

- Trunk control

Secondary outcome variable

- Gait
- Functional independence

Administration of the TCT

Validation and clinical utility procedure

Subjects were admitted to the study via nonprobability convenience sampling. We recruited those individuals who were discharged during the 3 years before study approval from the kinesiology division of the Manuel Rocca Rehabilitation Hospital and those who entered the division from the time of study approval until reaching the sample size or until 2 years after study protocol approval.

A kinesiologist applied the eligibility criteria and, in the case of subjects admitted to the study, conducted the initial evaluation himself. It consisted of recording the clinical-demographic data (extracted from the medical records) and the primary and secondary outcome variables, which were completed on the "A1 registration form" in paper format (Appendix B).

We evaluated with the Walking Index for Spinal Cord Injury (WISCI) II scale and the Spinal Cord Independence Measure (SCIM) version III after randomization, which we performed through simple random sampling using a table of computer-generated random numbers by a person unrelated to the study; we used this procedure to avoid the fatigue of the subjects included and to eliminate a possible bias in the last evaluation. The assignment was enclosed in sealed, opaque envelopes and was performed by the participant. The WISCI II scale was scored according to the guide proposed by Ditunno et. al[17] and the SCIM version III scale, with direct observation of the subject's performance; on the other hand, when the scoring of the items by direct observation was not possible (for example, bowel habits, evacuation or wheelchair/floor transfers), it was reported by the subject-participant[18]. We validated both scales in subjects with SCI[17,19]. However, we did not adapt them cross-culturally to Argentinean Spanish.

For the usefulness of the questionnaire, evaluator A recorded the total administration time of the TCT with a stopwatch, starting from the explanation of the tool to the completion of the scoring form.[20]

All the evaluators were kinesiology residents/concurrent residents of the institution. In addition, they underwent 3 hours of training before taking the tool and were provided with instructions with standardized indications (Appendix C) for the procedure of the evaluations to reduce possible biases.

Hypothesis testing for construct validity

The degree to which scores on an instrument are consistent with hypotheses (e.g., about internal relationships, relationships with other instruments, or differences between groups) assuming that the instrument validly measures the construct[14]. It is to be expected that subjects with a paraplegic injury sequela would perform better than those with a tetraplegic lesion and that subjects with complete SCI sequela, i.e., AIS A would score lower on the scale than those with incomplete SCI, i.e., AIS B, C, and D. The correlation was considered weak or null when a value between 0 and 0.25, weak between 0.26 and 0.5, moderate to strong between 0.51 and 0.75, and strong to perfect between 0.75 and 1[21].

Clinical utility

It refers to the property that provides information on whether the scale is easy to apply and process[22]. For this purpose, the total evaluation time was recorded.

Sample size

We estimated the sample size using the rule of thumb proposed by Terwee et al. of 50 subjects[23].

Lost data

To prevent data loss the study authors had training, and a procedure manual was drawn.

Statistical analysis

We described quantitative variables by expressing the mean and standard deviation when their distribution was parametric or median and interquartile range when their distribution was nonparametric.

We expressed categorical variables as proportions with the absolute values corresponding to each category.

For construct validity, we used Pearson's correlation coefficient if its assumptions were met; otherwise, we used Spearman's correlation coefficient.

For the validity of known groups, we used the t-test, provided its assumptions were met; otherwise, we used the Mann-Whitney test. For data analysis, we used the Stata program, version 15® (StataCorp, College Station, TX, USA).

RESULTS

Missing data

No missing data were recorded.

Characteristics of the participants

After applying the eligibility criteria, the sample consisted of 50 subjects. Their flow diagram appears in Figure 1. The clinical-demographic characteristics of the subjects included are shown in Table 1.

The sample consisted mainly of male subjects. Regarding the level of injury, the lower cervical level was the most prevalent, followed by the lower thoracic level. Regarding AIS classification, most participants suffered a complete SCI A, followed by incomplete SCI D, C, and the last one, B.

The median total score of the TCT test was close to its maximum value (a good trunk control), while in its three sections, only in the dynamic balance category, the median did not reach the maximum subscore.

Most subjects were unable to stand or walk with assistance and did not use a walking aid (APM) or orthosis.

Regarding clinical usefulness, the test administration in the sample obtained a median of 8 minutes and an interquartile range of [6-8].

Hypothesis test for construct validity

The following correlations were moderate: between the TCT total score and the WISCI II (Spearman's rho = 0.60; p = 0.01), between the TCT dynamic balance subscore and the WISCI II score (Spearman's rho = 0.67; p = 0.01), between the TCT total score and the SCIM total score (Spearman's rho = 0.67; p = 0.01), between the TCT total score and the SCIM self-care item (Spearman's rho = 0.53; p= 0.01), between the TCT total score and the SCIM mobility item (Spearman's rho = 0.68; p= 0.01) and between the SCIM mobility sub-item (Spearman's rho = 0.68; p= 0.01) and between the SCIM mobility sub-item (Spearman's rho = 0.01; p= 0.01). 01) and between the dynamic balance subscore of the TCT and the breathing and sphincter management subsection of the SCIM (Spearman's rho = 0.56; p= 0.01).

Conversely, we found a weak correlation between the static balance subscore and the WISCI II score (Spearman's rho = 0.19; p = 0.15).

Finally, the correlations mentioned below were weak: between the dynamic balance subscore for performing upper limb activities of the TCT and the WISCI II score (Spearman's rho = 0.40; p = 0.02), between the total score of the TCT and the breathing and sphincter management section of the SCIM (Spearman's rho = 0.47; p = 0.01), between the static balance subscore of the TCT and the breathing and sphincter management section of the SCIM (Spearman's rho = 0.26; p = 0.05) and between the dynamic balance subscore and the breathing and sphincter management section of the SCIM (Spearman's rho = 0.27; p = 0.04).

Hypothesis testing for known groups

The Mann-Whitney test shows that no difference was found between the total TCT score in subjects with tetraplegia and with paraplegia (Z = 0.67, p = 0.50), as well as the total TCT score obtained in subjects with a spinal cord injury classified as complete and those with an incomplete injury (Z = -1.93, p = 0.05).

DISCUSSION

We validated the Trunk control test assessment tool in subjects with SCI sequelae, evaluating its construct validity and clinical usefulness. Psychometric properties are helpful to know how valid the tool is and the time of application of the test.

Hypothesis testing for construct validity enables comparison of one test with others or with specific groups of the population evaluated; this is why it is so important to assess this property. The administration time makes it possible to know how quickly the trunk control of a subject with SCI sequelae can be evaluated, which enables us to include this evaluation as a commonly used test.

As for the clinical-demographic characteristics of the subjects, we can say that, as reported by Quinzaños et al.[12], most of them were men, middle-aged; however, the time of evolution was different since the researchers recorded an average of six months, while we found an average of 26 months.

Patients most frequently presented a level of cervical injury and a complete classification, also similar to the finding of Quinzaños et al.[12].

Construct validity

Evidence of psychometric property

The correlation between the TCT Argentine version and the WISCI II was moderate. The strength of association between the different domains of the TCT

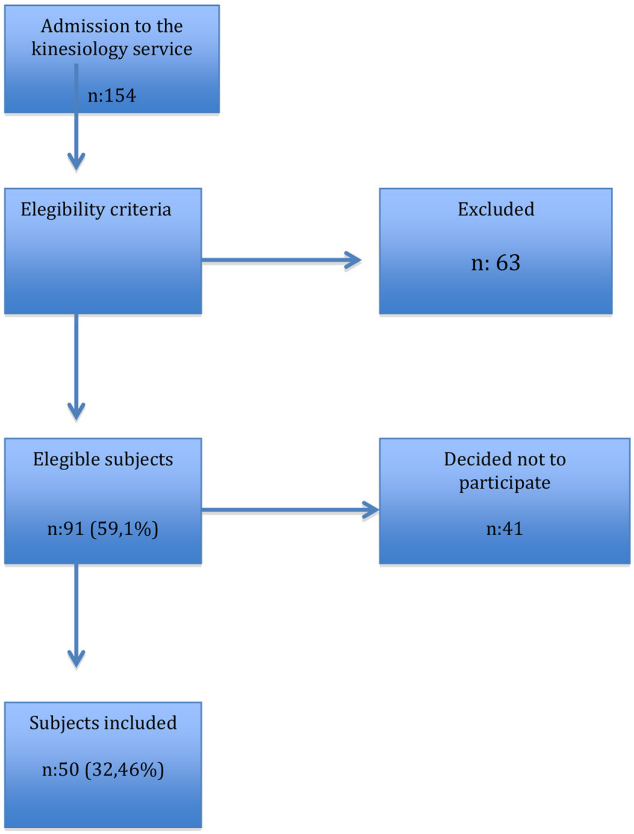

Figura 1. Flow chart

and the SCIM gradually decreased. Similar was the case with the WISCI II and the various domains of the TCT.

Practical relevance

That may explain why proper trunk control may not necessarily define whether or not the patient will achieve some form of gait. The highest correlation was with the mobility section of the SCIM III (r = 0.68). Quinzaños et al.12, when comparing the TCT with the SCIM obtained better results when compared to our work. While these are similar assessment tools, they are different versions, and it is worth noting that the section of real relevance is the mobility one because it will define whether the subject will be wholly dependent on the wheelchair or may have some form of mobility with orthotic elements and/or gait aids (APM, from Spanish *ayuda para la marcha*).

Another aspect to emphasize is that -although our initial hypothesis was that subjects with tetraplegia have worse test scores than subjects with paraplegia- this was not confirmed. The same was true for complete SCI versus incomplete SCI. Such findings may be because the subjects were in a chronic period, and one could think that they had already acquired the compensatory strategies to make up for the lack of musculature.

Clinical Utility

The administration time of the tool was 8 minutes, and this is the first time that the clinical utility is rated for this test. Schwarz[24] describes that clinical utility includes several elements, one of which is application time. The fact that an assessment tool requires little time for its application to subjects is an excellent property.

Future studies

Implications for research

Validating the psychometric properties of the assessment tools we use daily is necessary to know if they are useful for the population under study.

Implications for practice

The specific items of an assessment tool allow for a correct assessment of patients, and, for daily practice,

Table 1

Variables	n = 55
Mean Age (DS), years	39,2 (15,71)
Female sex n (%)	15 (30)
Median time since injury (IQR), months	28 (14-65)
Traumatic etiology n (%)	31 (62)
Level of injury n (%)	
High cervical (C1–C3)	1 (2)
Low cervical (C4–C8)	21 (42)
Upper thoracic (T1–T5)	4 (8)
Lower thoracic (T6–T12)	19 (38)
Sacrolumbar	5 (10)
AIS n (%)	
A	20 (40)
B	6 (12)
C	10 (20)
D	14 (28)
Tetraplegia n (%)	22 (44)
TCT total score, median (IQR), points	20 (16-21)
TCT static balance, median (IQR), points	6 (5-6)
TCT dynamic balance, median (IQR), points	5 (4-5)
TCT dynamic balance upper limbs, median (IQR), points	12 (10-12)
WISCI II n (%)	
0	29 (58)
1	2 (4)
3	1 (2)
6	1 (2)
9	2 (4)
12	1 (2)
13	2 (4)
14	1 (2)
19	2 (4)
20	9 (18)
Use of mobility aids (APM) n (%)	11 (22)
Use of orthoses n (%)	7 (14)
SCIM total score, mean (±SD), points	61,8 (22,31)
SCIM self-care, median (IQR), points	20 (15-20)
SCIM respiration and sphincter management, mean (±SD), points	27,31 (10,3)

IQR: interquartile range; SD: standard deviation; TCT: Trunk control test; AIS: ASIA impairment scale; c: cervical; t: torácico; UL: upper limbs; WISCI: Walking Index for Spinal Cord Injury; APM: Ambulation aid (from Spanish ayuda para la marcha); SCIM: Spinal Cord Independence Measure.

the time of application and feasibility are crucial characteristics of an assessment tool when applied. The daily use of these tools and frequent measurements to determine the progress of the subject's rehabilitation determine the kinesthetic approach and achieve an approach oriented to obtain maximum independence.

Strengths and weaknesses

The study's main strength was that, to our knowledge, it is the first Argentine article to explore the psychometric properties of an assessment tool that measures trunk control in subjects with SCI.

In addition, the sample (n = 50), which is considered adequate according to the recommendations provided by COSMIN, stands out. The sample size also decreased due to the coronavirus pandemic 2019 (COVID-19), coupled with the fear in patients and family members about going to a hospital in that context. Data collection was conducted at the same hospital. In addition, the subjects were mainly in a chronic or subacute stage, so we cannot extrapolate these findings to subjects in the acute stage. Finally, it is worth mentioning that we performed the validation with tools that were not adapted cross-culturally to Argentinean Spanish.

Changes in the test

In a future study, correlation should be studied with subjects included in an acute stage and with an AIS E level.

CONCLUSION

This study established the construct validity of the Argentine version of the TCT and its administration time. A total of 50 subjects were included. Trunk control measured by the TCT showed a moderate correlation with independence and gait. However, the strength of association decreased when correlated with the TCT and SCIM subdomains. The TCT scale does not allow differentiation between persons with complete or incomplete SCIM nor between tetraplegia and paraplegia. The administration time was 8 minutes.

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Authors' contributions: Conceptualization, Methodology, Validation Writing (GC), Conceptualization, Methodology, Visualization, Review (EC, MV, RSR).

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REFERENCES

1. World Health Organization. Spinal cord injury [Internet]. Geneva: WHO; 2024 Apr 16 [citado2024 sept 30]. Disponible en: https://www.who.int/news-room/fact-sheets/detail/spinal-cord-injury.
2. Furlan JC, Noonan V, Singh A, et al. Assessment of impairment in patients with acute traumatic spinal cord injury: a systematic review of the literature. J Neurotrauma. 2011;28(8):1445-1477. https://doi.org/10.1089/neu.2009.1152.
3. Peralta FG, Garcete LA, Drault Boedo ME. Características clínico-demográficas e impacto funcional de las úlceras por presión en sujetos con lesión medular en un centro de referencia. Estudio transversal y retrospectivo. Neurol Arg. 2018;10(1):24-29. https://doi.org/10.1016/j.neuarg.2017.07.002.
4. Lynch SM, Leahy P, Barker SP. Reliability of measurements obtained with a modified functional reach test in subjects with spinal cord injury. Phys Ther. 1998;78(2):128-133. https://doi.org/10.1093/ptj/78.2.128.
5. Chen CL, Yeung KT, Bih LI, et al. The relationship between sitting stability and functional performance in patients with paraplegia. Arch Phys Med Rehabil. 2003;84(9):1276-1281. https://doi.org/10.1016/s0003-9993(03)00200-4.
6. Shirado O, Kawase M, Minami A, et al. Quantitative evaluation of long sitting in paraplegic patients with spinal cord injury. Arch Phys Med Rehabil. 2004;85(8):1251-1256. https://doi.org/10.1016/j.apmr.2003.09.014.
7. Milosevic M, Masani K, Kuipers MJ, et al. Trunk control impairment is responsible for postural instability during quiet sitting in individuals with cervical spinal cord injury. Clin Biomech (Bristol). 2015;30(5):507-512. https://doi.org/10.1016/j.clinbiomech.2015.03.002.
8. Quinzaños-Fresnedo J, Fratini-Escobar PC, Almaguer-Benavides KM, et al. Prognostic validity of a clinical trunk control test for independence and walking in individuals with spinal cord injury. J Spinal Cord Med. 2020;43(3):331-338. https://doi.oeg/10.1080/10790268.2018.1518124.
9. Abou L, de Freitas GR, Palandi J, et al. Clinical instruments for measuring unsupported sitting balance in subjects with spinal cord injury: a systematic review. Top Spinal Cord Inj Rehabil. 2018;24(2):177-193. https://doi.org/10.1310/sci17-00027.
10. Sato H, Miyata K, Yoshikawa K, et al. Validity of the trunk assessment scale for spinal cord injury (TASS) and the trunk control test in individuals with spinal cord injury. J Spinal Cord Med. 2024;47(6):944-951. https://doi.org/10.1080/10790268.2023.2228583.
11. World Health Organization, Pan American Health Organization. Perspective of the components of the ICF. En: World Health Organization, Pan American Health Organization. ICF: International classification of functioning , disability and health. Geneva: WHO; 2001. p. 11-19.
12. Quinzaños J, Villa AR, Flores AA, et al. Proposal and validation of a clinical trunk control test in individuals with spinal cord injury. Spinal Cord. 2014;52(6):449-454. https://doi.org/10.1038/sc.2014.34.
13. Candoni G, Tomadín R, Valdéz M, et al. Adaptación transcultural y fiabilidad del trunk control test versión argentina en sujetos con secuela de lesión medular espinal. Rev Fac Cien Med Univ Nac Córdoba. 2024;81(3):552-569. https://doi.org/10.31053/1853.0605.v81.n3.42020.
14. Mokkink LB, Terwee CB, Patrick DL, et al. The COSMIN checklist for assessing the methodological quality of studies on measurement properties of health status measurement instruments: an international Delphi study. Qual Life Res. 2010;19(4):539-549. https://doi.org/10.1007/s11136-010-9606-8.
15. Gagnier JJ, Lai J, Mokkink LB, et al. COSMIN reporting guideline for studies on measurement properties of patient-reported outcome measures. Qual Life Res. 2021;30(8):2197-2218. https://doi.org/10.1007/s11136-021-02822-4.
16. Zarco-Periñan MJ, Barrera-Chacón MJ, García-Obrero I, et al. Development of the Spanish version of the Spinal Cord Independence Measure version III: cross-cultural adaptation and reliability and validity

study. Disabil Rehabil. 2014;36(19):1644-1651. https://doi.org/10.3109/09638288.2013.864713.
17. Ditunno JF Jr, Ditunno PL, Scivoletto G, et al. The Walking Index for Spinal Cord Injury (WISCI/WISCI II): nature, metric properties, use and misuse. Spinal Cord. 2013;51(5):346-355. https://doi.org/10.1038/sc.2013.9.
18. Catz A, Itzkovich M, Tesio L, et al. A multicenter international study on the Spinal Cord Independence Measure, version III: Rasch psychometric validation. Spinal Cord. 2007;45(4):275-291. https://doi.org/10.1038/sj.sc.3101960.
19. Cho DY, Shin HI, Kim HR, et al. Validity of the Korean version of the Spinal Cord Independence Measure III. Am J Phys Med Rehabil. 2020;99(4):305-309. https://doi.org/10.1097/PHM.0000000000001327.
20, Módica M, Ostolaza M, Abudarham J, et al. Validación del Timed up and go test como predictor de riesgo de caídas en sujetos con artritis reumatoide. Parte I: confiabilidad y aplicabilidad clínica. Rehabilitación. 2017;51(4):226-233. https://doi.org/10.1016/j.rh.2017.07.001.
21, Pendás LC, Ortega MM, Ortega RM, et al. The coefficient of correlation of spearman's ranks characterization. Havana J Med Sci. 2009;8(2).
22, Sánchez R, Echeverry J. Validación de escalas de medición en salud. Rev Salud Pública (Bogotá). 2004;6(3):302-318.
23. Terwee CB, Bot SD, de Boer MR, et al. Quality criteria were proposed for measurement properties of health status questionnaires. J Clin Epidemiol. 2007;60(1):34-42. https://doi.org/10.1016/j.jclinepi.2006.03.012.
24. Smart A. A multi-dimensional model of clinical utility. Int J Qual Health Care. 2006;18(5):377-382. https://doi.org/10.1093/intqhc/mzl034.

APPENDIX A
Patient Information Sheet and Informed Consent

This information and consent form describes a research study in which the physiotherapists involved are inviting you to participate. Please read this form carefully and take the time you need to discuss it with family members, your physiotherapist, or other people close to you. You may ask the research team any questions you have; they will explain anything you do not understand.

You have been invited to voluntarily participate in this study, which aims to investigate the cross-cultural adaptation of the Trunk Control Test (TCT).

Your participation is voluntary and does not replace your regular physiotherapy care. You may refuse to participate or withdraw from the study at any time without penalty or loss of benefits.

This information sheet outlines the objectives, procedures, risks, and benefits of the study.

Objective: To perform a cross-cultural adaptation of the Trunk Control Test (TCT) into Argentine Spanish, based on the Mexican version of the TCT, and to evaluate its psychometric properties for use in individuals with spinal cord injury sequelae.

If you agree to participate, we will administer the tool to you.

Your participation will provide information to determine whether the cross-culturally adapted version into Argentine Spanish has the same psychometric properties as the original tool, the degree of correlation and internal consistency between its items, whether it correlates positively with walking ability and functional independence, and whether its administration is complex or costly. Differentiating between these levels will allow future treatment strategies to be proposed based on bodily impairments and/or activity limitations identified through the assessment.

This study will not involve any cost to you or your medical coverage, if applicable. You will not be paid for participating in this study.

Your identity and physiotherapy-related medical information will be kept confidential as required by Law 26.529. The information you provide will be transferred to a database to be analyzed and/or published for scientific and/or academic purposes, and you or your family members may access it if desired. Without your consent, your data cannot be used, and therefore, you will not be able to participate.

Confidentiality will be maintained throughout the research process by the investigators and review committees, as established by Law 25.326.

If you have any questions about your rights as a participant in this research, are unable to resolve concerns with the study physiotherapist, or have general inquiries about what it means to take part in a research study, you may contact the ethics committees.

The committee members will always prioritize your autonomy and the confidentiality of your information. The study physiotherapist/investigator will be informed of any communication between you and the committee.

These committees are designed to help ensure that the rights of research participants are protected.

Consent Statement

I have read the information sheet provided for the study titled: *"Cross-cultural Adaptation, reliability, validity, and clinical utility of the Trunk Control Test in individuals with spinal cord injury sequelae. Validation study protocol."*

I had the opportunity to ask questions and discuss the study. All my questions were fully answered. I have received a signed and dated copy of this information and consent form, and I understand that the original will be included in the physiotherapy records for the study.

I understand that my participation is entirely voluntary and that I can withdraw at any time without having to express reasons and without affecting my physiotherapy care or any of the rights granted to me under Argentine law.

I freely consent to take part in this study, as outlined in the information provided.

I also understand that data from my medical history may be reviewed by auditors, members of the Research Ethics Committee, or regulatory authorities in locations where my participation in the study is relevant.

I hereby give my consent to participate in this study.

Patient signature.....Date.....

Patient name (in print).....

ID type and number.....

IN COMPLIANCE WITH PROVISION 06/2008 ISSUED BY THE NATIONAL DIRECTORATE FOR THE PROTECTION OF PERSONAL DATA, YOU MAY BE CONTACTED TO PROVIDE INFORMATION ABOUT THE INFORMED CONSENT PROCESS.

NAME OF THE PROFESSIONAL EXPLAINING THE INFORMED CONSENT (IN BLOCK LETTERS).

.....

SIGNATURE OF THE PERSON EXPLAINING THE INFORMED CONSENT

.....

DATE.....

I HEREBY CERTIFY THAT I HAVE DISCUSSED THIS STUDY WITH THE ABOVE-MENTIONED PATIENT.

Signature and printed name of the investigator .....

APÉNDIX C

**Date of assessment:

Evaluator:

Registration Form A1

ID: _____

Date of birth: _____

Sex: F/M

Duration of condition: _____

Etiology: Traumatic – Non-traumatic

Level of injury: _____

AIS: A - B - C - D - E

Tetraplegia – Paraplegia:

Assessment**

Assessment

		Sub-item score	Total score	Items not understood by the participant	Total administration time
Trunk control test (TCT)	1)				
	2)				
	3)				

	Score	Walking aid	Orthosis	Physical assistance
Walking Index for SpinalCord Injury II(WISCI II)				

Observations

	Sub-item score	*Total score*
Spinal Cord Independence Measure versión (SCIM III)		

Observations

APÉNDIX C
ASSESSMENT INSTRUCTIONS

Before beginning, confirm that you have all the materials necessary to carry out the assessment:

- Printed questionnaire
- Pen
- Stopwatch
- Examination table measuring 2.32 meters by 2.32 meters by 0.50 meters
- Cardboard
- Measuring tape
- Goniometer
- Flat, smooth, non-slip surface of 10 meters in length
- Parallel bars
- Cup
- Towel
- Comb
- Wheelchair
- Stairs with 3 steps
- Registration form

Since the patient was admitted to the Physical Therapy Division, the evaluating physical therapist applied the following eligibility criteria:

Inclusion criteria

1 Aged between 15 and 75 years
2 Diagnosed with spinal cord injury (SCI) regardless of its etiology, neurological level (NL), or time since injury
3 Willing to sign the informed consent

Exclusion criteria

1. Presence of another neurological diagnosis
2. Sensory organ impairments
3. Orthopedic, metabolic, or cardiovascular conditions that prevent the test from being performed

Procedure

First, the evaluator recorded the patient's personal information, followed by data related to the injury (SCI).
Once the preliminary steps were completed, the trunk control test was administered.
Subsequently, the patient was assessed using the **Walking Index for Spinal Cord Injury II (WISCI II)** and the Spinal **Cord Independence Measure version III (SCIM III)**. The order of evaluation was determined by simple random sampling using a table of computer-generated random numbers prepared by a person not involved in the study.

Assessment Description

The Argentine version of the TCT is attached since the one included in Appendix C is the original Mexican version.

Starting position: The subject to be assessed must be seated with their feet resting on a support surface. Hips and knees flexed at 90°, trunk unsupported, and hands resting on the thighs. The subject performs the test three times. The best attempt is recorded. The examiner may provide feedback during the tests. Verbal or non-verbal instructions (demonstration) may be given.

Ítem	Task description	Score description	Score		
Equilibrio estático					
1	Maintain the starting position for 10 seconds.	Falls	0	0	0
		Needs to support with upper limbs to avoid falling	1	1	1
		Maintains position for 10 sec	2	2	2
2	Cross the right lower limb over the left for 10 seconds.	Falls	0	0	0
		Needs to support with upper limbs to avoid falling	1	1	1
		Maintains position for 10 sec	2	2	2
3	Same as activity 2 but with the left lower limb, for 10 seconds	Falls	0	0	0
		Needs to support with upper limbs to avoid falling	1	1	1
		Maintains position for 10 sec	2	2	2
Static balance					
4	Try to touch the feet with both upper limbs	Does not perform	0		
		Requires assistance from one upper limb	1		
		Touches feet with both hands	2		
5	Lie down in the supine position and return to the starting position. Verbal command: "Lie on your back as if going to sleep, preferably without using your arms."	Does not perform	0		
		Requires assistance from one upper limb	1		
		Touches feet with both hands	2		
6	Turn to the right..	Does not perform	0	0	
		Performs	1	1	
7	Turn to th left.	Does not perform	0	0	
		Performs	1	1	

Dynamic balance for performing upper limb activities
From the starting position, one upper limb is maintained with 90° shoulder flexion, full elbow extension, forearm pronated, wrist in neutral, and fingers extended. A target made of cardboard shaped as a 10 cm diameter circle is used

8	Place the target at midline level at the height of the glenohumeral joint, 10 cm from the fingertips, and ask the participant to touch it with the right hand. Verbal command: "Raise your hand to shoulder level with your fingers extended, touch the target and return."	Does not perform Requires support from the contralateral limb Performs without support	0 1 2
9	Same as activity 8 but with the left hand.	Does not perform Requires support from the contralateral limb Performs without support	0 1 2
10	Place the target at 45° to the right of the starting position and ask the participant to touch it with the right hand. Verbal command: "Raise your hand to shoulder level with your fingers extended, follow the direction I'm showing and touch the target." Provide a physical demonstration of the direction.	Does not perform Requires support from the contralateral limb Performs without support	0 1 2
11	Same as activity 10, with the target to the left side and using the left hand.	Does not perform Requires support from the contralateral limb Performs without support	0 1 2
12	Place the target at 45° to the left of the starting position and ask the participant to touch it with the right hand.	Does not perform Requires support from the contralateral limb Performs without support	0 1 2
13	Same as activity 12, with the target to the right side and ask the participant to touch it with the left hand.	Does not perform Requires support from the contralateral limb Performs without support	0 1 2
		Total score	

The minimum score is 0 when the patient is unable to perform any task, and the maximum is 24.

Walking Index for Spinal Cord Injury II (WISCI II)

Subjects with SCI capable of standing and walking in parallel bars were eligible for evaluation. Individuals must walk at their own pace. Any physical contact with the subject, including "contact guarding," was considered physical assistance; supervision without actual contact should not be considered physical assistance.

First, the therapist interviewed the subject to determine the self-selected WISCI II level, defined as the level at which the subject walks in the community or, if not a community ambulator, at home. The therapist confirmed that the participant could walk 10 meters. This is the self-selected level, which may not be the maximum.

To determine the maximum WISCI II level, the therapist advanced the subject sequentially, starting one level above the self-selected level, until the subject failed or was considered unsafe for the next level. If the therapist believed the subject could walk three or more levels above their self-selected WISCI II level to avoid fatigue the subject could attempt a higher level directly. However, if the subject failed, the first omitted level was tested, and advancement continued until failure. Use of orthoses was permitted.

- A flat, smooth, non-slip 10-meter surface was used, in a straight path.
- Subjects walked at their own pace, and the 10 meters were not timed.
- Descriptors must indicate whether long leg braces had locked or unlocked knees.
- Clothing must not cover orthotic devices so therapists can visually confirm their presence.

The following definitions were used to standardize terms in each item:

- Any physical contact with the subject was considered physical assistance.
- Supervision was not considered physical assistance.
- One or two orthoses: short or long.
- Without orthoses.
- Walker: conventional rigid walker without wheels.
- Crutches: axillary or Canadian.
- Canes: conventional Canadian canes.

0	Unable to stand and/or perform assisted ambulation
1	Walks in parallel bars, with orthoses, assisted by 2 people, less than 10 meters
2	Walks in parallel bars, with orthoses, assisted by 2 people, 10 meters
8	Walks with a walker, without orthoses, assisted by 1 person, 10 meters
9	Walks with a walker, with orthoses, unassisted, 10 meters
10	Walks with 1 cane, crutch, or Canadian crutch, with orthoses, assisted by 1 person, 10 meters
11	Walks with 2 crutches or Canadian crutches, without orthoses, assisted by 1 person, 10 meters
12	Walks with 2 crutches or Canadian crutches, with orthoses, unassisted, 10 meters
13	Walks with a walker, without orthoses, unassisted, 10 meters
14	Walks with 1 cane, crutch, or Canadian crutch, without orthoses, assisted by 1 person, 10 meters
15	Walks with 1 cane, crutch, or Canadian crutch, with orthoses, unassisted, 10 meters
16	Walks with 2 crutches or Canadian crutches, without orthoses, unassisted, 10 meters
17	Walks without devices, without orthoses, assisted by 1 person, 10 meters
18	Walks without devices, with orthoses, unassisted, 10 meters
19	Walks with 1 cane, crutch, or Canadian crutch, without orthoses, unassisted, 10 meters
20	Walks without device, without orthoses, unassisted, 10 meters

Spinal Cord Independence Measure version III (SCIM III)

Scoring was based on direct observation of the subject's performance; when direct observation was not practical (e.g., bowel habits, evacuation, or transfers involving wheelchair/floor), the subject's self-report was used. The minimum score is 0 points and the maximum is 100 points.

PERSONAL CARE

1. Feeding

(Cutting, opening containers, serving, bringing food to mouth, holding a cup with liquid)

0. Requires parenteral nutrition, gastrostomy, or total assistance for oral feeding

1. Requires partial help to eat and/or drink, or to use assistive devices

2. Eats independently; needs assistive devices or assistance only for cutting food and/or serving and/or opening containers

3. Eats and drinks independently; no assistance or assistive devices required

2. Bathing

(Soaping, washing, drying body and head, handling faucets)

A. Upper body

0. Requires total assistance

1. Requires partial assistance

2. Washes independently with assistive devices or specific aids (e.g., chair, bars…)

3. Washes independently; no assistive devices or specific aids needed (nothing beyond what is typical for healthy individuals)

B. Lower body

0. Requires total assistance

1. Requires partial assistance

2. Washes independently with assistive devices or specific aids

3. Washes independently; no assistive devices or specific aids needed

3. Dressing

(Clothes, shoes, permanent orthoses: putting on, wearing, and taking off)

A. Upper body

0. Requires total assistance

1. Requires partial assistance with clothing that has no buttons, zippers, or laces

2. Independent with clothing that has no buttons, zippers, or laces; requires assistive devices and/or specific aids

3. Independent with clothing that may include buttons, zippers, or laces; does not require assistive devices or specific aids; needs help or aids only for buttons, zippers, or laces

4. Dresses independently (any garment); does not require assistive devices or specific aids

B. Lower body

0. Requires total assistance

1. Requires partial assistance with clothing that has no buttons, zippers, or laces

2. Independent with clothing that has no buttons, zippers, or laces; requires assistive devices and/or specific aids

3. Independent with clothing that may include buttons, zippers, or laces; does not require assistive devices or specific aids; needs help or aids only for buttons, zippers, or laces

4. Dresses independently (any garment); does not require assistive devices or specific aids

4. Grooming and appearance

(Washing hands and face, brushing teeth, combing hair, shaving, applying makeup)

0. Requires total assistance

1. Requires partial assistance

2. Grooms independently using assistive devices

3. Grooms independently without assistive devices

Subtotal (0–20) _____

RESPIRATION AND SPHINCTER MANAGEMENT

5. Respiration

0. Requires tracheostomy cannula and permanent or intermittent assisted ventilation

2. Spontaneous breathing with tracheostomy cannula; requires oxygen, major assistance for coughing or for managing the tracheostomy cannula

4. Spontaneous breathing with tracheostomy cannula; requires minor assistance for coughing or for managing the tracheostomy cannula

6. Spontaneous breathing without tracheostomy cannula; requires oxygen, major assistance for coughing, mask (e.g., positive expiratory pressure mask, PEP), or intermittent assisted ventilation (BiPAP)

8. Spontaneous breathing without tracheostomy cannula; requires minor assistance or stimulation to cough
10. Spontaneous breathing without assistance or devices

6. Bladder Management

0. Permanent catheter
3. Residual urine volume ≥100 cm^3; no regular catheterization or assisted intermittent catheterization
6. Residual urine volume ≤100 cm^3 or intermittent self-catheterization; needs assistance to use drainage equipment
9. Intermittent self-catheterization; uses external drainage devices; does not require assistance to place them
11. Intermittent self-catheterization; continent between catheterizations; does not use external drainage devices
13. Residual urine volume ≤100 cm^3; only uses external urinary drainage device; does not require assistance for drainage
15. Residual urine volume ≤100 cm^3; continent; does not use external drainage devices

7. Bowel Management

0. Irregular frequency or very low frequency of bowel movements (less than once every 3 days)
5. Regular frequency but requires assistance (e.g., to insert a suppository); occasional accidents (less than twice a month)
8. Regular evacuation, no assistance; occasional accidents (less than twice a month)
10. Regular evacuation, no assistance; no accidents

8. Toilet Use

(Perineal hygiene, adjusting clothing before/after, use of pads or diapers)

0. Requires total assistance
1. Requires partial assistance: does not clean self
2. Requires partial assistance: cleans self independently
4. Uses the toilet independently for all tasks but requires assistive devices or specific aids (e.g., bars)
5. Uses the toilet independently; no assistive devices or specific aids required

Subtotal (0–40) _____

MOBILITY (BEDROOM AND BATHROOM)

9. Bed mobility and pressure ulcer prevention activities

0. Requires assistance for all activities: turning upper body in bed, turning lower body in bed, sitting up in bed, lifting from wheelchair, with or without assistive devices (but not electric adaptations)
2. Performs one of these activities independently
4. Performs two or three of these activities independently
6. Performs all bed mobilization and pressure relief activities independently

10. Bed–wheelchair transfers

(Braking wheelchair, transferring)

1. Requires partial assistance and/or supervision, and/or assistive devices (e.g., transfer board)
2. Independent (or does not use a wheelchair)

11. Wheelchair–toilet–bath transfers

(If using a commode: perform transfers to and from it; if using a conventional wheelchair: brake the wheelchair, lift footrests, remove/adjust armrests, transfer, reposition feet)

0. Requires total assistance
1. Requires partial assistance and/or supervision, and/or assistive devices (e.g., grab bars)
2. Independent (or does not use a wheelchair)

MOBILITY (INDOORS AND OUTDOORS, ON ANY SURFACE)

12. Indoor mobility

0. Requires total assistance
1. Uses an electric wheelchair or requires partial assistance to use a manual wheelchair
2. Moves independently using a manual wheelchair
3. Requires supervision while walking (with or without aids)
4. Walks with walker or crutches (swing-through gait)
5. Walks with crutches or two canes (reciprocal gait)
6. Walks with one cane
7. Only requires lower limb orthoses
8. Walks without walking aids

13. Moderate distance mobility (10-100 meters)

0. Requires total assistance
1. Uses an electric wheelchair or requires partial assistance to use a manual wheelchair
2. Moves independently using a manual wheelchair

3. Requires supervision while walking (with or without aids)
4. Walks with a walker or crutches (swing-through gait)
5. Walks with crutches or two canes (reciprocal gait)
6. Walks with one cane
7. Only requires lower limb orthoses
8. Walks without walking aids

14. Outdoor mobility (more than 100 meters)

0. Requires total assistance
1. Uses an electric wheelchair or requires partial assistance to use a manual wheelchair
2. Moves independently using a manual wheelchair
3. Requires supervision while walking (with or without aids)
4. Walks with a walker or crutches (swing-through gait)
5. Walks with crutches or two canes (reciprocal gait)
6. Walks with one cane
7. Only requires lower limb orthoses
8. Walks without walking aids

15. Stair management

0. Unable to climb or descend stairs
1. Climbs and descends at least 3 steps with support or supervision from another person
2. Climbs and descends at least 3 steps using handrail and/or crutch or cane
3. Climbs and descends at least 3 steps without any support or supervision

16. Wheelchair–car transfers

(Approach the car, brake wheelchair, remove armrests and footrests, transfer to and from car, load/unload wheelchair)

0. Requires total assistance
1. Requires partial assistance and/or supervision and/or assistive devices
2. Transfers independently; does not require assistive devices (or does not use a wheelchair)

17. Floor-wheelchair transfers

0. Requires total assistance
1. Transfers independently with or without assistive devices (or does not use a wheelchair)

Subtotal (0–40) _____

SCIM Total Score (0–100) _____