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Immediate effects of adding mental practice to physical practice on the gait of individuals with Parkinson's disease: Randomized clinical trial

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Abstract.
BACKGROUND: Mental practice has shown benefits in the rehabilitation of neurological patients, however, there is no evidence of immediate effects on gait of individuals with Parkinson's disease.
OBJECTIVE: Determine the effects of mental practice activity added to physical practice on the gait of individuals with Idiopathic Parkinson's Disease (IPD).
METHODS: 20 patients classified with stage 2 and 3, according to the Hoehn and Yahr scale were randomized into 2 groups. The experimental group ($N = 10$) was submitted to a single session of mental practice and physical practice gait protocol and the control group ($N = 10$) only to physical practice. The primary outcomes were stride length and total stance and swing time. Secondary outcomes were hip range of motion, velocity and mobility. Subjects were reassessed 10 minutes, 1 day and 7 days after the end of the session.
RESULTS: There was no statistically significant difference between the groups. An intragroup difference was observed in velocity, stride length, hip range of motion, and mobility, as well as total stance and swing time. These results were also observed on follow-ups.
CONCLUSIONS: Mental practice did not have a greater effect on the gait of individuals with IPD than physical practice, after a single session.

Keywords: Primary parkinsonism, motor imagery, three-dimensional gait analysis

1. Introduction

Subjects with Parkinson's Disease (PD) exhibit important alterations in balance and gait, which are responsible for severe limitations in daily functions and functional independence (Schrag, 2000). Over the years, research has shown the importance of using

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external cues associated with physical practice, since the progress of the disease makes it more difficult to perform active and automatic movements, such as gait (Griffin et al., 2011; Jahanshahi et al., 1995).

External cues require attention (Lim et al., 2010; A Nieuwboer et al., 2007) and the frontal cortex regions are used to control the execution of movements similarly to what occurs in the initial phases of learning, when there is still no automatism in the execution of movements (Boutin & Blandin, 2010; Cohen et al., 2012). Thus, they appear to provide information that reduces the need for internal planning and improves the pattern executed (Alice Nieuwboer, 2008).

Another cognitive strategy that also demands attention to the sequence of trained movements is mental practice, defined as imagining a motor action without its physical execution, performed repeatedly, in order to improve motor performance (Dickstein & Deutsch, 2007; Guillot et al., 2009; Solodkin, Hlustik, Chen, & Small, 2004). Mental practice has been used in studies with different populations, primarily its kinesthetic modality (Leifert-Fiebach, Welfringer, Babinsky, & Brandt, 2013; Schuster et al., 2011), when the individual imagines performing the motor task and attempts to perceive the kinesthetic sensations of movement (Malouin & Richards, 2010). This modality seems to contribute to the activation of sensory-motor networks (Sirigu & Duhamel, 2001), facilitating motor learning, motor preparation, planning, precision movements and muscle activation (Grabherr, Jola, Berra, Theiler, & Mast, 2015; Schuster et al., 2011). This phenomenon is attributed to the central reorganization of motor programs, which makes this method a promising means for rehabilitating patients with different types of neurologic disorders, although their applicability in individuals with PD remains unclear (Fontani et al., 2007; Heremans et al., 2011; Malouin, Jackson, & Richards, 2013).

Mental practice exhibits a number of advantages that can help in motor rehabilitation, including the possibility of increasing the number of repetitions in a safe and autonomous manner and using more complex training tasks, such as gait (Malouin et al., 2013). Studies that investigated the effects of mental practice on patients with PD combined mental practice with physical practice, but there is still no consensus regarding the results. Whereas two studies (El-Wishy & Fayez, 2012; Tamir, Dickstein, & Huberman, 2007) showed an improvement in gait and motor task execution time when comparing physical practice combined with mental practice to physical practice alone, a multicenter study (Braun, Beurskens, Kleynen, Schols, & Wade, 2011) observed no difference between mental practice and relaxation with respect to mobility. Furthermore, the protocols and training time varied and the lack of follow-up did not allow confirming the retention time of the effects observed.

Studies in patients with PD that demonstrated effective results used different training periods, ranging from 12 to 24 sessions (El-Wishy & Fayez, 2012; Tamir et al., 2007), but it is necessary to determine how many sessions obtained positive results in this population. It is known that in hemiparetic subjects a single mental practice session promotes significant changes in the ability to rise and sit with the affected limb, results positively related with working memory (Malouin, Belleville, Richards, Desrosiers, & Doyon, 2004). However, in subjects with PD working memory is compromised (Rottschy et al., 2013), and it is not known at which point this cognitive impairment begins to interfere with the quality of movement. It is therefore important to determine whether a single mental practice session is capable of changing the movement pattern of this population, since in the mild and moderate phases of the disease subjects retain the ability to clearly imagine a motor task (Heremans et al., 2011).

Thus, does a single mental practice session improve the gait of patients with PD? Do these effects remain after 1 and/or 7 days? We therefore intend to determine the immediate effects of mental practice added to physical practice on the gait of individuals with idiopathic PD (IPD) and if the benefits persist after 1 and 7 days of training. It is hypothesized that the group submitted to mental practice will exhibit greater gains in the kinematic variables of gait when compared to the group submitted only to physical practice, immediately after the single training session, without retaining the effects.

2. Methods

2.1. Design

This is a randomized, blind, controlled clinical trial conducted under CONSORT recommendations, at the Laboratory of Interventions and Analysis of Movement of the Federal University of Rio Grande do Norte. It was carried out according to a neurologist's report and based on London Brain Bank criteria (Hughes, Daniel, Kilford, & Lees, 1992), whereby subjects were non-probability recruited.

2.2. Participants

Subjects with IPD had to be taking antiparkinsonian medication; be between stages 2 and 3 on the Modified Hoehn and Yahr Scale; be walking independently without any type of orthesis or gait-assistive device (Functional Ambulatory Category scores between 3 and 5) for at least 10 meters and not have undergone stereotaxic surgery.

2.3. Assessment instruments

Sociodemographic, clinical and anthropometric data were assessed using an identification form. Cognitive impairment was evaluated using the validated Brazilian version of the Montreal Cognitive Assessment (MoCA) (Nazem et al., 2009) and level of physical incapacity by the Modified Hoehn and Yahr Scale (Schenkman et al., 2001). The ability to perform gait was assessed by the Functional Ambulatory Category (FAC) (Holden, Gill, Magliozzi, Nathan, & Piehl-Baker, 1984). The clarity of the motor image in the kinesthetic modality was assessed by the Revised Movement Imagery Questionnaire (MIQ-R) (Williams et al., 2012). To detect the degree of disease progression and pharmacological treatment efficacy, the Motor Exploration and Activities of Daily Living domains of the Brazilian version of the efficacy of the Unified Parkinson's Disease Rating Scale (UPDRS) were applied ("The Unified Parkinson's Disease Rating Scale (UPDRS): status and recommendations.," 2003). Basic mobility was assessed by the Timed Up and Go Test (TUG Test) (Huang et al., 2011). Postural stability during different tasks involving gait was assessed by Functional Gait Assessment (FGA) (Leddy, Crowner, & Earhart, 2011). Kinematic evaluation of gait was conducted using the Qualisys Motion Capture Systems (Qualisys Medical AB, 411 13, Gothenburg, Sweden), which allows recording the spatiotemporal variables of gait, as well as angular variations in hip, knee and ankle joints.

2.4. Procedures

Subjects were randomly allocated, using the randomization.com website, into two groups: Control Group (CG, $N = 10$) and Experimental Group (EG, $N = 10$). Both groups identified the typical alterations in parkinsonian gait and memorized the stages of normal gait. The EG was submitted to a mental practice and physical practice gait protocol and the CG only to physical practice of gait.

Allocation was kept secret during the entire study. Twenty sealed envelopes were opened by the researcher responsible for conducting training, but only during the training of each participant. The researcher/evaluator responsible for initial assessment (Baseline), reassessment 10 minutes (Post-test 1), 1 day (Post-test 2) and 7 days (Retention) after training, was kept blind during the collection period.

2.5. Intervention

The single training session, conducted on the day following initial assessment, was subdivided into 7 steps, performed by both groups (1, 2, 3, 5 and 7) or only by the EG (4 and 6).

Stage 1: Both groups identified the alterations they observed in their own gait movements after the emergence of disease symptoms. Next, the researchers explained the difference between normal and parkinsonian gait.

Stage 2: Both groups memorized the phases of normal gait with the help of 9 cards containing images of a healthy elderly person executing postural movements, onset of gait and the normal phases of gait. After memorization, subjects followed the gait sequence, initially with assistance and then without assistance, five consecutive times. Participants' feet were marked with red adhesive tape (right foot) and blue adhesive tape (left foot). Furthermore, if the participant was male, they were shown cards with the image of an elderly man, and if they were female, an image of an elderly woman, to allow the subject to better identify with the image.

Stage 3: A representative keyword was created for each card. When the individual managed to put the first 9 cards in order, 6 more representing one step with the right lower limb and one with the left were added, for a total of 15 cards. The participant was asked to put them in order three more times, without assistance.

Stage 4: Only the EG performed mental practice during gait. Subjects remained comfortably seated and were instructed to keep their eyes closed and imagine each step of gait. They were encouraged to "feel the movement", emphasizing the kinesthetic perspective of the mental task. At the same time, they were asked to verbalize the keywords on the cards, indicating the imagination of each step of the movement, which allowed the researcher to count the number of steps imagined. This stage was divided into 3 series (30 seconds apart) of 10 repetitions, with 8 steps per repetition, totaling 240 imagined steps.

Stage 5: Both groups performed physical practice during gait. All the subjects walked in 3 series of 10 repetitions, 8 steps per repetition, totaling 240 steps executed.

Stage 6: Mental practice in a complex setting was performed only by the EG, who imagined themselves walking on a busy street and shopping at a supermarket. Each situation was imagined in 1 series of 10 repetitions, 8 steps per repetition, totaling 160 imagined steps.

Stage 7: At the end, both groups performed physical practice during gait in a complex setting. The busy street was simulated by placing obstacles (a step, 2 cones and one 0.50m-high door). The supermarket was simulated with cards containing images of supermarket products on the wall of a corridor. Subjects were instructed to walk along the corridor avoiding the obstacles or removing the cards in 1 series of 10 repetitions, with 8 steps per repetition, totaling 160 steps executed.

2.6. Outcome measures

The primary outcomes were stride length and total stance time, assessed by the *Qualisys Motion Capture System*. The secondary outcomes were hip range of motion and velocity, assessed by same system, and mobility by the TUG Test.

2.7. Statistical analysis

The *Statistical Package for the Social Sciences* 17.0 was used, with a 5% significance level. Normal data distribution was verified by the Shapiro–Wilk test. The Mann-Whitney and non-paired T-tests verified intergroup homogeneity at baseline. Repeated measures ANOVA showed the intergroup interaction at baseline and at 3 post-training moments.

2.8. Ethical procedures

The initial project was approved by the Research Ethics Committee of Federal University of Rio Grande do Norte under protocol number 275.155, in compliance with National Health Council recommendations and in accordance with Resolution 466/12. The protocol of this trial was registered under NCT02118506 at *ClinicalTrials.gov Protocol Registration System.*

3. Results

A total of 20 individuals with IPD, 14 men and 6 women, aged 61.35 years (SD = ±9.26) took part in this study. Figure 1 describes the flow of participants. Table 1 shows means/medians and standard deviation/interquartile range of the two groups, demonstrating no significant difference between the groups at baseline.

There was no intergroup difference in the variables analyzed. Intragroup comparison, however, showed a significant difference in Post-test 1, Post-test 2 and Retention, where both groups exhibited altered movement patterns.

Table 2 shows intragroup comparisons between spatiotemporal variables. Post-test 2 exhibited a significant increase in velocity ($F = 10.6$; $P < 0.001$) and stride length ($F = 5.2$; $P = 0.01$). The same result was found for Retention ($F = 10.6$; $P = 0.005$ and $F = 5.2$; $P = 0.004$, respectively). Post-test 2 also showed a significantly lower execution time on the TUG Test ($F = 4.94$; $P = 0.03$), which was also observed for Retention ($F = 4.94$; $P = 0.04$).

In Post-test 1 there was a significant increase in total swing time ($F = 10.6$; $P < 0.001$) and total stance time ($F = 11.4$; $P < 0.001$). However, in Post-test 2 and Retention there was a return to baseline values. There was no change in double stance time ($F = 2.79$; $P = 0.07$) over time.

Table 3 presents the results of intragroup comparisons in relation to the angular variables of the more affected limb, in the sagittal plane. Only hip range of motion increased significantly in Post-test 2 ($F = 4.67$; $P = 0.01$), as well as in Retention ($F = 4.67$; $P = 0.01$). There were no significant changes in knee and ankle range of motion over time.

4. Discussion

Performing mental practice requires that individuals be aware of the stages of movement to be imagined and sequential movements can be learned both through mental imagination and the use of keywords that represent the stages of the movement (Saimpont et al., 2013). In the present study, individuals from both groups were informed about the main alteration in gait pattern after disease onset and the necessary adjustments to improve this pattern. Next, all subjects participated in organizing the cards and memorizing the keywords, which represented the phases of gait. Given that both groups exhibited changes in spatiotemporal gait patterns, we suggest that the fact that the CG had also undergone sequential organization of movement may have influenced the results obtained.

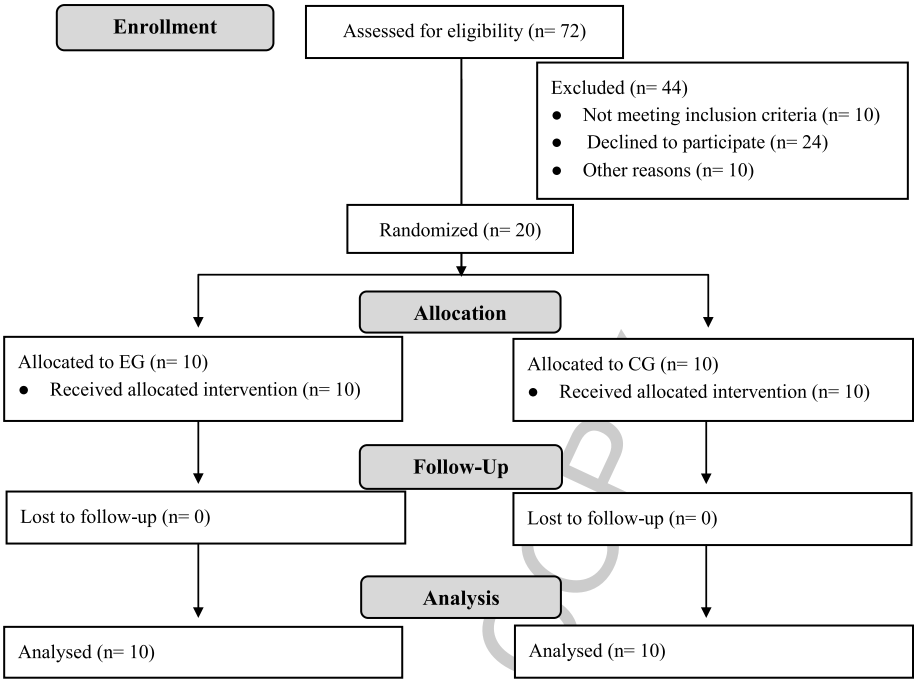

Fig. 1. Flow of participants.

Table 1
Intergroup comparison at baseline

Variable	Pre-intervention condition		
	CG	EG	*P*
Age (years)	61.40 ± 9.05	61.30 ± 9.95	0.98
Weight (Kg)	69.50 ± 13.23	68.99 ± 8.22	0.91
Height (cm)	166.0 (159.0–171.25)	169.0 (156.5–170.25)	1.00[a]
Time since diagnosis (years)	4.0 (2.0 – 8.25)	5.0 (4.0 – 9.0)	0.17[a]
MoCA	23.30 ± 5.55	23.70 ± 3.77	0.85
H and Y	2.25 (2.0 – 3.0)	2.75 (2.0 – 3.0)	0.27[a]
MIQ-R – Kinesthetic	19.78 ± 3.70	21.00 ± 3.55	0.47
UPDRS – ADL	14.70 ± 5.51	17.60 ± 5.14	0.24
UPDRS – Motor	20.90 ± 14.85	27.60 ± 10.04	0.25
TUGTest (s)	10.95 (10.0 – 13.89)	12.0 (10.92 – 14.37)	0.27[a]
FGA	21.90 ± 4.55	18.20 ± 4.61	0.08

[a]Significance determined by the Mann-Whitney test. Values are presented as mean ± standard deviation and median (quartiles 25–75). Abbreviations: MoCA: *Montreal Cognitive Assessment*; H and Y: *Modified Hoehn and Yahr scale*; MIQ-R – Kinesthetic: *Revised Movement Imagery Questionnaire* (kinesthetic modality); UPDRS: *Unified Parkinson's Disease Rating Scale*; ADL: *Activities of Daily Living*; TUGTest: *Timed Up Ang Go Test*; FGA: *Functional Gait Assessment.*

Instructions on normal movement patterns ensure that individuals pay attention to the adjustments required during the actual execution of the movement (Boutin & Blandin, 2010). Cerebral activation during this process occurs in a similar fashion to the initial phases of the motor learning process (Boutin & Blandin, 2010). Thus, individuals' intrinsic feedback is stimulated when they are able to perceive their mistakes while performing the task and attempt to modify their movement pattern. This allows them to create specific movement strategies because the motor experience means they perceive the characteristics of the environment and their individual restrictions (Santos-Couto-Paz, Teixeira-Salmela, & Tierra-Criollo, 2013).

Analysis of the immediate effects of Post-test 1 training on gait pattern shows an increase in total stance and swing time. This increase may characterize an improvement in stride length or slowness in performing the

Table 2
Spatiotemporal variables

	Baseline		Post-test 1		Post-test 2		Retention	
Spatiotemporal variables	EG ($n = 10$)	CG ($n = 10$)	EG ($n = 10$)	CG ($n = 10$)	EG ($n = 10$)	CG ($n = 10$)	EG ($n = 10$)	CG ($n = 10$)
Velocity (m/s)	1.05 ± 0.06	1.06 ± 0.06	1.03 ± 0.05	1.04 ± 0.6	1.09 ± 0.06*	1.09 ± 0.6*	1.12 ± 0.07*	1.09 ± 0.7*
Stride length (m)	1.11 ± 0.1	1.17 ± 0.1	1.14 ± 0.1	1.18 ± 0.1	1.16 ± 0.1*	1.21 ± 0.1*	1.17 ± 0.05*	1.18 ± 0.05*
Total stance time (s)	1.37 ± 0.06	1.47 ± 0.06	1.45 ± 0.06*	1.52 ± 0.06*	1.37 ± 0.06	1.47 ± 0.06	1.34 ± 0.06	1.45 ± 0.06
Total swing time (s)	0.75 ± 0.02	0.76 ± 0.02	0.80 ± 0.01*	0.79 ± 0.02*	0.76 ± 0.01	0.77 ± 0.02	0.75 ± 0.01	0.76 ± 0.02
Double stance time (s)	0.31 ± 0.02	0.35 ± 0.02	0.32 ± 0.02	0.36 ± 0.02	0.31 ± 0.02	0.34 ± 0.02	0.29 ± 0.02	0.33 ± 0.02
TUG Test	12.6 ± 1.0	13.1 ± 1.2	12.5 ± 0.8	12.7 ± 0.9	11.3 ± 0.7*	12.1 ± 0.8*	11.3 ± 0.8*	12.0 ± 0.9*

*The intergroup difference between means is statistically significant in relation to baseline (Initial assessment) ($P < 0.05$). Data are presented as mean and standard deviation and mean and confidence interval. Abbreviations: Post-test 1: Reassessment after 10 minutes; Post-test 2: Reassessment after 1 day; Retention: Reassessment after 7 days; TUG Test: *Timed Up and Go Test*.

Table 3
Angular variables in the saggital plane

	Baseline		Post-test 1		Post-test 2		Retention	
Angular variables	EG ($n = 10$)	CG ($n = 10$)	EG ($n = 10$)	CG ($n = 10$)	EG ($n = 10$)	CG ($n = 10$)	EG ($n = 10$)	CG ($n = 10$)
Max. hip ext. in stance	–5.6 ± 2.2	–7.4 ± 2.4	–6.9 ± 2.1	–7.5 ± 2.2	–5.7 ± 2.5	–5.5 ± 2.7	–4.4 ± 2.5	–3.1 ± 2.7
Max. hip flex. in swing	28.2 ± 1.9	26.3 ± 1.8	26.9 ± 1.4	28.6 ± 1.3	29.2 ± 2.0	30.8 ± 1.9	31.1 ± 2.7	32.2 ± 2.5
Hip ROM	33.9 ± 1.6	36.6 ± 1.6	34.7 ± 1.4	36.9 ± 1.4	35.7 ± 1.7*	38.8 ± 1.7*	36.1 ± 1.7*	38.2 ± 1.7*
Max. knee flex.	68.7 ± 1.3	69.3 ± 1.2	68.1 ± 1.1	71.0 ± 1.1	68.6 ± 1.0	72.3 ± 0.9	71.2 ± 1.7	72.5 ± 1.7
Knee ROM	61.7 ± 1.8	59.5 ± 1.6	61.4 ± 1.4	61.4 ± 1.3	61.5 ± 1.9	61.7 ± 1.7	62.0 ± 1.9	60.7 ± 1.7
Plantar flexion in Toe off	–14.8 ± 2.1	–16.8 ± 1.5	–16.2 ± 2.7	–17.4 ± 1.9	–14.9 ± 3.0	–18.6 ± 2.1	–17.1 ± 2.9	18.5 ± 2.0
Dorsiflexion in swing	1.0 ± 1.2	0.7 ± 1.0	1.2 ± 0.8	1.5 ± 0.6	1.0 ± 1.1	1.1 ± 0.9	1.4 ± 1.2	0.8 ± 0.9
Ankle ROM	22.9 ± 0.8	23.4 ± 0.7	23.3 ± 1.2	24.3 ± 1.1	22.8 ± 1.6	27.1 ± 1.5	22.8 ± 1.4	24.8 ± 1.3

*The intergroup difference between means is statistically significant in relation to baseline (Initial assessment) ($P < 0.05$). Data are presented as mean ± standard deviation and mean and standard deviation. Abbreviations: Post-test 1: Reassessment after 10 minutes; Post-test 2: Reassessment after 1 day; Retention: Reassessment after 7 days; Ext.: extension; Flex.: flexion; Max.: maximum; ROM: Range of motion.

movement cycle. It is believed that both occur, since there was a tendency towards an increase in the mean stride length of both groups in Post-test 1, albeit not significant. Although there was a significant difference in this variable in Post-test 2, the rise in total stance and swing time was not sustained during this observation period; on the contrary, the measures returned to those observed at baseline. It is believed, therefore, that this increase in stance and swing time in Post-test 1 occurred primarily because of the slowness of the movement, with lesser influence from the longer stride length. Physical fatigue or a reduction from the effects of antiparkinsonian medication may also explain these results, since each subject took approximately 2 hours to complete the entire protocol, even though they initiated it under the effects of the medication.

Other important findings occurred in stride length, velocity and hip range of motion, with significant increases in Post-test 2 and Retention. It is known that an increase in hip extension in the stance phase contributes to thrust, allowing greater flexion in swing and consequently higher gait velocity (Lewis, Byblow, & Walt, 2000). These results are directly related to the increase in hip range of motion, which is an important gain, since the literature reports that reduced activation in hip extensor muscles seems to contribute considerably to gait disorders in individuals with PD (Dietz, Zijlstra, Prokop, & Berger, 1995).

The improved gait velocity was also reflected in reduced TUG Test execution time in Post-test 2, a result also observed for Retention. The results of this test can predict falls in elderly patients (Dal Bello-Haas, Klassen, Sheppard, & Metcalfe, 2011). Therefore, the reduced execution time on the test demonstrates improved dynamic stability in participants from both groups.

Retention 1 day and 7 days after training provides important data for the literature, given that a single session to familiarize participants with gait adjustments and execution of the movement was enough to alter their pattern. Although the principles of motor learning point to the need for repetition to consolidate learning and change movement patterns (Jueptner, Frith, Brooks, Frackowiak, & Passingham, 1997), memorizing the sequence of movements and the adjustments required as well as executing this adjusted pattern may have influenced performance during the tests conducted in a laboratory setting. It is explained because in PD the malfunction of the Basal Ganglia-Supplementary Motor Area interaction, due to the reduction in striatal dopamine, results in commitment of kinematic parameters and difficulty sequencing movements in automatic mode, however, attention control of movement remains intact (Morris, Iansek, Matyas, & Summers, 1994). Thus, these motor abnormalities generate a cognitive dependence on movement pattern improvement of gait (Iansek, Danoudis, & Bradfield, 2013).

In this study, only one training session was held and intergroup comparison showed no differences in the variables analyzed. To date, no studies have been found that investigated the effect of a single practice session on subjects with PD. However, a study (Malouin et al., 2004) with hemiparetic subjects showed significant changes in the ability to stand up and sit down with the affected limb occurred after only one training session, since working memory increases (visuospatial, verbal and kinesthetic domains). Patients with PD exhibit a deficiency in working memory (Rottschy et al., 2013), suggesting the need for greater practice frequency in order to achieve positive results. Two studies using mental practice in patients with PD (El-Wishy & Fayez, 2012; Tamir et al., 2007) reinforce the need for more sessions to obtain good results.

Patients with mild or moderate PD are capable of maintaining a clear mental image, and can benefit from mental practice (Heremans et al., 2011). Data obtained from the MIQ-R showed that both groups reported maintaining a clear mental image with mean scores of 19.78 ($\pm$3.70) and 21.00 ($\pm$3.55) in the CG and EG, respectively, indicating that it is “somewhat easy” to imagine the motor task proposed by the kinesthetic modality. As this is an internal training, monitoring of the produced mental image quality is rare among studies, however, more objective ways of monitoring the mental image sharpness are important to control the fulfillment of the imagined activity. For this, it is suggested specific instruments such as capture of electroencephalographic activity (Bai, Huang, Fei, & Kunz, 2014).

Thus, the hypothesis suggested was not confirmed; that is, a single mental practice session showed no advantage over physical practice in the gait parameters of individuals with IPD. The short training period may have influenced the results. It is recommended that future studies use larger number of participants and greater training frequency. Moreover, to determine whether the fact that the CG memorized the stages of movement influenced the results, it is suggested that the CG not be submitted to this stage of the protocol.

5. Conclusion

Mental practice showed no improved effects, compared to physical practice, on the gait of individuals with IPD after a single session. Independent of its association with mental practice, physical practice had an effect on velocity, stride length, performance on the TUG Test and hip range of motion 1 day and 7 days after training. Further studies are needed to investigate whether the factors that influenced the unfavorable mental practice results are related to the time of mental imagery training.

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Conflict of interest

There are no conflicts of interest.

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