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Trunk control: The essence for upper limb functionality in patients with multiple sclerosis

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ABSTRACT

Background: Multiple sclerosis (MS) involves impaired trunk control, leading to impaired upper-limb functionality, dexterity, and independence. Deciding early on a comprehensive approach pointing of functional disturbances and personal needs is essential for a multimodal, individualized, goal-oriented assessment and treatment program, recognizing the broad range of symptoms and disabilities associated with MS. In clinical practice, postural control of the trunk is purported to be an important contributor to voluntary upper-limb function, including motor control and dexterity. The objective of this study was to point out the impairments of and relationship between trunk control and comprehensive upper-limb functions in individuals with MS.
Methods: Tasks that were sought are optimal screening for deterioration in trunk control (Trunk Control Test [TCT] and Trunk Impairment Scale [TIS]) and upper-limb functionality by comparing them with the Expanded Disability Status Scale (EDSS), Nine Hole Peg Test (NHPT), Duruoz's Hand Index (DHI), and Functional Independence Measurement (FIM) results of 49 well-defined relapsing-remitting MS (RRMS) participants with those of 49 age-gender matched healthy subjects.
Results: Significant differences between the groups were evident across all tasks of the clinical tests studied ($p < 0.05$), except the TCT-balance in sitting position subscore. EDSS, NHPT, DHI, and FIM scores were highly correlated with the TCT subscores (rolling to weak side, sitting up from lying down) and TCT-total score, as well as TIS subscores (dynamic and coordination) and TIS total score ($p \leq 0.005$). While TIS subscores were highly correlated with almost all parameters, just TIS-static subscore did not correlate with the DHI and FIM-cognitive scores. Also, DHI-hygiene subscore correlated poorly just with the TIS-coordination and TCT-coming to sitting position ($p < 0.05$).
Conclusion: We found that patients with MS would present impaired upper-limb movement and decreased trunk control with high correlation between them, even in RRMS and in the very mild form of the disease. Identifying trunk control deficits provides better insight into dexterous difficulties of patients with MS and allows a more targeted neurorehabilitation focusing on upper limbs. In future studies, it would be of interest to examine the prognostic value of trunk control and upper-limb functionality in patients with MS using a longitudinal approach.

1. Introduction

Multiple sclerosis (MS) is a common and disabling neurologic disease associated with impaired trunk control and functionality, leading to a combination of motor (weakness, spasticity), sensory (proprioception loss, ataxia), fatigue, psychological, visual, and cognitive impairments (Jacobs and Kasser, 2012). Postural imbalance is one of the most disabling MS symptoms that affects about 75% of patients and is often described as an initial symptom (Aruin et al., 2015). Trunk control affects not only sitting and standing, but also the ability to sequence movement appropriately during more complex activities, such as reaching, upright standing, walking, or recovering independent functions (Genthon et al., 2007). Based on the literature, it is clear that very little is known about whether trunk control affects upper-limb functionality for people with MS (Jacobs and Kasser, 2012; Yozbatiran et al., 2006).

Dexterity is usually understood as skill and ease in use of the hands, but it is also generally defined as adroitness and competency in use of the limbs and posture, especially during task performance (Canning et al., 2000). Pinch and grip strength, disability level,

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patients' perceived disability in daily tasks, quality of life, cognitive function, and sensation are related with upper-limb function in patients with MS (Yozbatiran et al., 2006). Research about motor behavior of the upper limb in patients undergoing neurorehabilitation should not only address the hand's dexterity, but also proximal components (i.e., trunk, shoulder, elbow) and their link with trunk and balance control, which is an unexplored field (Silva et al., 2014; Tettamanti et al., 2013).

In clinical practice, postural control of the trunk is purported to be an important contributor to voluntary upper-limb function, including motor control and dexterity (Chung et al., 2008). People with MS have been found to have reduced trunk stability during arm movements when sitting compared to healthy subjects (Freeman et al., 2010). The clinical basis for diagnosis, prognosis, and intervention must be done with the reliable and valid evidence referred to as evidence-based practice, whenever possible. To the best of our knowledge, the importance of trunk control in patients with MS in predicting comprehensive upper-limb functionality outcome has not been investigated multidimensionally. We thus predicted that trunk control impairments would correlate with objective measures of upper- limb function. The objective of this study was to point out the impairments in and relationship between trunk control and comprehensive upper-limb functions in individuals with MS.

2. Material and methods

2.1. Participants

This study used a cross-sectional design in participants with relapsing-remitting MS (RRMS) ($n = 49$) and a control group with age- and gender-matched healthy individuals ($n = 49$), and all were assessed at a single time point. Physical characteristics, such as age, height, and weight, were obtained. All volunteers with RRMS also underwent a clinical evaluation by the study neurologists during a separate visit. The evaluation included medical history, neurological exam, and determination of each individual's disease severity using the Expanded Disability Status Scale (EDSS). Descriptive statistics of participants for each group are found in Tables 1 and 2.

Inclusion criteria for individuals with RRMS included having neurologist approval, the definite diagnosis of RRMS by modified McDonald criteria (Polman et al., 2011) by a neurologist, and a score of 6.5 or below on the EDSS. Exclusion criteria were pregnancy, orthopedic limitations of the upper limb or trunk, and use of prednisone or other steroids for an MS flare-up during the previous month. All control participants were apparently healthy and free of any known disorder that could influence trunk control and upper-limb functionality, including orthopedic, visual, vestibular, somatosensory, and neurological disorders. All participants gave written informed consent before participation after receiving information about the study protocol, which conformed to the standards for human experiments set by the Declaration of Helsinki and was approved by the Ethics Committee for Human Investigations at the Pamukkale University.

Tasks that were sought are optimal screening for deterioration in trunk control and upper-limb functionality by comparing them with the test results of 49 well-defined RRMS patients and with those of 49 age- and gender-matched healthy subjects.

Table 1
Distribution of participants.

		RRMS Group ($n = 49$)		Control Group ($n = 49$)		χ^2	p
		n	%	n	%		
Gender	Woman	38	77.6	38	77.6	0.000	1.000
	Man	11	22.4	11	22.4		
Dominance	R	48	98.0	44	89.8	2.841	0.092
	L	1	2.0	5	10.2		

χ^2: Chi-Square Test.

Table 2
Demographics of participants.

	RRMS group ($n = 49$)		Control group ($n = 49$)		t	p
	X	SD	X	SD		
Age (year)	40.33	10.22	39.80	4.05	0.338	0.736
Weight (kg)	67.13	11.95	75.69	12.65	−3.444	0.001*
Height (cm)	162.39	7.49	165.55	8.11	−2.005	0.048*
BMI (kg/m^2)	25.43	3.99	27.56	3.73	−2.726	0.008*
EDSS	1.88	1.65	–	–	–	–
Disease duration (year)	5.96	4.38	–	–	–	–
Number of relapses	3.37	1.93	–	–	–	–
Last relapse duration (month)	2.14	1.90	–	–	–	–

BMI: Body Mass Index, EDSS: Expanded Disability Status Scale, t: Student's *t*-Test, *$p < 0.05$.

2.2. Measured tasks

The Kurtzke Expanded Disability Status Scale (EDSS) is the most widely used and administered scale by neurologists as a standardized measure of neurologic impairment in clinical trials and practice. However, EDSS does not provide an adequately sensitive measurement of other important determinants of functional capacity in MS, such as cognition and manual dexterity (arm/hand function) (Karabudak et al., 2015).

The Trunk Control Test examines four simple aspects of trunk movement. The patient lies supine on the bed and is asked to roll to the weak side, roll to the strong side, sit up from lying down, and sit in a balanced position on the edge of the bed, with feet off the ground for a minimum of 30 seconds. The tests are short, easily applied on the ward, do not require any special training, are easily communicated, and can be incorporated into normal neurological examination procedures (Collin and Wade, 1990; Franchignoni et al., 1997). Score of each item was 0 for "unable to perform movement without assistance", 12 for "able to perform movement, but in an abnormal style, for example, pulls on bed clothes, rope or monkey pole, or uses arms to steady self when sitting" or 25 for "able to complete movement normally". Just for the sitting balance item, a patient scores 12 if they need to touch anything with their hands to stay upright, and 0 if they are unable to stay up (by any means) for 30 seconds. Total score of TCT was sum points of four (Collin and Wade, 1990).

The Trunk Impairment Scale (TIS) provides reliable assessment for the quality of trunk movement and performance in people with MS (Verheyden et al., 2006; Keser et al., 2013). Trunk movement consists of appropriate shortening and lengthening of the trunk, selective movements of the upper and lower parts of the trunk, and movements of the trunk without compensations in three subscales: static sitting balance, dynamic sitting balance, and coordination (Lombardi et al., 2017). The static subscale investigates: (1) the ability of the subject to maintain a sitting position with feet supported; (2) the ability to maintain a sitting position while the legs are passively crossed, and (3) the ability to maintain a sitting position when the subject crosses the legs actively. The dynamic subscale contains items on lateral flexion of the trunk and unilateral lifting of the hip. To assess the coordination of the trunk, the subject is asked to rotate the upper or lower part of his or her trunk 6 times, initiating the movements either from the shoulder girdle or from the pelvic girdle, respectively. For each item, a 2-, 3- or 4-point ordinal scale is used. On the static and dynamic sitting balance