Original Article

Impact of Trunk Control on Balance and Functional Abilities in Chronic Stroke Patients

Hanan Helmy[1], Tamer Emara[2], Sherine El Mously[3], Magdy Arafa[4], Waleed Mansour[4], Noura El Kafrawy[4]

Departments of Neurology; Cairo University[1], Ain Shams University[2], Fayoum University[3];
Physical Therapy for Neuromuscular Disorders and its Surgery[4];
Faculty of Physical Therapy; Cairo University; Egypt

ABSTRACT

Background: The proximal trunk stability is a major pre-requisite for balance and coordinated extremity use in daily functional activities. **Objective:** To evaluate the trunk control in chronic stroke patients , and to determine to what extent it affects balance abilities and functional performance of those patients. Another aim is to detect the best clinical measure that can be used to test trunk muscle control and may predict functional recovery. **Patients and Methods:** Forty adult post-stroke ambulant patients participated in this study. The testing protocol included assessment of trunk control by Trunk Impairment Scale (TIS), evaluation of balance ability by Biodex Balance System, and assessment of the functional performance by Functional Independence Measure (motor subscale). **Results:** The mean age of the study sample was 56.1 ±5.45 years. The trunk control was impaired in 39 (97.5%) out of 40 patients. Measures of trunk control were significantly correlated with measures of balance and functional ability. Univariate regression analysis and partial correlation showed that the dynamic sitting balance subscale of the TIS has the highest effect on measures of balance and functional ability. In addition, the patients' functional performance is strongly dependent on their balance ability. **Conclusion:** The trunk performance is still impaired in most of chronic stroke patients and it strongly affects their balance and functional abilities. The dynamic sitting balance component of the TIS is a reliable clinical indicator of balance and functional recovery. **[Egypt J Neurol Psychiat Neurosurg. 2014; 51(3): 327-331]**

Key Words: chronic stroke, functional recovery, trunk control, balance stability, trunk impairment scale

INTRODUCTION

Stroke is the main cause of long-term disability in adults.[1] Regaining trunk control has been identified as an important early predictor of functional recovery after stroke. Proximal trunk control is a prerequisite for distal limb movement control, balance stability and functional ability.[2]

Decreased trunk control leads to poor bilateral integration, impaired automatic postural control, and hence increased risk of falls.[3] Balance problems have been implicated in the poor recovery of activities of daily living, mobility[4] and an increased risk of falls.[5]

Also, Prediction of functional abilities at an early stage enables clinicians to select appropriate treatment programs and goals, facilitate a proper discharge plan, and anticipate the need for home adjustments and community support.[6]

Correspondence to Hanan Helmy, Neurology Department, Cairo University; Egypt.
Tel: +201229123430 Email: drhananelgendy76@yahoo.com

Aim of Work: To examine the trunk muscle control in a group of chronic stroke patients and to find out if there is a direct correlation between poor trunk muscle control on one hand and balance and functional abilities on the other hand. We looked into whether or not one of our outcome measures may be used as a clinical predictor of functional recovery after stroke.

PATIENTS AND METHODS

Forty adult ambulant ischemic chronic stroke patients (more than 6 months after stroke onset) were recruited from the outpatient clinic and Balance System laboratory of Faculty of Physical Therapy, Cairo University between October 2011 and January 2013.

All patients recruited were experiencing their first ever stroke, had at least average cognitive functions that enabled them to follow commands. Patients were excluded if they had severe proprioceptive deficit, any other neurologic or orthopedic disorders, disabling visual or hearing impairment or unstable medical condition.

All patients were examined using the trunk impairment scale (TIS)[7] to assess trunk control (primary outcome measure). This scale has a total score of 23 and

it includes 7 points for static, 10 points for dynamic sitting balance, and 6 points for coordination. TIS scores of 21 or more indicate normal trunk muscle function.[8] Balance was also assessed using the dynamic limits of stability test and the overall stability index (OASI) that was done using the automated Biodex Balance System. Subsequent functional limitation was examined using the motor subscale of the Functional Independence Measure (FIM_motor).

Statistical Analysis

The collected data were statistically analyzed using SPSS statistical software (version 18). Descriptive statistics (mean and standard deviation) were used to assess the demographic data of all patients. Pearson correlation coefficient (r) was used to study the correlation between TIS (total score and scores of its subscale) and both (balance and functional abilities measures); Univariate regression analysis (R^2) was used to determine to what extent trunk control affects balance and functional abilities in stroke patients, and to compare between the subscales of TIS in relation to balance and functional abilities. $P<0.05$ is considered of statistical significance and $P \leq 0.0001$is considered highly significant.

RESULTS

Forty patients with first-ever ischemic stroke were recruited. The sample included 29 males (72.5%) and 11 females (27.5%) with a mean age of 56.1±5.45 (Range: 50-65) and mean duration after stroke of 9.8±2.68 (Range: 6-15 months). Twenty-four patients (60%) had left side affection while 16 (40%) had right side affection. Results of the patients' assessment are described in Table (1).

The TIS total score was low with a median of 16 (IQR 13-20). Only one patient (2.5%) had a score of 21, which represents normal trunk control. Upon correlating the TIS to other measures of balance and function, there was a highly significant direct correlation between the TIS total score and each of the OASI, dynamic limits of stability and the FIM (r=0.929 / P=0.0001 and r=0.985 / P=0.0001, respectively). In addition, there was negative highly significant correlation between the TIS total score and OASI (r =-0.945, P=0.0001). The TIS subscales, namely the static and dynamic sitting balance items also significantly correlated with the OASI, dynamic limits of stability and the FIM_motor scale (Table 2).

Results of univariate regression analysis between the TIS total score and its subscores on one side and measures of balance and functional skills (OASI, dynamic limits of stability, and FIM_motor) on the other side are presented in Table (3). All results for the dynamic sitting balance and total score are significant. This indicates that there is a high probability of having low scores of OASI, dynamic limits of stability and FIM_motor when the TIS total score or dynamic sitting balance are low. Nevertheless, the coordination scale results were all insignificant. For the static sitting balance component of the test, the results were significant except the values between the sitting balance score and the dynamic limits of stability test.

Table 1. Sample characteristics.

	Median (IQR)	Range
TIS_total	16 (13-20)	11-21
TIS_static sitting balance	7(6-7)	5-7
TIS_dynamic sitting balance	7(5-9)	4-10
TIS_coordination	2 (2-4)	1-4
OASI	3.8 (2.95-5.1)	2.1-7.3
Dynamic limits of stability	13 (10-23)	8-36
FIM_motor	62.5 (57-70)	49-77

FIM_motor: Functional Independence Measure-motor subscale, ***OASI*** overall stability index, ***TIS*** trunk impairment scale

Table 2. Correlation between TIS total score and subscores and each of OASI, overall dynamic limits of stability and FIM.

	OASI	Dynamic limits of stability	FIM_motor
TIS_total	r= -0.95 p=0.0001*	r =0.93 p =0.0001*	r =0.99 p =0.0001*
TIS_static sitting balance	r= -0.79 p= 0.0001*	r =0.63 p =0.0001*	r =0.78 p =0.0001*
TIS_dynamic sitting balance	r= -0.93 p= 0.0001*	r =0.92 p =0.0001*	r =0.96 p =0.0001*
TIS_coordination	r= -0.81 p= 0.0001*	r =0.87 p =0.0001*	r =0.88 p =0.0001*

FIM_motor Functional Independence Measure-motor subscale, ***OASI*** overall stability index, ***r*** correlation coefficient, ***TIS*** trunk impairment scale

*significant at P<0.01

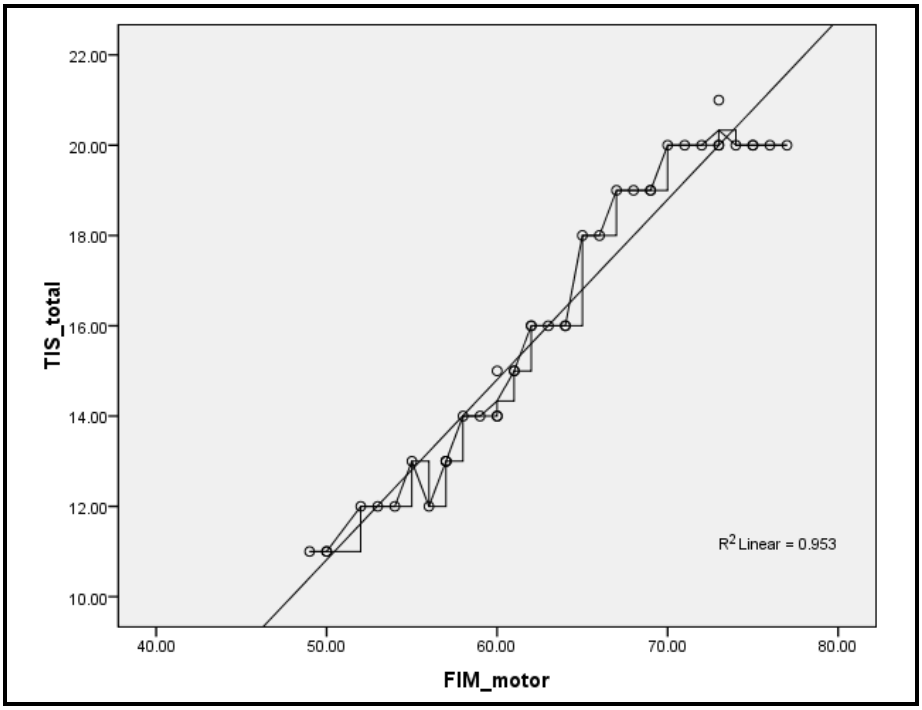

Figure 1. Correlation between TIS total score and FIM_motor score.

Table 3. Univariate regression analysis between TIS total score and subscores and each of OASI, overall dynamic limits of stability and FIM. Values presented as R^2 (p value).

	OASI	Dynamic limits of stability	FIM_motor
TIS_total	0.89 (p <0.0001*)	0.86 (p <0.0001*)	0.97 (p <0.0001*)
TIS_static sitting balance	0.9 (p =0.001*)	0.89 (p >0.05) NS	0.97 (p <0.0001*)
TIS_dynamic sitting balance	0.9 (p <0.0001*)	0.89 (p <0.0001*)	0.97 (p <0.0001*)

FIM_motor Functional Independence Measure-motor subscale, ***NS*** not significant, ***OASI*** overall stability index, ***r*** correlation coefficient, ***TIS*** trunk impairment scale
*significant at P<0.01

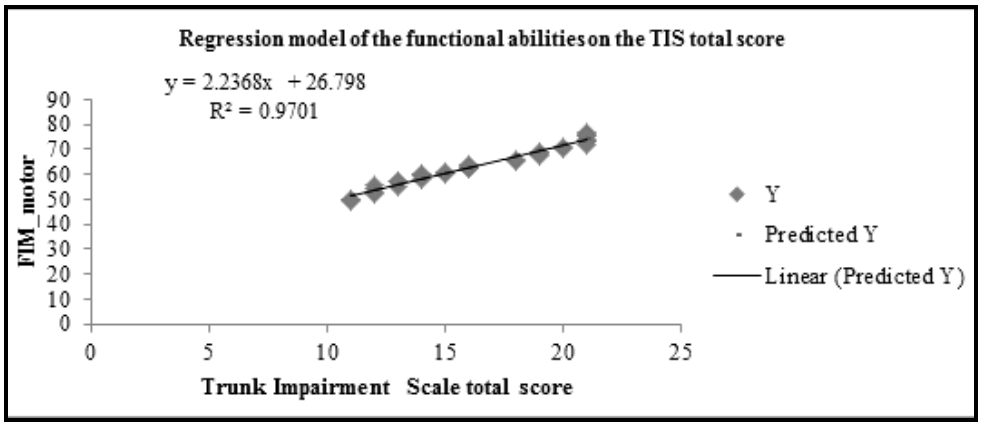

Figure 2. Regression model of the TIS total score and FIM_motor score showing a strong positive interaction between both variables (R^2=0.97, p <0.0001).

DISCUSSION

We aimed to assess the state of trunk muscle control in stroke patients at least six months after the onset. Several studies had shown that chronic stroke patients had poor trunk control.[9-11] We investigated the trunk muscle control in chronic stroke patients with good recovery, so we only recruited patients who can walk independently. We used the TIS as it is more sensitive in detecting changes in trunk muscle control.[9]

Our findings showed that 39/40 patients had a degree of trunk muscle control impairment relative to age matched controls reported in the literature.[8] The median score was 16 which is equivalent to 69.6% of the total score. Trunk impairment can be explained by post-stroke affection of trunk muscle strength, neural control and trunk proprioception which are prerequisites for good trunk control and provision of stable foundation for movement.[12]

Our second aim was to find out whether there is a correlation between trunk muscle control problems and balance and/or functional activities of our selected patient group. Our results demonstrated a highly significant correlation between the TIS total score, TIS subscores on one side and balance and functional activities on the other side. This is concordant with other studies that showed that trunk flexion and extension muscle weakness when assessed clinically[13] or by CT[14] directly correlated with balance, functional recovery scores[13,14] and speed of gait.[14]

The positive highly significant effect of trunk control on balance and functional abilities of stroke patients can be attributed to the fact that, the trunk is the central key point of the body that provides proximal stabilization. Lack of this stabilization after stroke influences the affected limbs profoundly-any attempt to move upright against gravity leads to an increase of distal spasticity-which in turn affect the patient's balance control, mobility and functional capacity.

In addition, control of movement proceeds from proximal to distal body regions; so, if an improved level of proximal trunk control were attained, a better distal limb control might be anticipated during balance and functional performance.[15]

The final target of our study was to look into the best clinical predictors of trunk muscle control and subsequent functional recovery. Regression analysis results showed that the TIS total score and dynamic sitting balance subscore show the best signal in terms of predicting balance and functional outcomes (table 3). We would suggest the use of the dynamic sitting balance portion of the TIS as a valid assessment tool of trunk muscle control that will also serve to predict future functional recovery.

Conclusion

This study highlights the role of trunk muscle control as an independent predictor of functional recovery. This can be rapidly and reliably assessed using the TIS dynamic sitting balance subscale. These findings should propel our neurorehabilitation teams to objectively test and subsequently work on regaining efficient trunk control even in stroke patients who recovered the ability to walk again.

[Disclosure: Authors report no conflict of interest]

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الملخص العربى

تأثير التحكم في الجزع على الاتزان والقدرات الوظيفية عند مرضى السكتة الدماغية المزمنين

التحكم في الجذع شرط رئيسي للاتزان والاستعمال المنسق للأطراف في النشاطات الوظيفية اليومية. يهدف هذا البحثِ إلى تقييم التحكم في الجذع عند مرضى السكتة الدماغية ودراسة مدى تأثير اختلال التحكم في الجذع على الاتزان والقدرات الوظيفية لهؤلاء المرضى. كما يهدف إلى تحديد أي من المقاييس الثانوية لمقياس اختلال الجذع الرئيسي هو المؤشر الحقيقي للاتزان والقدرات الوظيفية لهؤلاء المرضى وإيضاح مدى تأثير اختلال الاتزان على الأداء الوظيفي لهم.

أجريت هذه الدراسة على أربعين مريضا مزمنا بالسكتة الدماغية المترددين على العيادة الخارجية بكلية العلاج الطبيعي– جامعة القاهرة. تضمنت التجربة تقييم التحكم في الجذع عن طريق مقياس اختلال الجذع وقياس الاتزان الحركي بجهاز الاتزان البيودكس، وتقييم القدرات الوظيفية لهؤلاء المرضى باستخدام المقياس الوظيفي اللااعتمادي.

نتائج البحث: دلت النتائج على اختلال التحكم في الجذع عند ٩٧,٥% من إجمالي المرضى. كما أوضحت وجود ارتباط ذو أهمية إحصائية بين مقياس اختلال الجذع ومقاييس الاتزان والأداء الوظيفي للمرضى. كذلك تبين من التحليل الانحداري ومعامل الارتباط الجزئي أن مقياس الاتزان المتحرك هو أقوى المقاييس الثانوية لاختلال الجذع تأثيرا على الاتزان والقدرات الوظيفية للمرضى وأن أدائهم الوظيفي يعتمد بقوة على قدرتهم على الاتزان. ومن هنا يتضح أن اختلال التحكم في الجذع يظل عند معظم المرضى حتى المرحلة المزمنة من المرض وأنه يؤثر بشكل كبير على اتزان المرضى وقدراتهم الوظيفية.