INDIVIDUALS WITH MULTIPLE SCLEROSIS PRESENT LOWER VELOCITY AND SIMILAR CADENCE TO HEALTHY PEERS

PESSOAS COM ESCLEROSE MÚLTIPLA APRESENTAM BAIXA VELOCIDADE NA MARCHA E MESMA CADÊNCIA QUE PESSOAS SAUDÁVEIS

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Abstract: Purpose: To investigate velocity and cadence in people with multiple sclerosis (MS) submitted to different walking tasks, and to compare the results with those found in healthy control peers. **Methods:** One hundred thirty-three participants, sixty-six with MS and sixty-seven without MS, were enrolled in this study. Subjects were divided into three groups according to clinical condition and disease severity. Group 1 was formed by forty mild stage subjects with MS, group 2 was composed by twenty-six moderate stage subjects with MS and group 3 was formed by sixty-seven healthy control peers. Participants' velocity (meters/second) and cadence (steps/minute) were assessed during a walking test, using a two-dimensional gait system. The tests were applied with motor and cognitive distractors. Statistical procedures involved repeated measures analyses of variance to test main effects for group and task. Significance was set at 5%. **Results:** The results showed velocity as being task- and group-dependent, *id est*, the impact on the outcome differs according to clinical condition (p=0.001; power of 99.9%) and to task complexity (p=0.001; power of 99.9%). Cadence, differently, showed to be task- but not group-dependent. That is, complex tasks affect cadence in both groups (p=0.001; power of 99.9%) but on a similar basis (p=0.290; power of 26.8%). **Conclusion:** The results suggest that in MS clinical condition and disease severity impact gait velocity on a bigger extend than cadence. Further studies should be carried out to investigate the adaptation mechanisms that occur in MS during challenging mobility situations.

Keywords: Multiple Sclerosis; Mobility limitation; Task Performance and Analysis; Multitasking behavior; Neurologic Gait Disorders.

Resumo: Objetivo: Investigar velocidade e cadência em pessoas com esclerose múltipla (EM) submetidas a diferentes tarefas de caminhada e comparar resultados com os encontrados em controles saudáveis. **Métodos:** 133 participantes, 66 com e 67 sem EM, foram incluídos neste estudo. Os indivíduos foram divididos em três grupos de acordo com o quadro clínico e a gravidade da doença. O grupo 1 foi formado por 40 indivíduos com EM estágio leve, o grupo 2 foi composto por 26 indivíduos com EM estágio moderado e o grupo 3 foi formado por 67 sujeitos controles saudáveis. A velocidade dos participantes (m/s) e cadência (passos/minuto) foram avaliados durante um teste de caminhada, usando um sistema de marcha bidimensional. Os testes foram aplicados com distratores motores e cognitivos. Para a análise estatística utilizou-se o teste de análise de variância de medidas repetidas, sob significância de 5%. **Resultados:** Os resultados mostraram que velocidade depende da tarefa e do grupo, isto é, o impacto difere de acordo com a condição clínica (p=0,001; poder: 99,9%) e tarefa (p=0,001; poder: 99,9%). A cadência mostrou-se dependente da tarefa, mas não do grupo. Ou seja, tarefas complexas afetam a cadência em ambos os grupos (p=0,001; poder: 99,9%), mas de forma semelhante (p=0,290; poder: 26,8%). **Conclusão:** Os resultados sugerem que a condição clínica e a gravidade da EM afetam a velocidade da marcha em uma extensão maior que a cadência. Novos estudos devem ser realizados para investigar os mecanismos de adaptação que ocorrem na EM durante situações desafiadoras.

Palavras-chave: Esclerose múltipla; Limitação de mobilidade; Análise de desempenho de tarefas; Comportamento multitarefa; Transtornos neurológicos da marcha

INTRODUCTION

Multiple sclerosis (MS) is an autoimmune condition that causes demyelination in the white matter of the central nervous system. The most common form of the disease is relapsing-remitting, characterized by the combination of neurological dysfunctions with remission episodes[1]. The disease progression is associated with the intensity of cellular apoptosis and with the presence of autoreactive T cells. Lymphocytes activations end up affecting the reorganization of the myelin sheath, causing several symptoms to patients[2,3].

Patients with MS suffer a wide range of motor and non-motor symptoms that impact subjects' everyday life. Previous studies reported postural instabilities, cognitive decline, balance problems, lack of coordination, and depression in MS[4-7]. While such symptoms are commonly affected during human aging, in MS the individual seems to present these symptoms early[8,9].

The impact that complex tasks has on the mobility of subjects with MS has been well studied. Fritz and colleagues[10], for example, found that patients with MS suffer a maladaptive plasticity during movement that ends up activating complementary areas of the brain – namely the supplementary motor area. When complex tasks are associated with cognitive challenges, Etemadi[11] reported that patients with MS are subject to a greater imbalance and to an increasing risk of falls.

In this study, authors performed an in-depth analysis about how disease severity impact mobility in subjects with MS. The differential of this study upon the others is that most studies focus on tasks performance and in this study authors focused on the impact of disease severity upon the task.

The hypothesis raised by the authors was that dealing with complex situations constitutes an increasing risk for subjects with MS, causing pitfalls in decision making processes. Authors expected that participants in the advanced stages of the disease would show a decreasing velocity (meters per second) and an increasing cadence (steps per minute) during mobility tasks, reinforcing a conflict between cognitive and motor demands.

METHODS

Individuals with MS were recruited from the Multiple Sclerosis Outpatient Center at the hospital complex of the Federal University of Mato Grosso do Sul. Community dwelling controls were selected according to sociodemographic measures of the MS group, ensuring homogeneity for age and sex. This research was conducted in accordance to the Declaration of Helsinki and its protocol was approved by the institutional Ethics Committee (Protocol 2111.925;CAAE: 13647513.8.0000.0021). All participants provided written consent prior the assessments.

The inclusion criteria involved participants older than 18 years, diagnosed as having relapsing-remitting MS, all sedentary, and with disease severity 0 to 6 according the Kurtzke Expanded Disability Status Scale (EDSS)[12]. The exclusion criteria involved participants with cognitive decline, individuals that were unable to walk independently, and those who had history or were using psychotropic or antipsychotic drugs. Subjects that could not

attend the outpatient center, were also excluded.

Methodological Procedures

Participants who met the inclusion criteria were divided into three groups: G1, G2, and G3. Groups were allocated according to participants' disease severity and clinical condition. Sample size calculation showed the need of a minimum of 78 participants, 26 per group. Such analysis was grounded with the delimitation of a 5% alpha error, a statistical power of 95% and an effect size of 0.4[13].

In this study, the groups were formed by 40 mild stage subjects with MS (G1), 26 moderate stage individuals with MS (G2), and 67 healthy control peers (G3). Participants' demographic and clinical characteristics are detailed in table 1.

Table 1. Demographics and clinical characteristics of the groups

Variables	G1	G2	G3	*p*
Sample size	40	26	67	0.001
Sex (Male:Female)	28:12	20:6	49:18	0.825
Age (years)	37.0 ± 12.7	43.0 ± 12.0	39.4 ± 12.5	0.163
Disease severity (points)	1.60 ± 0.8	4.3 ± 1.2	---	0.001

Data are expressed in mean ± standard deviation. Inferential analyses involved chi-squared test for sample size and sex, the one-way ANOVA for age, and the independent student t-test for disease severity

To investigate the impact of disease severity on mobility in MS, authors assessed subjects' cadence and velocity during a walking test. Cadence (steps/minute) and velocity (meters/second) were measured using a two-dimensional gait system, during a getting-up, walking, returning and seating task[14,15]. The task should have to be done as fast as possible, involving three conditions that required different capabilities: a single task, a motor dual task (carrying a glass of water), and a cognitive dual task (counting progressive odd numbers). The order of the tasks was random for each participant. The assessments involved two trained researchers, and the measures were done in a private and quiet evaluation room.

The tasks were administered after a full explanation of the procedures. Participants were advised to observe task priority (walking without spilling the contents of the cup and walking and maintaining the accuracy of the count) but they should conclude the test as fast as possible, safely, and with no help of any assistive device.

Data analysis

Descriptive statistics were used to calculate means and standard deviations. Shapiro-Wilk and Levene's tests confirmed parametric assumptions for normality and homogeneity of variances. Thus, repeated measures ANOVA was applied to estimate main effects of mobility on velocity and cadence. Outliers were excluded prior the inferential analyses[16]. The level of significance was set at 5%.

RESULTS

One hundred and fifty subjects were recruited in this study (~92% above the minimal sample size needed). Due to eligibility criteria, seventeen participants were excluded. Reasons for the exclusions were other types of MS than relapsing-remitting (n=6), participants with cognitive decline (n=5), patients unable to walk independently (n=4) and subjects aged under 18 years (n=2). The final sample was composed by one hundred thirty-three participants, sixty-six with MS and sixty-seven healthy control peers.

The variability of gait cadence and velocity in the MS and control groups is shown in Table 2.

Table 2. Variability of cadence (steps/minute) and velocity (meters/sec) according to each mobility condition.

Variables	Groups	Single task	Motor dual-task	Cognitive dual-task	Group		Task		Group vs task	
					p	Power (%)	*p*	Power (%)	*p*	Power (%)
Cadence, steps/minute	G1	84.6 ± 14.9	84.2 ± 16.0	76.4 ± 16.9	0.290	26.8	0.001	99.9	0.029	75.1
	G2	76.3 ± 19.8	78.2 ± 15.8	72.0 ± 15.5						
	G3	80.5 ± 13.3	81.6 ± 14.3	78.6 ± 14.3						
Velocity, meters/sec	G1	0.6 ± 0.2	0.6 ± 0.2	0.5 ± 0.2	0.001	99.9	0.001	99.9	0.420	30.8
	G2	0.5 ± 0.2	0.4 ± 0.2	0.4 ± 0.2						
	G3	0.6 ± 0.1	0.6 ± 0.1	0.6 ± 0.1						

Data are expressed in mean ± standard deviation. Inferential analyses involved repeated measures analysis of variance for group, task and group vs task interaction

DISCUSSION

Physical decline in MS burden patients and families. The situation gets worse with the progression of the disease, when subjects end up losing their independence on everyday activities[17,18]. In this scenario, this study investigated how velocity and cadence behavior in face of disease progression.

The use of a functional test to assess mobility showed to be useful for the achievements proposed. As alternating directions occurs in most of the movements done in everyday tasks, authors forced subjects' to deal with pitfalls during the tasks to see how efficient the response of the central nervous system is in individuals with MS[19].

The findings confirmed the authors' hypothesis when showed velocity as being task- and group- specific, *id est*, the impact on the

outcome differs according to clinical condition and to task complexity. Differently, analyses involving cadence went against authors' hypothesis. While it was expected to find interference on group and task, results confirmed cadence as being task- but not group-dependent. This finding suggests that complex tasks affect cadence in subjects with and without MS on a similar basis. An in-depth analysis of the predictors that affect mobility during single and dual tasks is important not only to understand the physiological mechanisms involved on mobility in MS, but it is also crucial when proposing new therapies to such population.

Cadence and velocity represent, along other spatial and temporal parameters, predictors directly related to patients' risk of falls. In the present study the authors believed that participants would end up decreasing the velocity and increasing their cadence as a way to guarantee a smaller and safer support base. The velocity indeed decreased as harder was the tasks performed (as expected) – corroborating previous publications[6,20,21]. The cadence, differently, increased during motor dual task (as expected) and decreased during cognitive dual tasks. This pattern suggests that patients with MS present more difficulties in processing motor dual tasks than cognitive dual tasks.

The similar pattern of cadence seen in participants with and without MS is a point that deserves reflection and complementary analyses. As detailed before, authors expected to find a higher cadence in MS subjects due to a neurophysiological response that indirectly would have decrease the step length and would have made support bases smaller and safer for the patient. The similar pattern between groups can either suggest that the tasks were not as demanding to impact cadence, or it can imply that such predictor is not affected on mild to moderate subjects with MS. Further studies with more challenging situations are necessary to confirm such premise.

The findings of this study on velocity and cadence shall be useful for health care professionals. As stated by Muratori and colleagues[22], gait parameters are a sensitive biomarker of disease progression and they must guide professionals during analysis of interventions' effectiveness.

It is worth mentioning that the data are grounded by a representative sample size, which has exceeded in more than 70.5% the minimum amount of subjects required. The strong power of the statistical analyses (seen in table 2) gives the authors the support to affirm that the type-1 and type-2 errors were controlled, ensuring that no false-positive or false-negative data affected the results.

Limitations

Although the current study provides important information on mobility in individuals with MS, it has some limitations that need to be considered. First, it is important to emphasize that only participants with mild to moderate degrees of compromise resulting from MS were enrolled in this study. The exclusion of subjects with a severe compromise was because independence of locomotion is unusual in advanced stages of the disease[23]. In addition, none of the participants had cognitive impairment – although this aspect is common in MS[24]. The reason for excluding

subjects with cognitive impairment was because the cognitive decline could make the understanding of the tasks difficult. The results, thus, may not be generalizable to people with more severe MS and to those with cognitive impairment.

CONCLUSION

The results suggest that, in MS, clinical condition and disease severity impact gait velocity on a bigger extend than cadence. Considering that one of the goals of health care professionals is to promote functional independence and improve patients' quality of life, the results may support professionals in planning new therapies.

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