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Original Article

Walking ability after stroke in patients from Argentina: predictive values of two tests in subjects with subacute hemiplegia

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Abstract. [Purpose] This study aimed to determine the predictive values of the trunk control test (TCT) and functional ambulation category (FAC) for independent walking up to 6 months post stroke. [Subjects] Twenty-seven subjects with hemiplegia secondary to a unilateral hemisphere stroke were included. [Methods] The protocol was started at 45 days post stroke, with the TCT and FAC as walking predictors. At 90, 120, and 180 days post stroke, the subjects' independent walking ability was assessed by using the Wald test. [Results] The TCT was identified as an independent predictor of ambulation at 90, 120, and 180 days. Subjects who scored ≥ 49 in the initial test had 93.8% probability of achieving independent gait at 6 months. The FAC proved that 100% of the subjects who scored 2 at 45 days post stroke walked independently at 90 days, 100% of the subjects who scored 1 walked independently at 120 days, and only 33.3% of the subjects who scored 0 walked independently at 180 days. [Conclusion] The TCT and FAC can predict independent walking at 45 days post stroke. In subjects with FAC 0, the TCT should be used to predict patients who will be able to walk independently.
Key words: Stroke, Predictors, Walking

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INTRODUCTION

Stroke is the main cause of disability in adults. Although stroke is often associated with older individuals, 45% of survivors are younger than 65 years and 27% are younger than 55 years[1)]. With the increasing costs of stroke treatment[2, 3)] and marked heterogeneity in stroke manifestation and recovery, accurate and reliable predictors of walking independence are needed[4–6)]. After rehabilitation, 64% of survivors will recover independent walking function, 14% will be able to walk with assistance, and 22% will not recover walking function[7)]. Gait predictors are evidence-based tools that allow physicians to (1) set realistic and attainable therapeutic goals, (2) facilitate proper discharge planning strategies, and (3) anticipate the need for home adjustments and community support[5)].

Kwakkel et al.[5)] defined a number of variables used in the early post stroke stage in order to predict recovery, such as initial disability (first 2 weeks), urinary incontinence, degree of paralysis or motor paresis, loss of consciousness within 48 hours, and poor seating balance.

The trunk control test (TCT) and functional ambulation category (FAC) have been used in the subacute stage of post-stroke recovery. The TCT has been proven to have a predictive value for ambulation in several series with stroke patients[8–12)]. The study conducted by Collin and Wade[8)] established a cutoff value of 37 points at 45 days as a predictor of ambulation at 18 weeks. Another study showed an association between a TCT score lower than 37 points and worse results for ambulation at 6 months in patients assessed 2 weeks after the event[9)]. Meanwhile, the FAC scale distinguishes 6 levels of walking ability[13)]. Mehrholz et al. showed good predictive value, sensitivity, and specificity for community ambulation in stroke subjects at 6 months and FAC 4 at 1-month post stroke[14)].

Post-stroke admission time in rehabilitation centers varies between different series. Our subject population mainly consisted of subacute stroke survivors with an average post-stroke admission time of 39 days (FLENI). The reason for this reality in Argentina is multifactorial and includes mainly demographic obstacles and administrative and cultural barriers among other variables[15)]. Given the fact that most series base the prediction of walking independence on the acute stage, we believe that new walking independence predictors for the subacute stage are needed.

The purpose of this study was to determine the predictive

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value of the TCT and FAC for independent walking within 6 months post stroke in subjects assessed at 45 days after the event.

SUBJECTS AND METHODS

Subjects admitted for treatment of hemiplegia secondary to a unilateral hemisphere stroke as seen on magnetic resonance imaging were assessed consecutively between December 2012 and February 2014. Subjects who met the following criteria were included: up to 45 days post stroke, unable to walk independently, no previous disability or coexisting condition affecting ambulation, or no cognitive disorders. All the subjects provided informed consent for participation in the study. The study was approved by the institution's ethics committee.

All the subjects enrolled in the study participated in an intensive, standardized neurological rehabilitation program. Therapists trained in neurorehabilitation instructed the patients regarding 2 hours of physical therapy and 1 hour of occupational therapy for 5 days a week while in the hospital. After that, the therapy continued in the outpatient setting in our institution or at home, 3 to 5 times a week.

As the subjects started the protocol, TCT[8] and FAC[14] were used as walking predictors at 45 days post stroke. At 90, 120, and 180 days post stroke, the subjects were assessed with the 10-m walking test (10-MWT)[16] in order to determine if they could walk independently, and their functional ability (household or community ambulation) was measured as a second parameter.

The TCT[8] is a simple test that assesses the following four movements in bed: rolling from a supine position to the weak side (T1) and to the strong side (T2), sitting up from a lying-down position (T3), and sitting in a balanced position on the edge of the bed with feet off the ground for 30 seconds (T4). The scoring is as follows: 0, unable to perform movement without assistance; 12, able to perform movement but in an abnormal manner; and 25, able to complete movement normally. The TCT score, ranging from 0 to 100, is the sum of the scores obtained on the four tests.

The FAC[14], a visual gait assessment scale, is simple and easy to interpret. Only stairs and a 15-m path are needed to administer the test. The scores were defined as follows: FAC 0: nonfunctional ambulator; FAC 1: ambulator who requires continuous physical assistance; FAC 2: ambulator who requires intermittent physical assistance; FAC 3: ambulatory, dependent on supervision; FAC 4: ambulatory, independent, and level surfaces only; FAC 5: ambulatory and independent.

The 10-MWT is used to assess gait speed. The subject walked a 14-m distance twice at a comfortable speed. Time was recorded in the middle 10 m, and the mean speed was calculated[16].

At the same time, the following independent demographic data were recorded: age, gender, time from stroke, affected side, and the lower limb Fugl-Meyer motor function score[17]. All the tests were performed by 2 physical therapists trained in the use of the scales. Independent walking was defined as the ability to walk 10 m without physical assistance[8], irrespective of the use of an ankle foot orthosis or a walking aid, except of a walker[14]. The classification of walking handicap in the stroke population[18] was used to determine the functional walking ability of the subjects. The subjects were categorized according to their gait speed as follows: less than 0.4 m/s in household ambulation and greater than 0.4 m/s in limited and unlimited community ambulation.

We used nonparametric tests for comparisons between the groups (less than 0.4 m/s vs. greater than 0.4 m/s). The Mann-Whitney U test was used to compare the two groups. A univariate logistic regression analysis was conducted to establish how the predictive value of TCT affects subjects' ability to walk independently at 90, 120, and 180 days post stroke by using the Wald test. The χ^2 test was used to compare between the FAC and the ability of walking independently. The Mann-Whitney U test was also used to compare the TCT scores between household and community ambulation. FAC frequencies were low, and comparison between the two groups could not be performed. The significance level was set at $p = 0.05$. The IBM SPSS version 20 statistical package was used.

RESULTS

During the study period, 52 patients with unilateral hemispheric lesions were admitted to our institution. Twenty-five subjects were excluded, namely 2 patients with a previous disability that affected ambulation, 1 with cognitive disorders, 17 whose evolution was longer than 45 days at the onset of the program, and 5 who started to ambulate before day 45 post stroke. The study sample therefore comprised 27 subjects. Three patients did not complete the assessment at 180 days. The clinical and demographic characteristics of the subjects are described in Table 1.

At 90, 120, and 180 days post stroke, 14 of 27, 17 of 27, and 16 of 24 subjects, respectively, had been able to walk independently. The median initial TCT score showed statistically significant differences between those recovered their walking function and those who did not as follows: at 90 days (median: 37 vs. 81, $p = 0.001$), at 120 days (median: 37 vs. 75, $p = 0.001$), and at 180 days (median: 37 vs. 75, $p = 0.000$; Table 2).

Ambulation prediction was determined by performing a univariate logistic regression analysis (Table 2). The TCT was determined as an independent predictor of ambulation at 90 days ($p = 0.007$), 120 days ($p = 0.009$), and 180 days ($p = 0.013$). Sensitivity/specificity values are shown in Table 3.

Statistically significant differences were noted in the frequencies of FAC between those who walked independently and those who did not at 90 ($p = 0.001$), 120 ($p = 0.001$), and 180 days ($p = 0.002$; Table 4). Sixteen subjects were able to walk independently, of whom 4 were household ambulators (TCT median: 62, range: 24–87) and 12 were community ambulators (TCT median: 62, range: 24–100). No statistically significant differences were observed between the two groups.

DISCUSSION

This study was restricted to a homogeneous group of subjects with severe hemiplegia, secondary to unilateral hemispheric stroke, who could not walk independently at 45

Table 1. Patients' baseline characteristics

Characteristics	Patients (n = 27)
Gender (male/female)	20/7
Age (years)*	63.2 ± 14.0 (64, 27–83)
Ischemic/hemorrhagic	23/4
Left/right	15/12
Time from onset at admission (days)*	25.3 ± 9.5 (25, 7–44)
Hospitalization time (days)*	98.4 ± 44.7 (86, 19–180)
Fugl-Meyer leg score*	14.0 ± 8.9 (14, 4–31)

*Mean ± SD (median, range)

Table 2. Relationship between TCT values and independent walking ability

	Walking at 90 d*	Walking at 120 d*	Walking at 180 d*
	Yes/No	Yes/No	Yes/No
TCT values (median)	81/37	75/37	75/37

*Significance level at $p < 0.05$

Table 3. Logistic regression analysis of TCT score as independent walking predictor

	Wald test	B	Sensitivity (%)	Specificity (%)
90 days	7.215*	1,088	61.5	85.7
120 days	6.816*	1,077	70.0	88.2
180 days	6.234*	1,112	87.5	93.8

*Significance level at $p < 0.05$

Table 4. FAC contingency: independent walking at 90, 120, and 180 days

	Walking 90 d*	Walking 120 d **	Walking 180 d ***
FAC at 45 days	Yes/No	Yes/No	Yes/No
Score 0	2/11	3/10	4/8
Score 1	6/2	8/0	6/0
Score 2	6/0	6/0	6/0
n total	27	27	24

*χ^2 test at 90 days: 14.21, $p = 0.001$
**χ^2 test at 120 days: 17.10, $p < 0.001$
***χ^2 test at 180 days: 12.00, $p < 0.002$

days post stroke. The study results provide evidence of the excellent power of both the TCT and FAC to predict independent walking at 45 days post stroke. The TCT proved to be a good predictor of independent walking at 90, 120, and 180 days. Our findings suggest that subjects who scored ≥ 49 in the initial test had 93.75% probability of achieving independent gait at 6 months. Meanwhile, in those who did not reach the cutoff point, the chance of independent walking decreased to 12.5%. These findings are concordant to the results of a prospective study by Colin and Wade[8] in subjects with hemiplegia, where a cutoff value of 37 at 45 days was proposed as a predictor of ambulation. Unlike this study, which predicts walking at 140 days post stroke, the follow-up period in the present was 180 days. This fact increases the sensitivity and specificity of the test (at 120 days, 70.0/88.2 and at 180 days, 87.5/93.8), as 3 of 21 subjects recovered their walking function between 120 and 180 days, which would justify the longer follow-up period because more severe hemiplegic subjects attained 95% of spontaneous recovery within 6 months post stroke[7, 19].

Meanwhile, the FAC proved that 100% of the subjects who scored 2 at 45 days post stroke had walked independently at 90 days and that 100% of the subjects who scored 1 at 45 days post stroke had walked independently at 120 days. Thus, the test proved to predict independent walking in these ambulation categories. In subjects with FAC 0 at 45 days post stroke, only 33.33% walked independently at 180 days, which suggests that TCT is a good complement in that subject category to predict patients who will be able to walk independently. This adds to the findings of Mehrholz et al.[14], who proved that the FAC had good predictive value, sensitivity, and specificity for community ambulation at 6

months post stroke in patients with FAC 4 on week 4.

The psychometric properties of the TCT and FAC are controversial[20]. As pointed out by Franchignoni[21], the TCT exhibits a pronounced ceiling effect, and hence, it could not be considered a promising measure for discriminative and evaluative purposes. We evaluated subjects who were in a subacute severe stage. Therefore, this ceiling effect did not affect our study. Meanwhile, Tyson[22] in a systematic review reported that the FAC is well known and feasible for use in clinical settings but that its psychometric properties are not fully developed, which prevented them to recommend it. In view of our results, the FAC could be used as a clinically meaningful predictive tool.

In this work, 70% of the subjects who did not walk independently at 45 days post stroke, walked within the first 6 months. This finding shows a major difference in results with those reported in the literature[7, 23] in that from among all the subjects who recovered their walking function after stroke, only 20% do so after 45 days. This agrees with the result from the study of Kwakkel[24], who stated that early intensive intervention is associated with better results and increased walking skills and functional independence measurement, and a shorter hospitalization time. The reason for this difference could be based on the post-stroke admission time in both series (12 hours in Jorgensen's study vs. 25 days in this study). This applies especially in developing countries, where the need for clinically relevant research requires an adaptation of international standards to local needs[25].

This study mainly showed that the TCT and FAC could predict independent walking at 45 days post stroke. In subjects with FAC 0, we suggest the use of the TCT to predict patients who will be able to walk independently.

A limitation of this study is that the study population was not compared between household and community ambulation because of the limited sample size. Future studies should report whether there is a relationship between TCT score or FAC and functional walking ability.

REFERENCES

1) Culler KH, Wang YC, Byers K, et al.: Barriers and facilitators of return to work for individuals with strokes: perspectives of the stroke survivor, vocational specialist, and employer. Top Stroke Rehabil, 2011, 18: 325–340. [Medline] [CrossRef]
2) Osberg JS, McGinnis GE, DeJong G, et al.: Long-term utilization and charges among post-rehabilitation stroke patients. Am J Phys Med Rehabil, 1988, 67: 66–72. [Medline] [CrossRef]
3) Smurawska LT, Alexandrov AV, Bladin CF, et al.: Cost of acute stroke care in Toronto, Canada. Stroke, 1994, 25: 1628–1631. [Medline] [CrossRef]
4) Jongbloed L: Prediction of function after stroke: a critical review. Stroke, 1986, 17: 765–776. [Medline] [CrossRef]
5) Kwakkel G, Wagenaar RC, Kollen BJ, et al.: Predicting disability in stroke—a critical review of the literature. Age Ageing, 1996, 25: 479–489. [Medline] [CrossRef]
6) Park SY, Lee IH: The influence of age, lesion side and location on rehabilitation outcome after stroke. J Phys Ther Sci, 2011, 23: 817–819. [CrossRef]
7) Jørgensen HS, Nakayama H, Raaschou HO, et al.: Recovery of walking function in stroke patients: the Copenhagen Stroke Study. Arch Phys Med Rehabil, 1995, 76: 27–32. [Medline] [CrossRef]
8) Collin C, Wade D: Assessing motor impairment after stroke: a pilot reliability study. J Neurol Neurosurg Psychiatry, 1990, 53: 576–579. [Medline] [CrossRef]
9) Duarte E, Morales A, Pou M, et al.: [Trunk control test: early predictor of gait balance and capacity at 6 months of the stroke]. Neurologia, 2009, 24: 297–303. [Medline]
10) Duarte E, Marco E, Muniesa JM, et al.: Trunk control test as a functional predictor in stroke patients. J Rehabil Med, 2002, 34: 267–272. [Medline] [CrossRef]
11) Franchignoni FP, Tesio L, Ricupero C, et al.: Trunk control test as an early predictor of stroke rehabilitation outcome. Stroke, 1997, 28: 1382–1385. [Medline] [CrossRef]
12) Verheyden G, Nieuwboer A, Van de Winckel A, et al.: Clinical tools to measure trunk performance after stroke: a systematic review of the literature. Clin Rehabil, 2007, 21: 387–394. [Medline] [CrossRef]
13) Holden MK, Gill KM, Magliozzi MR, et al.: Clinical gait assessment in the neurologically impaired. Reliability and meaningfulness. Phys Ther, 1984, 64: 35–40. [Medline]
14) Mehrholz J, Wagner K, Rutte K, et al.: Predictive validity and responsiveness of the functional ambulation category in hemiparetic patients after stroke. Arch Phys Med Rehabil, 2007, 88: 1314–1319. [Medline] [CrossRef]
15) Cavagnero E: Health sector reforms in Argentina and the performance of the health financing system. Health Policy, 2008, 88: 88–99 H. [Medline] [CrossRef]
16) Bohannon RW: Walking after stroke: comfortable versus maximum safe speed. Int J Rehabil Res, 1992, 15: 246–248. [Medline] [CrossRef]
17) Fugl-Meyer AR, Jääskö L, Leyman I, et al.: The post-stroke hemiplegic patient. 1. a method for evaluation of physical performance. Scand J Rehabil Med, 1975, 7: 13–31. [Medline]
18) Perry J, Garrett M, Gronley JK, et al.: Classification of walking handicap in the stroke population. Stroke, 1995, 26: 982–989. [Medline] [CrossRef]
19) Friedman PJ: Gait recovery after hemiplegic stroke. Int Disabil Stud, 1990, 12: 119–122. [Medline] [CrossRef]
20) Sullivan JE, Crowner BE, Kluding PM, et al.: Outcome measures for individuals with stroke: process and recommendations from the American Physical Therapy Association neurology section task force. Phys Ther, 2013, 93: 1383–1396. [Medline] [CrossRef]
21) Franchignoni F: Psychometric properties and practical attributes of the trunk control test in stroke patients [letter to the editor]. J Rehabil Med, 2003, 35: 150, author reply 150–151. [Medline] [CrossRef]
22) Tyson S, Connell L: The psychometric properties and clinical utility of measures of walking and mobility in neurological conditions: a systematic review. Clin Rehabil, 2009, 23: 1018–1033. [Medline] [CrossRef]
23) Veerbeek JM, Van Wegen EE, Harmeling-Van der Wel BC, et al. EPOS Investigators: Is accurate prediction of gait in nonambulatory stroke patients possible within 72 hours poststroke? The EPOS study. Neurorehabil Neural Repair, 2011, 25: 268–274. [Medline] [CrossRef]
24) Kwakkel G, van Peppen R, Wagenaar RC, et al.: Effects of augmented exercise therapy time after stroke: a meta-analysis. Stroke, 2004, 35: 2529–2539. [Medline] [CrossRef]
25) Anjos SM, Cohen LG, Sterr A, et al.: Translational neurorehabilitation research in the third world: what barriers to trial participation can teach us. Stroke, 2014, 45: 1495–1497. [Medline] [CrossRef]