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Effects of mental practice associated with motor physical therapy on gait and risk of falls in Parkinson's disease: a pilot study

Efeitos da prática mental associada à fisioterapia motora sobre a marcha e o risco de quedas na doença de Parkinson: estudo piloto

Efectos de la práctica mental asociada a la fisioterapia motora sobre la marcha y el riesgo de caídas en la enfermedad de Parkinson: estudio piloto

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ABSTRACT | The objective of this pilot study, carried out in a university hospital of reference in Pernambuco, was to assess the effects of mental practice associated with motor physical therapy on gait and the risk of falls in people with Parkinson's disease. The study sample consisted of 18 subjects, of both sexes, with idiopathic Parkinson's disease, divided into experimental group (8 individuals) and control group (10 individuals). Both groups performed fifteen 40-minute sessions of motor physical therapy twice a week. In the intervention group, physical therapy was associated with mental practice (15 minutes). Regarding the primary outcome variables, the duration of the timed up and go test and of the 10-meter walking test reduced, but the difference was not significant. Speed, cadence and dynamic gait index increased after the intervention in the experimental group, with a significant difference (p=0.02). The number of steps was maintained in both groups. The results suggest that the mental practice associated with motor physical therapy reduces the risk of falls compared with applied motor physical therapy alone.

Keywords | Parkinson Disease; Gait; Accidental Falls; Imagination.

RESUMO | O objetivo deste estudo piloto, realizado em um hospital universitário de referência em Pernambuco, foi avaliar os efeitos da prática mental associada à fisioterapia motora sobre a marcha e o risco de queda em pessoas com doença de Parkinson. A amostra da pesquisa foi composta por 18 sujeitos, de ambos os sexos, com doença de Parkinson idiopática, divididos em grupo experimental (8 indivíduos) e controle (10 indivíduos). Ambos os grupos realizaram 15 sessões de 40 minutos de fisioterapia motora, duas vezes por semana. No grupo de intervenção, a fisioterapia foi associada a prática mental (15 minutos). Em relação às variáveis de desfecho primário, o tempo de execução do *timed up and go* e do teste de caminhada de 10 metros reduziu, mas a diferença não foi significativa. Em relação à velocidade, cadência e escore do *dynamic gait index,* houve aumento após a intervenção no grupo experimental, com diferença significativa (p=0,02). O número de passos foi mantido em ambos os grupos. Os resultados sugerem que a prática mental associada à fisioterapia motora reduz o risco de quedas em comparação com a fisioterapia motora aplicada isoladamente.

Descritores | Doença de Parkinson; Marcha; Acidentes por Quedas; Imaginação.

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RESUMEN | El objetivo de este estudio piloto, realizado en un hospital universitario de referencia en Pernambuco, fue el de evaluar los efectos de la práctica mental asociada a la fisioterapia motora sobre la marcha y el riesgo de caída en personas con enfermedad de Parkinson. La muestra de la investigación fue compuesta por 18 sujetos, de ambos sexos, con enfermedad de Parkinson idiopática, divididos en grupo experimental (8 individuos) y de control (10 individuos). Ambos grupos realizaron 15 sesiones de 40 minutos de fisioterapia motora, dos veces por semana. En el grupo de intervención, la fisioterapia se asoció a la práctica mental (15 minutos). En cuanto a las variables de desenlace primario, el tiempo de ejecución del *timed up and go* y de la prueba de caminata de 10 metros se redujo, pero la diferencia no fue significativa. En cuanto a la velocidad, cadencia y puntaje del *dynamic gait index*, hubo aumento después de la intervención en el grupo experimental, con diferencia significativa (p=0,02). El número de pasos se ha mantenido en ambos grupos. Los resultados sugieren que la práctica mental asociada a la fisioterapia motora reduce el riesgo de caídas en comparación con la fisioterapia motora aplicada aisladamente.

Palabras clave | Enfermedad de Parkinson; Marcha; Accidentes por Caídas; Imaginación.

INTRODUCTION

Parkinson's disease (PD) is the second most common neurodegenerative disease, affecting millions of people around the world. It is estimated that by 2030, between 8.7 and 9.3 million people worldwide will have the disease and that by 2020 more than 40 million will have motor disorders secondary to PD[1]. The appearance of the main signs and symptoms of PD is related to the dysfunction of the nigrostriatal pathway, culminating with changes in the control of automatic movements essential for the gait[2].

PD gait is characterized by anterior trunk flexion, restriction in upper limb balance, reduction in gait length and, mainly, decrease in the walking speed. As gait disturbances are associated with falls and reduced independence, great efforts are directed towards the treatment of these alterations[3].

Falls, common among older people, are one of the main clinical and public health problems. They are factors of morbidity and mortality in individuals over 65 years of age and are a concern because of the frequency with which they occur and the consequences that they have on the quality of life of older adults[4].

Although pharmacological therapy is the basis of PD treatment, physical therapy is also important, seeking to minimize or delay the evolution of symptoms and provide greater functionality and consequent improvement in the quality of life[5].

Mental practice (MP) has been suggested as a possibility of auxiliary therapy in the motor rehabilitation of patients with neurological disorders. MP is a training method that promotes the activation of cerebral areas related to movement, allowing movements that were once unconsciously accessed to be accessed consciously[6]. MP occurs through a mental simulation repeated several times in the absence of any movement, and it can be performed kinesthetically, when the patient feels or visualizes the imagined movement[7].

Although previous studies[8-10] have not found clinical evidence of the use of MP in PD, other studies [11-13] suggest the opposite, not clarifying the effectiveness of the strategy in this population. The scarcity of publications limits the conclusions about the effects of MP in PD, and it is important to carry out more research on the subject.

Given this context, the objective of this study was to evaluate the effects of MP associated with motor physical therapy (MPT) on gait and risk of falls in PD patients. The hypothesis was that MP associated with MPT can show better results on gait and risk of falls than MPT alone.

METHODOLOGY

Study design and ethical considerations

A randomized evaluator-blinded trial was conducted according to the Consort checklist. Allocation to the control (CG) and experimental (EG) groups was done by simple draw. Experienced and distinguished physical therapists performed the assessments (screening and outcome) and the intervention.

Participants

Subjects of both sexes with clinical diagnosis of idiopathic PD according to Ordinance no. 228/2010 of the Brazilian Ministry of Health[14], with classification from I to III in the original Hoehn and Yahr scale[15], treated at a university hospital of reference in Pernambuco. Patients with other neurological diseases, decompensated systemic diseases, musculoskeletal alterations that hindered the movements, lowering of the cognitive level evaluated through the mini-mental state exam[16,17], dyspnea, medical restriction to perform exercises, moderate to severe depression assessed by Beck's depression inventory[18], participation in a rehabilitation program, and patients who were unable to perform the motor imagery during the application of the kinesthetic and visual imagery questionnaire were excluded[19].

To characterize the sample we collected: age, time of diagnosis, disease stage (HY), mental status (MMSE) and mood (BDI). The 10-meter walk test (10MWT)[20] was used to evaluate spatiotemporal gait parameters, and the dynamic gait index (DGI)[21] and timed up and go (TUG)[22] test were used to evaluate the risk of falls.

10-meter walk test

The spatiotemporal and kinematic attributes of gait were evaluated through this test, which requires a 10-meter walk in a straight line, the initial 2 meters being reserved for acceleration, 6 meters for walking at comfortable speed and 2 final meters for deceleration in order to analyze the speed, cadence, number of steps and time to cover 6 meters. The result of the assessment was obtained through the average of three tests.

Dynamic gait index and timed up and go test

These tests were used to assess the risk of falls. DGI consists of eight tasks involving walking, developed in different situations – along with head rotation movements, for example. Results of 19 points or less are considered as cutoff points for risk of falls.

In TUG, the patient is instructed to get up from a chair, walk for ten meters, turn around, return and sit back on the chair. An execution time of 10 seconds or less indicates a low risk of falls, 20 seconds or less indicates a medium risk of falls, and 30 seconds or more indicates a greater risk of falls. TUG was performed once for patient familiarization and then three more times, and the result was obtained through the mean of the three tests.

Intervention

The EG patients performed 15 individualized sessions, twice a week, with 40 minutes of MPT followed by 15 minutes of MP. The CG patients received the same care, except for the MP. The assessment of the patients occurred one day before the first session, and the reassessment was on the day after the 15th session, that is, after approximately two months of intervention.

The MPT protocol common to both groups was developed by the Pro-Parkinson Program, based on the European physical therapy guideline for PD, aiming to standardize the practice of evidence-based physical therapy[23].

The MPT protocol was composed of nine exercises divided into three levels of difficulty, with evolution every five sessions. Each MPT session consisted of exercises that included: decubitus training, strengthening (with emphasis on lower limbs), reaching exercises, scapular and pelvic girdle dissociation, trunk, gait and step control training, balance and proprioception.

Gait training was carried out in the parallel bar and progressed for a space of 10 meters. In the parallel bar, the patients were instructed to go forward until the end of the parallel bar and to return backwards; then the lateral gait was trained; and, finally, patients were instructed to walk forward, as fast as possible, and return. Ten replicates of each sequence were performed. In the space of 10 meters, the training was guided so that the patient varied the gait speed from "normal" to the fastest possible. The difficulty of the training was increased by adding half-kilo shin guards.

Step training was performed with alternating lower limbs at three distinct speeds, at the therapist's command ("normal/comfortable," "faster than normal" and "slower than normal") and a uni, bi and tridirectional way. Both the lower limb that would start the training and the direction to be followed were drawn at the time of the training.

The MP protocol for step training was developed by the team of physical therapists of the Pro-Parkinson Program, based on the PhD thesis of Paz[24]. As soon as he could identify and sequence the joints and movements needed to take a single step (flexion of the thigh and leg, leg extension, foot dorsiflexion, heel touch, foot weight discharge and leaning the body forward), the patient was oriented by the physical therapist to verbally describe the movements required to perform a single step while executing them (first phase of the MP protocol). Then the patients were instructed to verbally describe the movements required to take a single step while imagining themselves performing the step, retaking each component mentally (second phase of the protocol). In the last phase of the MP protocol, the patient was instructed to just imagine the step and try, during the imagery, resume the kinematic components trained. Phases 1 and 2 of the protocol aimed to prepare the patient for the motor step imagery. Each phase was performed in a series of 10 repetitions. In all sessions the patient was instructed to use the lower limb most affected to perform the task and perform the visual motor imagery.

To monitor individuals during all MP sessions, the time used by the patient to perform the first and third phases of the protocol was timed, in a strategy already described in the literature[25]. A self-adhesive and disposable sham electrode was also used, connected to the electroencephalograph, aiming to potentiate patient engagement during MP. Through this procedure the patients believed that the MP was being monitored by the equipment, but, despite visualizing the connected device, monitoring was not being performed (sham effect).

Statistical analysis

Data were analyzed using Statistica 13.2 software, considering $p<0.05$. The Kolmogorov-Smirnov test was used to verify normality. For the normal variables, we used repeated measures Anova, and for sphericity correction, Greenhouse-Geisser was used. For non-normal variables, the Mann-Whitney test was used. The time to perform phases 1 and 3 of MP was analyzed by paired T-test.

RESULTS

The sample consisted of 18 subjects, 8 in the EG and 10 in the CG (Figure 1). In both groups the patients had mild to moderate PD, absence of depression or minimal depressive symptoms and more than seven years of schooling. The groups were considered comparable before the intervention (Table 1).

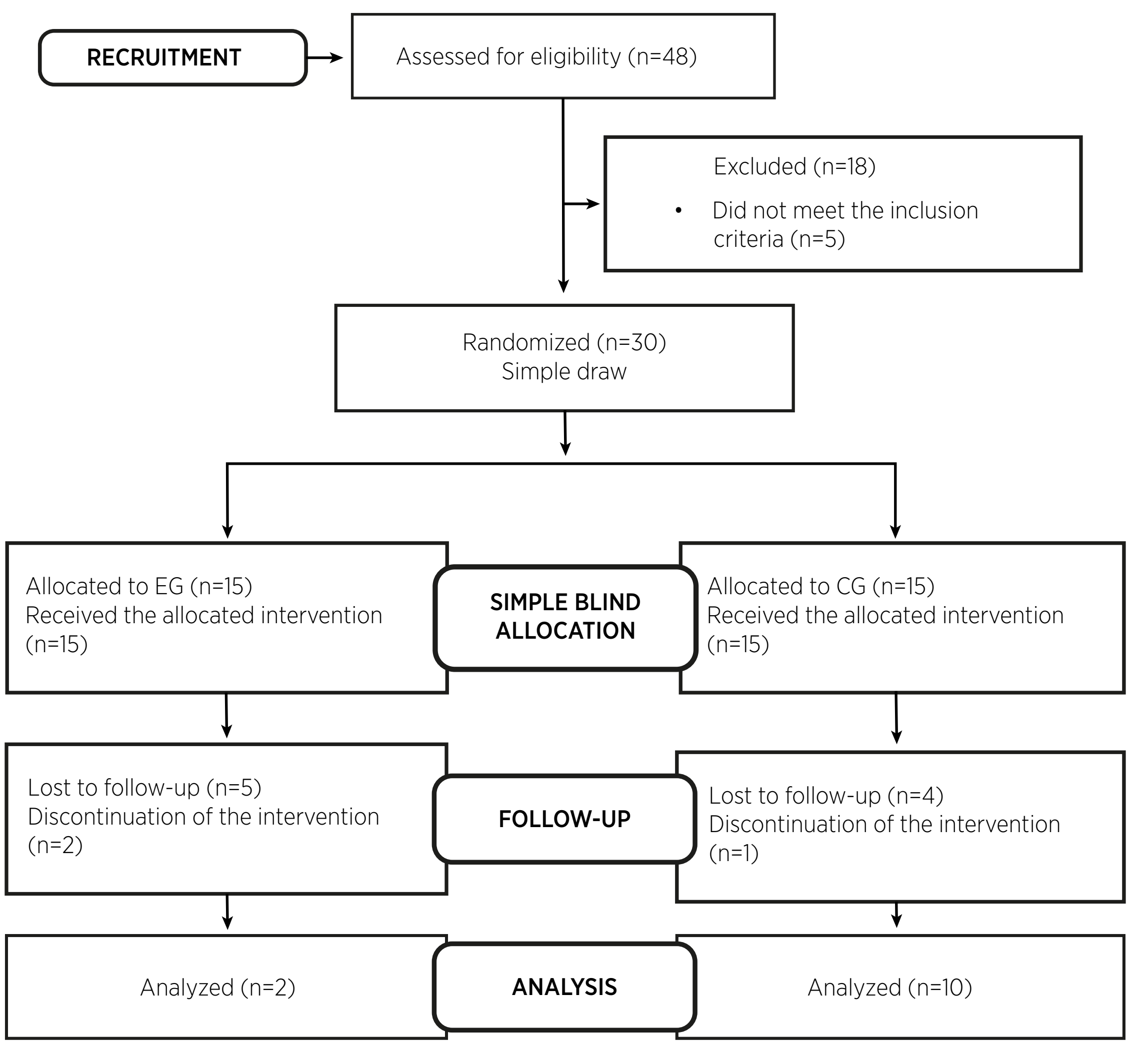

Figure 1. Flowchart of sample constitution

Table 1. General characteristics of the sample

	EG (n=8)	CG (n=10)	
	Mean (±)	Mean (±)	P
Age	63 (8)	64 (7)	0.78
Time of diagnosis	04 (3)	06 (4)	0.42
HY	02 (1)	02 (0)	1.00
BDI	08 (5)	09 (6)	0.70
MMSE	28 (2)	28 (2)	0.59

P: T test for continuous variables and Mann-Whitney test for ordinal variables; EG: experimental group; CG: control group; HY: Hoehn and Yahr scale; BDI: Beck's depression inventory; MMSE: mini-mental state exam; Mean (±): mean (standard deviation).

The results of 10MWT did not show main effect for group. In each analyzed parameter of 10MWT there was a main effect for time (assessment *vs.* reassessment), except for the speed parameter. 10MWT parameters: time (expressed in seconds, p=0.004), number of steps (p=0.005), speed (expressed in meters/second, p=0.432) and cadence (expressed in steps/second, p=0.007). There was no interaction (Figure 2).

In EG, there was a significant increase in the DGI score after the intervention, that is, there was an improvement in functional mobility with a reduction in the risk of falls (Figure 3). Regarding the TUG, no main effect for group was found. In both groups there was a decrease in the time to perform the test (Figure 4).

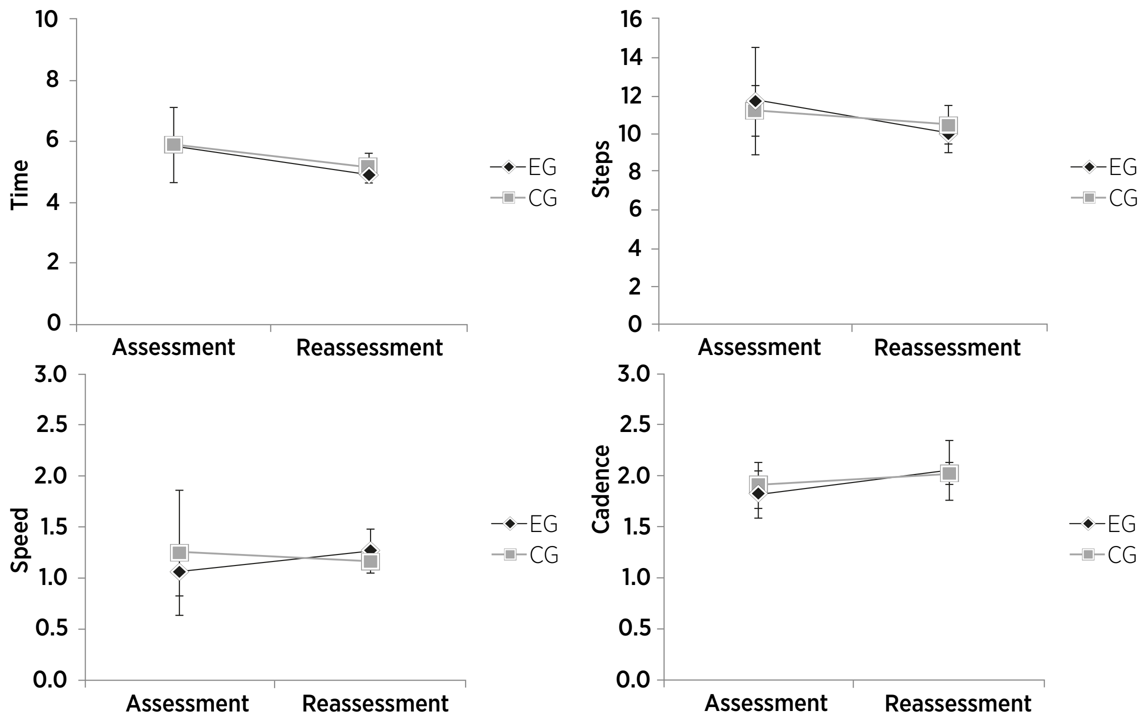

Figure 2. Repeated measures Anova of the 10MWT
EG: experimental group; CG: control group. Two repeated measures in each group for the parameters: time, number of steps, speed and cadence. Main effect group and main effect time (assessment and reassessment) were analyzed. No main effect for group was found in the parameters. Main effect for time was observed in all parameters, except for speed.

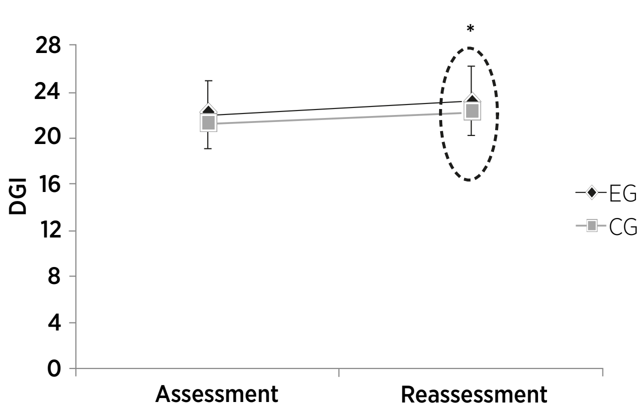

Figure 3. Results of the intervention in the groups in relation to the dynamic gait index (Mann-Whitney test)

*p=0.026; DGI: dynamic gait index; EG: experimental group: CG: control group.

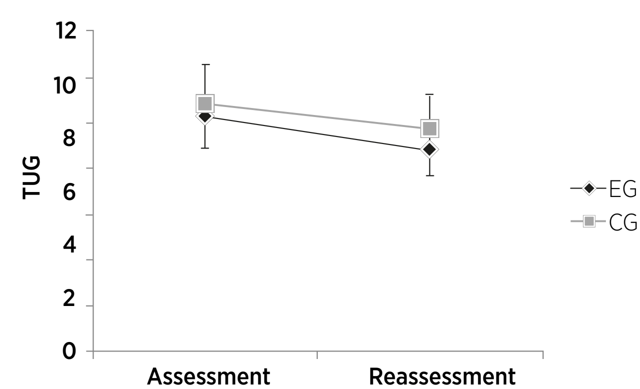

Figure 4. Repeated measures Anova of the timed up and go test of patients with Parkinson's disease.
TUG: timed up and go test, expressed in seconds; EG: experimental group; CG: control group. Two repeated measures in each group for time (expressed in seconds). Main effect group and main effect time (assessment and reassessment) were analyzed. No major effect for group was found. Main effect for time p=0.001.

Regarding the results of the time (expressed in minutes) of phase 1 of MP, the averages of the first and last sessions were respectively 2.3 (0.5) and 1.3 (0.5) (paired T test, p=0.01). In phase 3, the time averages of the first and last sessions were respectively 2.1 (0.8) and 1.4 (0.5) (paired T test, p=0.01).

DISCUSSION

The findings of this research confirm the hypothesis that MP associated with MPT promotes better results on the risk of falls when compared with MPT applied alone, but they do not confirm the same hypothesis regarding the gait.

No TUG results were found to be significant in relation to the risk of falls. However, the study by Tamir, Dickstein and Huberman[12], whose objective was to compare the treatment of MPT associated with MP with MPT applied alone in PD, showed a significant improvement in the TUG performance. This result may be associated with the type of MP protocol adopted in the study, which included MP of activities such as standing and sitting, different from that adopted in this study. Regarding the assessment of the risk of falls, using the DGI, the result in the EG was superior in comparison with the CG. This result suggests better motor learning and planning in EG.

Better motor learning is of great importance in the rehabilitation of patients with PD, because, besides allowing the storage and consolidation of information related to a particular motor task in long-term memory, it increases the spatial and temporal accuracy of movement. Motor planning contributes to motor rehabilitation, allowing the organized execution of a sequence of movements[26,27].

Neuroimaging studies performed in patients with PD showed activation of cortical regions involved mainly in motor planning and learning during motor imagery of gait.[28-30] The participation of these areas is of great importance in the rehabilitation of these patients, since PD causes changes in the circuits of the nuclei of the base, which are brain structures that aid in the planning and execution of movements.

DGI also enables the patient's dynamic balance to be evaluated. Thus, the outcome in relation to the risk of falls may also be associated with an improvement in balance. The study by Cha and Kim[31], conducted with healthy adults, found that the application of MP with jump training positively affected the balancing ability compared with the group that performed only the jump training.

Among the significant results is the shorter response time of the actual execution of the step, which may also indicate better motor learning and planning in the EG. The average time to perform the actual step and its mental simulation shows little difference. A previous study shows that the smaller the difference between the duration of the real movement and the duration of the motion simulation, the more vivid is the motor imagery[25]. It is noteworthy that up to the present moment there are no published studies that used the DGI in the assessment of the mental practice associated with motor physical therapy in patients with PD.

As in the TUG, no significant intergroup results were found in relation to gait parameters assessed by 10MWT. The intragroup analysis showed a significant result in the EG in all parameters of the 10MWT, except for speed. We believe that the motor learning provided by the MP leads the patient to perform the movements with prior planning, without the usual automatism (deficit in PD), making the task slower. Perhaps the training performed with speed variation during MP, similar to the MPT protocol, is an alternative to this issue. On the other hand, the cognitive demand necessary to perform the MP of a complex task can hinder its execution even in healthy people.

It is important to highlight that a "ceiling effect" may have provided the maintenance of the results between the groups, which is considered a gain, given the progressive characteristic of PD.

The 10MWT was also used by Braun et al.[10] to verify if the mental practice associated with motor physical therapy was more effective than the motor physical therapy associated with relaxation in the improvement of the mobility of people with PD. Corroborating the results of this study, Braun et al.[10] did not find results in 10MWT that confirmed the superiority of the efficacy of mental practice in relation to relaxation in the improvement of the mobility of people with PD. Among the justifications for the result, Braun et al.[10] mentioned the size of the sample and the difficulty in monitoring MP, which was also performed by the patients at home, without the therapist's supervision.

The variety of MP protocols used in the studies and the non-alignment between MPT and MP protocols observed in the literature make it difficult to compare the studies and limit the conclusions about the effects of MP on motor parameters in PD.

Limitations of the study

The lack of assurance that the patient actually performs MP is one of the most important limitations to the use of this strategy. To minimize this possibility, we timed the first and third phases of MP and fixed a sham electrode, which was supposed to monitor MP, on the patient's scalp. Other limitations were the lost to follow-up and discontinuation of the intervention in both groups, mainly due to the outbreak of arboviruses (such as dengue, zika and chikungunya) that affected the region. We also emphasize that the number and frequency of the sessions may have limited the expected gains.

CONCLUSION

In this pilot study, MP associated with MPT enhanced both motor learning and planning as well as the dynamic balance, promoting more effective results in reducing the risk of falls in PD patients than MPT alone. Regarding gait, we did not find results in the studied kinematic components that showed the superiority of MP associated with conventional physical therapy.

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