European Journal of Molecular & Clinical Medicine
ISSN 2515-8260 Volume 08, Issue 03, 2021

Effect of Dual Task on Balance in Multiple Sclerosis Patients

Basant Said Hegazy
Demonstrator of Physical Therapy for Neuromuscular Disorders and its Surgery
Faculty of Physical Therapy
Cairo University
Tel.no; +201090223765
Fax.no; +2020290588
Email address; Physiotherapistbasant@gmail.com

Dr. Mohammad Sadik Badawy
Professor of Physical Therapy for Neuromuscular Disorders and its Surgery
Faculty of Physical Therapy
Cairo University

Dr. Usama Mohammad Rashad
Professor of Physical Therapy for Neuromuscular Disorders and its Surgery
Faculty of Physical Therapy
Galala University

Dr. Hanan Helmy El-Gendy
Professor of Neurology
Faculty of Medicine
Cairo University

Abdelaziz Abdelaziz Elsherif

Lecturer of Physical Therapy for Neuromuscular Disorders and its Surgery

Faculty of Physical Therapy
Cairo University

Shortened title: Dual Task On Multiple Sclerosis Balance

Abstract

Background: Multiple Sclerosis (MS) is a complicated neurological disorder. Imbalance and ataxic features are challenging symptoms in MS.

Objective: To assess the effect of dual task on balance in ataxic MS patients.

Methods: Thirty relapsing remitting MS patients, ataxic type, were assessed under two conditions: single task condition (A) for assessing balance and dual task condition (B)assessing balance while doing a motor task. Two types of motor dual tasks were chosen, "holding a tray task " and " coin transfer task". For balance assessment, Biodex Balance System (BBS) and Timed up and go (TUG) were used.

Results: Condition (B) significantly change balance indices measured by BBS. Such changes were more pronounced under "coin transfer task" in comparison to "holding tray task". Moreover, there was increase in time of TUG-motor in comparison to TUG test.

Conclusions: Motor dual tasks can affect balance of ataxic MS patients, such effects depend on secondary task difficulty. There are subclinical impairments that can be unmasked by reinforced balance assessment using motor dual tasks. Both static and dynamic balance assessments are considered complementary, its important to assess both to get a realistic evaluation.
Key words: Multiple sclerosis – Ataxia – Balance – Dual task -Complementary motor task.

1)Introduction:

Multiple sclerosis (MS)is a chronic autoimmune disease of the central nervous system (CNS) in which inflammation, demyelination and axonal loss occurs in even early stages of the disease. MS has a heterogeneous pathological and clinical presentation that proposes deterioration of motor, sensory and/or cognitive function such as executive functions lead to symptoms such as gait deficits, postural instability and predispose falls in this population **[1].**

Postural control and human balance are encompassing terms both define the ability of the body to react to conditions interrupting stability and how to maintain or to change body position to avoid a fall. Moreover, from a functional point of view, many daily activities require performing an additional task while maintaining balance (i.e., dual-task performance) **[2]**. Cerebellar and brainstem lesions were associated with poor performance on static balance tests. Moreover, volumes of demyelination within the brainstem, cerebellum and spinal cord were associated with the length and velocity of static weight shifts on a balance platform [3]. The negative physical and psychological impact of repeated and unexpected falls in patients with MS has led to falls risk detection and prevention to become a rapidly emerging research area in rehabilitation for MS patients**.** Moreover, recent evidence showed that balance in individuals with MS can be negatively affected by adding of a concurrent secondary task (i.e. dual task).Based on that, examining the performance of dual-task activity (i.e., performing two or more tasks concurrently) is considered one model for early assessing balance control in MS patients and the effects of increased demands on cognitive resources that is manifested as executive dysfunction in MS patients [4]. The dual-task paradigm is an experimental method used to measure how the brain deals with two competing tasks performed simultaneously. It has been used to investigate the risk of falling, cognitive function, gait pattern and balance by adding an additional (cognitive or motor) task to a primary task. Neurological disorders affect the quality of dual tasking hence affecting the quality of life where multiple tasks are needed to be handled simultaneously and falls may occur in such situations [5]. The purpose of the study is to assess the effect of motor dual task on balance in ataxic multiple sclerosis patients using Biodex Balance System (BBS) as well as measurement of Timed Up and Go test (TUG) under single and dual task conditions.

2) Materials and Methods

2.1 Participants

This is a repeated measure study design conducted on thirty(n=30) relapsing-remitting multiple sclerotic patients with ataxic symptoms of both sexes. They were selected from multiple sclerosis specialized clinic in the Neurology department, Faculty of Medicine, Cairo University. Patients were assessed by Montreal cognitive assessment (MoCA) scale to ensure sufficient and equal

cognitive state among participants as its considered superior to Mini mental Status (MMES) in assessing cognitive impairment in MS patients [6]. The Arabic version was used in this study. Their Expanded disability status scale (EDSS) ranged from 1-4 and their MoCA scores ranged from 30-26. Patients with any other neurological deficits, orthopedics abnormalities or severe cognitive deficits preventing participation in the study were excluded. All patients had an almost equal physiotherapy program.

2.2) Primary outcome

To measure the effect of adding motor task on balance during static standing on Biodex balance system (BBS) and while doing the Timed up and go test (TUG).

2.3) Procedures

The selected patients performed two assessment conditions, (A) Single task condition: Patient performed balance assessment only and (B) Dual task condition: Patient performed balance assessment while doing a concurrent motor task.

Balance assessment was measured using the Biodex balance system BBS (Model 945-302, software version 3.12, New York), patients' weight , height , age and personal data were introduced in the device. Patients were informed to keep the vertical projection with their center of gravity in the midpoint of the platform, given a visual feedback by a vertical screen located 30 cm in front of their face. Each assessment took 20 seconds, with 10-seconds rest periods in-between. In single task condition (A) patients stood on the platform with eyes open and the BBS was set to constant instability (Level 8), which is considered the least unstable level in the device [7]. In dual task condition (B), same procedures were done while adding a motor task. Two motor tasks were chosen:

Holding a tray task: Patient stand still while holding a tray with three empty plastic cups with both hands [8].

Coin transfer task: where participants wear a belt with pockets and transfer coins from one pocket to another with their dominant hand [9].

The index of overall stability is measured in degrees (where 0° is the best possible value) and higher scores indicate poor balance control.

Patients balance also assessed using Timed up and go test (TUG), it is well known quick and simple measure when the clinical goal is to get an accurate objective assessment of balance [10]. The test started with the subject sitting on a stable chair, the subjects were ordered to stand up, walk to the line on the floor, turn around and walk back to the chair and sit down. Patients walked at their regular pace and timing was recorded from standing up till sitting down back. For TUG-dual/ TUG-motor, same procedures were done while having the patient to hold a water filled cup [11].

Every task was done three times and average was taken. Each patient performed the two assessment conditions with three days' rest in between. The choice of which condition to be started with was random for each patient by selection of sealed envelopes.

All patients received the full information about purpose of the study, privacy, procedures and the use of data before study beginning and they agreed to participate, and they made a written consent for that. The study was approved by the ethical committee at Faculty of physical therapy, Cairo university (No:P.T.REc/012/002860) and was also approved by Pan African Clinical Trial Registry

(PACTR202103587471967).

2.5) Statistical analysis

Descriptive statistics will be conducted for presentation of patients' demographic data. Repeated measures MANOVA will be conducted for comparison of APSI, MLSI, OVSI, between single and dual task conditions. Paired t test was conducted for comparison of TUG between single task and dual task. The level of significance for all statistical tests will be set at $p < 0.05$. All statistical measures will be performed through the statistical package for social studies (SPSS) version 25 for windows.

3) Results

*Thirty patients with remitting – relapsing multiple sclerosis with ataxic features participated in this study. Their mean ± SD age, weight, height and BMI were 33.9 ± 3.98 years, 71.76 ± 13.2 kg, 165.83 ± 6.5 cm and 26.06 ± 4.27 kg/m² .The mean ± SD EDSS of the study group was 2.66 ± 0.66 with maximum value of four and minimum value of one. The mean ± SD MoCA of the study group was 26.66 ± 0.84 with maximum value of 30 and minimum value of 26 as shown in table (1).

*The sex distribution of the study group revealed that there were 16 females with reported percentage of 53.3% while the number of males was 14 with reported percentage of 46.7%.

Table (1: Descriptive statistics for the age, weight, height , BMI , EDSS and MoCA of the study group

	$\bar{X}$ **±SD**	**Maximum**	**Minimum**
Age (years)	33.9 ± 3.98	40	30
Weight (kg)	71.76 ± 13.2	100	50
Height (cm)	165.83 ± 6.5	181	151
BMI (kg/m²)	26.06 ± 4.27	33.43	18.37
EDSS	2.66 ± 0.66	4	1
MoCA	26.66 ± 0.84	30	26

$\bar{X}$: Mean difference SD: Standard Deviation

*There was a significant difference in APSI, MLSI and OVSI between single, tray and coin transfer tasks, with a highly significant increase in balance indices occurred at coin transfer task in comparison to single task and holding a tray task as shown in table (2).

Table (2); Comparison of balance indices between single task, tray task and coin transfer task(ANOVA test).

APSI $\bar{X}$ **±SD**			**F-value**	**p-value**	**sig**
Single task	**Tray task**	**Coin transfer task**			
2.41 ± 0.58	2.72 ± 0.89	3.06 ± 0.78	11.35	0.0001	HS
MLSI $\bar{X}$ **±SD**					
Single task	**Tray task**	**Coin transfer task**			
2.26 ± 0.46	2.43 ± 0.74	2.84 ± 0.82	14.08	0.001	HS
OASI $\bar{X}$ **±SD**					
Single task	**Tray task**	**Coin transfer task**			
3.06 ± 0.65	3.26 ± 0.84	3.84 ± 0.84	18.47	0.0001	HS

$\bar{X}$: Mean SD: Standard deviation p value: Probability value
HS: Highly significance

*The mean ± SD time at single TUG was 12.77 ± 3.86 sec while at dual TUG (TUG-motor) was

14.08 ± 4.87 sec. There was a high significant increase in the dual TUG (TUG-motor) time compared with that of single TUG (p = 0.001)

4) Discussion

This study was conducted to investigate the effect of motor dual task on balance in ataxic multiple sclerosis patients and to analyze to which extent balance indices can be changed in comparison to single task condition. All enrolled patients were diagnosed with ataxic RRMS and fulfilled the Revised McDonald's criteria for diagnosis of multiple sclerosis 2017 **[12,13]**,expanded disability status scale(EDSS) was used to assess and classify the participants ensuring equality between patients. Considered the most disabling feature in MS patients, fatigue was avoided in this study by allowing for multiple rests during study procedure, optimization of temperature, performing study procedures in days different from patients' scheduled physiotherapy program and finally, allowing for rest period three days between the single task condition and the dual task condition. Moreover, the patients randomly assigned to the starting condition i.e. eliminating any learning effects that may favor the results of the second familiarized condition over the first novel condition.

The results of the current study proved that motor dual task significantly affect ataxic MS patients' balance, such effect was higher during the "coin transfer" task than " holding a tray " task and was more prominent in BBS results than dual TUG (TUG-motor) results, suggesting the presence of subclinical balance impairments that can highly affect patients daily living and function quality without being detected during routine neurological examination and subsequently will be missed from the recommended rehabilitation program. However, these findings are contradicting to those findings in a recent study, as they found that motor dual task significantly increased the balance when compared to single task **[14,15,16].** This could be the effect of increased concentration of the patients, due to the challenge of the position patients tend to focus more on their posture leading to a more balanced state. To be mentioned this finding was observed only during holding a tray task. Dual task deficits occur in people with cognitive impairment according to the complexity of the dual task and the degree of the cognitive dysfunction **[17,18,19].**

In the current study we found that TUG and TUG-motor scores were much higher in ataxic RRMS patients with low EDSS scores than reference scores of normal subjects indicating increased safety problems in those patients. This is highly important issue because the patient group in this study was highly active and mobile. Despite their mild disability, balance and related safety problems were still an issue in such patients. Moreover, there was a significant increase in dual TUG time compared with TUG revealing that motor dual task significantly affecting MS patients dynamic balance.

In this study we attempted to find a relationship between static balance abilities, quantitatively assessed through Biodex balance system, with TUG test as it is considered a reliable clinical tool for assessing balance in MS. We found that TUG and TUG-motor scores showed weak non-significant correlation with single and dual task Biodex data respectively, these results suggest that the TUG test is more related to dynamic rather than static balance in the MS population and the existence of a relationship between static and dynamic balance abilities appears substantially poorly supported by data. The reasons for this lack of correlation may lie in the different demands posed by these postural tasks , that is during static standing, the brain subconsciously directs the attention from balance control (the low attention demanding task) to the secondary task (the high attention demanding task) and the posture control is under automatic control ,this situation reveals postural

control abnormalities; however, during the dynamic balance test, the attention is focused on the primary postural task as its now more attention demanding.

5) Conclusion

Motor dual task unmasked balance impairments in ataxic MS patients, who have a mild and stable disability, indicating a sub clinical impairment in those patients. Such impairments didn't appear in routine balance assessment, despite their lower performance than normal subjects. Static and dynamic balance assessments are not interchangeable, but rather complementary. Thus, a complete view of postural control issues associated with MS must include both static and dynamic balance assessments under varied conditions of single and dual tasking. The difficulty level of the test used to assess patients is of critical importance, it must be challenging enough to reveal the real disability status but convenient to not aggravate stress and worsen the results. The exercises, on the other hand, chosen to improve the balance in physiotherapy programs, should be difficult enough to increase the concentration level, but easy to retain the balance, as well.

Declaration of interest:

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

Funding:

None..

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