REVIEW ARTICLE

Analysis of spatiotemporal gait parameters in individuals with neurological dysfunction treated with mental practice: a systematic review

Análise dos parâmetros espaço-temporais da marcha em indivíduos com disfunção neurológica tratados com prática mental: uma revisão sistemática

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ABSTRACT

Gait ability after neurological pathology is often impaired and limited to short distances, with walking time, stride length and cadence being inferior to people without known pathologies or disabilities. Currently, mental practice has been combined with the clinical context, in the rehabilitation of patients with neurological sequelae, especially after a stroke. **Objective:** To analyze the effects of mental practice, associated or not with other intervention strategies, on the spatiotemporal gait parameters of people with neurological diseases. **Methods:** This is a systematic literature review on spatial gait parameters in patients with neurological dysfunction treated with mental practice. The databases searched were Pubmed/Medline LILACS, Scopus, Web of Science and Cochrane. **Results:** Most studies presented stroke as a neurological dysfunction, followed by Parkinson's disease, spinal cord injury and multiple sclerosis. The selected studies presented protocols of mental practice associated with physical therapy combined or not with other treatment strategies in the experimental group, including transcranial magnetic stimulation and rhythmic auditory stimulation. Among the spatiotemporal gait parameters, speed was the most evaluated parameter and the least evaluated stride length. **Conclusion:** Mental practice had positive effects on time, speed and gait cadence of stroke patients. Few studies limit the interpretation of results for Parkinson's disease, multiple sclerosis and spinal cord injury.

Keywords: Gait, Neurologic Manifestations, Physical Therapy Specialty

RESUMO

A habilidade da marcha após uma patologia neurológica muitas vezes é prejudicada e limitada a curtas distâncias, sendo o tempo de caminhada, o comprimento do passo e a cadência inferiores às pessoas sem patologias ou deficiências conhecidas. Atualmente a prática mental vem sendo combinada ao contexto clínico, na reabilitação de pacientes com sequelas neurológicas, principalmente pós-Acidente Vascular Cerebral. **Objetivo:** Analisar os efeitos da prática mental, associada ou não a outras estratégias de intervenção, nos parâmetros espaço-temporais da marcha de pessoas com doenças neurológicas. **Métodos**: Trata-se de uma revisão sistemática da literatura sobre os parâmetros espaciais da marcha em pacientes com disfunção neurológica tratados com prática mental. As bases de dados pesquisadas foram Pubmed/Medline LILACS, Scopus, Web of Science e Cochrane. **Resultados:** A maioria dos estudos apresentou o Acidente Vascular cerebral como disfunção neurológica, seguidos de Doença de Parkinson, Lesão medular e Esclerose múltipla. Os estudos selecionados apresentaram protocolos de prática mental associado à fisioterapia combinado ou não com outras estratégias de tratamento no grupo experimental dentre elas estimulação magnética transcraniana e estimulação auditiva rítmica. Dentre os parâmetros espaço-temporais da marcha a velocidade foi o parâmetro mais avaliado e o comprimento da passada o menos avaliado. **Conclusão:** A prática mental apresentou efeitos positivos nos parâmetros tempo, velocidade e cadência da marcha de pacientes com AVC. Poucos estudos limitam a interpretação dos resultados para doença de Parkinson, Esclerose múltipla e Lesão medular.

Palavras-chave: Marcha, Manifestações Neurológicas, Fisioterapia

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INTRODUCTION

The analysis of the gait of subjects affected by neurological dysfunction can be performed from the spatiotemporal parameters that allow the identification of the most common changes in gait pattern of these patients[1]. Among the changes, one may emphasize the reduction in walking speed, decreased of step length, stride and cadence, reduced range of motion of the affected lower limb joints and increased energy expenditure for gait execution.[1,2,3] The degree of these limitations will depend on each pathology and the areas of the central nervous system affected.[4]

Rehabilitation involves gait training through neuroevolution using the Bobath concept, strength training and specific training tasks aimed at the improvement of functional independence and requiring the development of cognitive skills such as attention and executive functions.[5]

Among these techniques, Mental Practice (MP) has been shown to be a promising strategy and has been used in the clinical context for the rehabilitation of individuals with neurological pathology sequelae, especially after stroke.[6] Formerly MP was used in sports, where mental rehearsals were performed to promote an increase in the skills of athletes of various modalities.[7]

MP consists of a training technique whereby a motor action is reproduced consciously and repeated with the intention of promoting the improvement of a motor skill, since the imagination of a movement corresponds to a dynamic state during the representation of a specific action, reactivated internally in working memory and in the absence of any movement.[8,9]

Studies have shown that mental practice has become an additional technique to conventional physical therapy for the recovery of patients with neurological disease sequelae.[9 - 11] However, studies on the topic are scarce and present some difficulties, such as small samples, heterogeneity among patients and especially the diversity of intervention protocols.[9]

OBJECTIVE

To analyze the effects of MP, associated or not with other intervention strategies, on spatiotemporal gait parameters of people with neurological diseases. The hypothesis is that MP improves the spatiotemporal gait parameters of people with neurological diseases.

METHODS

This is a systematic review of the literature conducted in accordance with the PRISMA[12] guidelines registered with the CR rosette CRD42018093200 and can be accessed at https://www.crd.york.ac.uk/prospero/ .

Two independent reviewers searched five electronic databases on December 23, 2017, *Pubmed/Medline,Web of Science, Scopus, Lilacs* and *Cochrane* without publication date and language restrictions. The search strategy used on all bases was performed as follows ("mental practice " or " imagery training" or "engine imagery " or imagination) and gait) in the title and abstract. The corresponding terms in Portuguese were used in South American bases. The descriptors were selected according to the DeSC and MeSH lists. The references of the selected papers were also considered for inclusion ("snowball" search strategy).

Two independent reviewers conducted the study selection and data extraction by checking the concordance between the study selection lists and the validation of the final list by a third reviewer.

We included studies of clinical trial with humans, of both sexes, with a sample of individuals with neurological disease whose intervention was only MP or MP associated with another rehabilitation technique. The paper should also present in its results Timed and Up Go (TUG) test values , at least one of the spatiotemporal gait parameters (Speed, Stride Length, Stride Length, Time and Cadence) and present their analysis. Intergroup, cross-sectional, qualitative studies, letters to the editor, case reports, dissertations, theses, crossover studies and event abstracts were excluded.

For the methodological critical analysis of the included papers, the Critical Appraisal Skill Program (CASP) (adapted) was applied , which includes 10 items to be scored, including: 1) objective; 2) adequacy of the method; 3) presentation of theoretical and methodological procedures; 4) sample selection criteria; 5) sample detail; 6) relationship between researchers and respondents (randomization/blinding); 7) respect for ethical aspects; 8) rigor in data analysis; 9) property to discuss results and 10) research contributions and limitations. For item 8, the rigor of the methodological analysis was considered the adequacy to the data analysis, as the intention-to-treat analysis. In the end, studies were classified as level A (score between 6 and 10 points), being considered of good methodological quality and reduced bias[13] (Chart 1).

To summarize the data, we considered the percentage of studies whose intergroup analysis was significant for the expected outcome. Percentages refer to the number of significant results divided by the total number of results.[14] Most studies with significant results were considered to indicate that MP achieved a positive effect on the variable and was indicated with a "+" sign. In cases of a tie or analysis of only one study there is doubt about the effect of MP, being indicated with "?" and cases with zero studies with significant result or minority of studies with significant result was considered that there was no effect on the variance, being indicated with a "-" sign .

RESULTS

510 studies were identified, leaving 13 papers for analysis and composition of the final sample after double checking the eligibility criteria (Figure 1). The descriptive and methodological data of the studies are expressed (Chart 1, 2 and 3). The included papers presented quality A with a score between 6 and 10 in the CASP. The studies had similar sample characteristics: 8 studies with a sample composed of individuals with stroke, 3 with Parkinson's disease (PD), 1 with multiple sclerosis (MS) and 1 with incomplete chronic spinal cord injury (SCI) (Chart 1).

Among the studies, Cho et al.[15] , Kumar et al.[19] and Lee et al.[20] did not detail the MP intervention protocol. The selected studies have MP protocols combined with physiotherapy associated or not with other treatment strategies in the experimental group, and transcranial magnetic stimulation in the study by Ji et al.[17] and rhythmic auditory stimulation in the study by Seebacher et al.[26] (Chart 2).

Gait time was assessed by the timed up and go test (TUG) in the studies by Cho et al.[15], Kim & Lee,[18] Hwang et al.[16] , Braun et al.[23] and Santiago et al.[25] , through the 10-meter walk test (TC10) in the studies by Cho et al.[15] , Ostra et al.[21] and Braun et al .[23] and the 25-foot timed walk test in the study by Seebacher et al.[26]

Gait speed was the most evaluated parameter, being, therefore, seen in the studies by Hwang et al.[16] , Ji et al.[17] , Kim & Lee[18] , Kumar et al.[19] , Lee et al.[20] , Verma et al.[22] , El Wishy & Fayez[24] , Santiago et al.[25] and Sharp et al.[27] (Chart 3).

Step length was evaluated in the studies by Hwang et al. [16] , Ji et al. [17] , Kim & Lee [18] ,

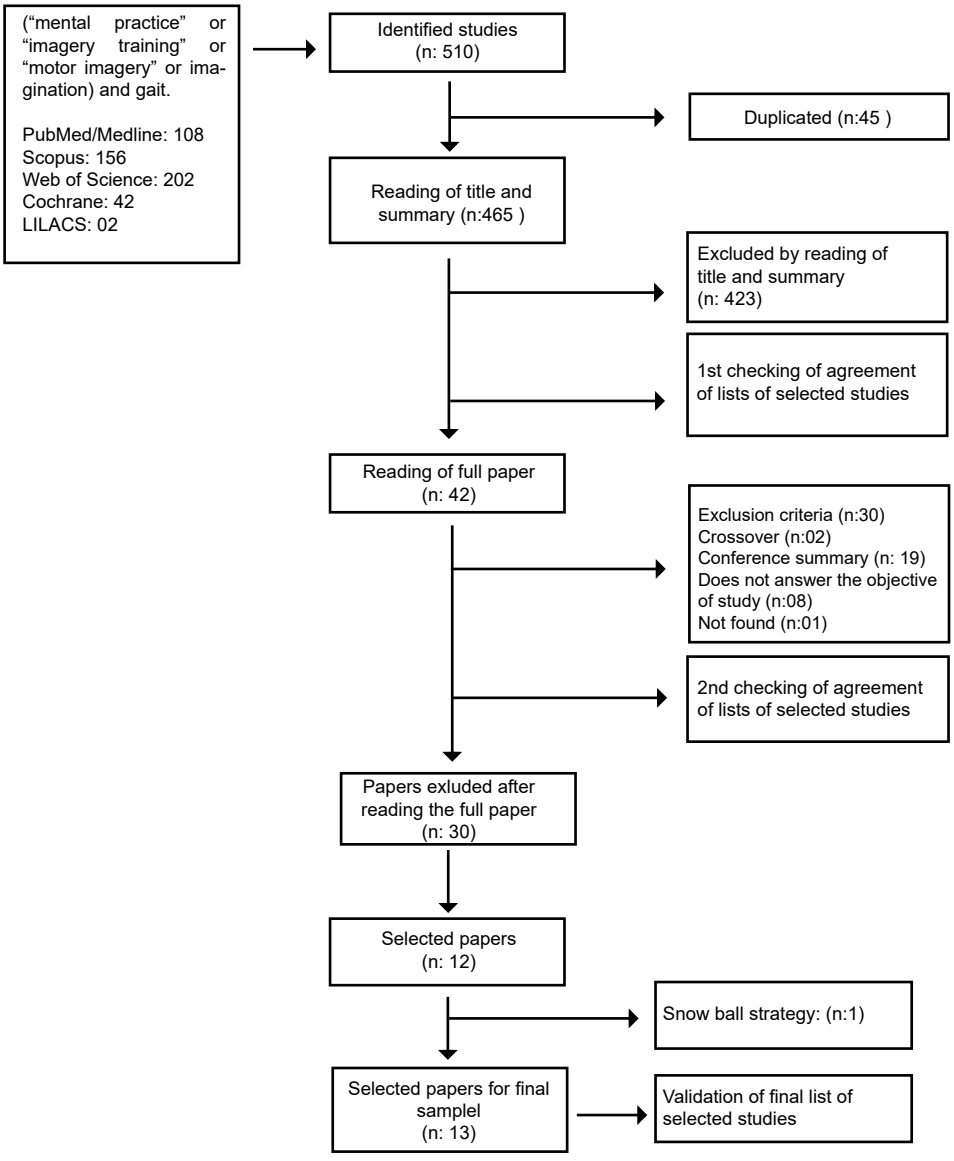

Figure 1. Flowchart of the consulted databases and number of articles that comprised the study sample.

Lee et al. [20], El Wishy & Fayez [24] and Santiago et al. [25] Stride length was the least evaluated parameter, being reported only by Ji et al. [17], Kim & Lee [18] and Lee . [20] Cadence was evaluated in the studies by Ji et al. [17], Kim & Lee [18], Lee et al. [20] and Verma , et al.[22] The study by Kim & Lee, [18] therefore was the most complete in the assessment of spatiotemporal gait parameters (Chart 3).

DISCUSSION

Among the included papers, 8 had a population of stroke, 3 with PD, 1 with SC and 1 with MS. The diversity of MP protocols, as well as the lack of studies of their application in other neurological diseases are the main challenges in identifying evidence of their effect.

TUG

For stroke patients, the time to perform the TUG decreased significantly by two[15, 18] among the three studies analyzed, unlike the population studies with PD, which did not significantly reduce (Chart 3). The studies by Cho[15] and Kim & Lee[18] used video and audio guided gait MP respectively where videos and audios of normal gait movement were shown for participants to imagine them.

As for the physiotherapy protocol, Cho[15] used treadmill gait exercises for 30 minutes, while Kim & Lee[18] opted for trunk control training, lower extremity training, weight shifting, gait leveling and stair climbing. The study by Hwang [16], although also using video-guided PM, did not make clear the physiotherapy protocol used, making it difficult to compare their findings with other studies.

Podsiadlo and Richardson[28] developed Timed Up and Go (TUG) to assess the risk of falls and to measure functional mobility in the elderly and classified their results into three groups: low, medium and high risk of falls. It is a widely used and sensitive test to measure walking time at 3 meters and can be useful for identifying gait characteristics of the affected and least affected side by identifying the severity of PD.[29]

In the study by Son et al.[29] the characteristics of the TUG gyrus were evaluated using three-dimensional analysis during the test in PD patients compared to healthy elderly, PD subjects exhibited significantly longer total time compared to the elderly, and a larger number of total steps (mean 15) being considered significantly lower than the control group (average of 10), corroborating our findings where the 2 studies with PD[23,25] did not significantly decrease the total time of TUG.

In a systematic review[9] on the mental practice protocols in PD, it was found that the studies aimed to improve the mobility and gait of these individuals. Most of them used TUG among their evaluative instruments, half of them found a significant reduction in the time to perform the test with the association of PM with physiotherapy, different from that observed in our study, where none of the authors obtained significant TUG results in subjects with PD. Probably because the evaluated PD subjects achieved ceiling effect in the baseline test.

Walking time

Walking time, measured by the 10-meter walking test, was the parameter that showed significant improvement in stroke patients[15,21] and in Multiple Sclerosis patients,[26] measured by the 25-foot test (T25FW). In the only study[23] with PD patients found, it is possible to notice a non-significant, lower than average reduction in stroke.

Chart 1. Objective description, study design, spatiotemporal gait variables, sample and article quality

Author year	goal	Study Design	Variable (unity)	Sample	CASP Evidence
Cho 2013[15]	To investigate the effects of motor imagery training on postural stroke balance and gait	Randomized Trial	Time (s) - TUG Time (s) - TC10	N = 28 individuals with stroke 2 groups GE (n = 15) and GC (n = 13)	A (10/10)
Hwang 2010[16]	Assess if motor imaging training leads to clinical improvements in post-stroke gait	Controlled clinical trial	Walking Speed (m / s) Step length with affected side - LA (m) and least affected side - LMA (m) Time (s) - TUG.	N = 24 individuals with stroke GC (# 13) GE (# 11)	A (8/10)
Ji 2014[17]	To verify if the practice of motor imagery in conjunction with transcranial magnetic stimulation applied to the stroke patient can improve their gait.	Clinical trial	Speed (cm / s), Stride Length (cm), Stride Length (cm); and cadence (steps / min)	N = 29 individuals with stroke EG (n = 15) and GC (n = 14)	A (9/10)
Kim 2013[18]	To compare the effects of action observation training and motor imaging training on the recovery of individuals with chronic stroke.	Pilot randomized controlled trial	Speed (cm / s); Cadence (steps / min); step length (cm); Stride Length (cm) - Time (s) - TUG	N = 27 individuals with stroke GE1 (n = 9) GE2 (n = 9) GC (n = 9)	A (8/10)
Kumar 2016[19]	To evaluate the effects of combining motor imagery with physical practice on gait and lower extremity performance in stroke patients	Randomized Trial	Walking Speed (m / s) - TC10	N = 40 individuals with stroke GC (n = 20) and GE (n = 20)	A (9/10)
Lee 2011[20]	To investigate the effects of motor imagery training on improving march a ability in individuals with chronic stroke	Clinical trial	Speed (cm / s), Cadence (steps / min), Stride Length (cm) and Stride Length (cm)	N = 24 individuals with chronic stroke. EG (n = 13) and GC (n = 11)	A (7/10)
Oyster 2015[21]	To evaluate the effect of mental practice on motor imagery ability and to evaluate its influence on gait rehabilitation in individuals with subacute stroke.	Randomized Trial	Speed (m / s) - TC10	N = 44 individuals with subacute stroke GE (n = 21) CG (n = 23)	A (8/10)
Verma 2011[22]	To evaluate the effectiveness of motor imagery task-oriented circuit training in the march of individuals with acute stroke	Clinical trial	Stride Length (cm), Stride Length (cm), Stride Width (cm), Cadence (steps / min), Comfortable Speed -VC (m / s) Maximum Speed VM (m / s) - TC10 and walking (m) -TC6M	N = 30 individuals with subacute stroke. EG (n = 15) and GC (n = 15)	A (10/10)
Braun 2011[23]	Verify whether rehabilitation with FP-associated PM is more effective when compared to FP-combined relaxation rehabilitation to improve mobility in people with PD	Randomized Trial	Time (s) - TUG Time (s) - TC10	N = 33 individuals with PD. EG (n = 18) and GC (n = 15)	A(8/10)
El Wishy 2013[24]	To evaluate the effect of motor imagery training associated with physical therapy on gait in PD patients	Controlled clinical trial	Step length (m); Walking Speed (m / s)	N = 26 individuals SD GC (n = 13) and GE (n = 13)	A (7/10)
Santiago 2015[25]	Determine the immediate effects of mental practice associated with physical practice on gait of individuals with PD	Randomized Trial	Speed (m / s), stride length (m) and Time (s) - TUG	N = 20 individuals with PD EG (n = 10) and GC (n = 10)	A (8/10)
Seebacher 2016[26]	To investigate the effect of motor imagery associated with rhythmic auditory stimulation on walking, fatigue and quality of life in individuals with MS	Randomized Trial	25-Step Walking Time (s) - (T25FW) and 6-Minute Walking Test- 6WMT	N = 101 individuals with MS GA (n = 34), GB (n = 34) and GC (n = 33)	A (9/10)
Sharp 2014[27]	To compare the effectiveness of mental practice associated with ground training with only ground training at gait speed and lower extremity motor outcomes in individuals with chronic incomplete SCI.	Randomized Trial	Gait speed (cm / s) 1 week after intervention	N = 15 individuals with chronic incomplete ML. EG (n = 8) and GC (n = 7)	A (7/10)

Stroke: stroke; PD: Parkinson's disease; MS: Multiple Sclerosis; ML: Spinal cord injury; (s): PF: Physical practice; seconds; (m): meters; EG: Experimental group; CG: Control Group; TUG: Timed up and go test; TC10: 10-meter walk test; GE1: experimental group 1; GE2: experimental group 2; GA: Experimental Group A; GB: Experimental Group B and GC:

There are some explanations for this study[23] that it did not present significant results: its population consisted of individuals with mild disease according to the Hoehn and Yarh classification, not being sensitive or not presenting any impairment in gait spatiotemporal measurements, in which case the treatment achieves a "ceiling effect". In addition to the fact that the recruited participants were previously receiving physiotherapy, mental practice was performed unguided, and during therapy, image attempts and movements were combined, ie, movements were performed with the imagination to generate information. sensory.

The 10-meter walking test (TC10M) is an instrument used to evaluate the spatial and temporal kinematic gait parameters, from which the average gait speed, number of steps and cadence are evaluated. 2 markers are placed at position 2 and 8 m, and the patient is directed to walk at a comfortable pace from one end to the other. Using a stopwatch determines how long it takes the subject to cross the central 6 m of the course.[30]

Gait speed

Speed is generally the parameter most commonly measured in gait assessment procedures[31] and was the most used measure in the studies included in this review, being found in 69% of the sample, similar to the

Chart 2. Description of protocol used and final considerations

Author, year	# sessions	# / without	Protocol			Considerations endings
			Session Duration (minutes)	Associated intervention strategy	PM Type	
Cho 2013[15]	18 sessions, 3x a week	3x	GE: 45 min; GC: 30 min	Both groups performed treadmill training at comfortable speed with low intensity for 30 minutes.	The EG had an additional 15 minutes of normal walking PMV with therapist explanation, where subjects would have to explain the movement they were seeing from visual and kinesthetic perspectives .	Gait training with PMV improves balance and gait skills in patients with chronic stroke when compared with gait training alone.
Hwang 2010[16]	20 sessions	5x	GE and GC: 85 to 90 min	All subjects received motor physical therapy	The GE received PMV in addition to physical therapy, while the GC watched health documentary. In the GE two different videotapes were used, one tape showed a normal adult in the 3 views in a 10m line with the individual walking at a slow and comfortable speed and the rest of the tape showed the man walking at a normal speed. The second videotape showed each patient in the 3 views as they walked along line 10 at a comfortable speed. During the past three weeks, patients underwent PM according to a five-phase protocol: progressive relaxation, external imaging (task sequence analysis), problem identification, internal imaging, and mental rehearsal.	PMV can be considered as a useful option for restoration of ambulation in individuals with chronic hemiparetic stroke who cannot participate in gait physical training.
Ji 2014[17]	30 sessions	5x	GE and GC: 60 min	Both groups received traditional physical therapy and PM, the EG was instructed to perform repetitive transcranial magnetic stimulation and the GC was instructed to perform simulated stimulation.	In GE the protocol was 6 weeks divided into: 1) there was familiarization with PM, emphasizing the imaging experience, using all sensory modalities. 2) practice of deficient components in paretic lower extremity gait performance . 3) Additional emphasis on loading the affected side during position and increasing walking speed. 4) cycle of steps and increased symmetry and gait speed. 5) Practice occurred as walking with the desired gait pattern inside and outside the individual's home. 6) Practice involved walking as fast as possible on different terrain . Added to magnetic transcranial formulation	Results showed that BMP (associated with transcranial magnetic stimulation) is more effective in improving gait capacity than BM
Kim 2013[18]	20 sessions	5x	GE1 and GE2: 90 min and GC: 30 min	All participants underwent neuroevolutionary therapy for 30 minutes. The exercise program included trunk control training to learn to roll, sit, stand, and normal gait pattern.	The Action Observation Training Group (GE1) program consisted of viewing a video of the task on TV, following physical training with a video-based therapist. The PMA group (GE2) participated in a training session and the program played through the computer speaker, and participants underwent physical training for 10 minutes (identical to GE1). The programs consisted of 4 stages, 1 for each week, increasing their degree of difficulty. GC: Physiotherapy only	Action observation training and MAP improve dynamic balance and walking ability, suggesting the feasibility and appropriateness of action observation training for patients with chronic stroke.
Kumar 2016[19]	12 sessions	4x	GE: 75 to 90 min and GC: 45 to 60 min	Both groups underwent specific training for lower extremity functions focused on improving endurance of functional tasks such as moving from sitting to standing, walking, turning, transferring.	The experimental group received PMA-based lower extremity mobility task from visual and kinesthetic perspectives , being the first week of familiarization phase.	Task-specific PMA training improves paretic muscle strength and gait performance in people with stroke
Lee 2011[20]	18 sessions	3x	GE: 60 minutes. GC: 30 min	Both groups received treadmill gait training.	The EG received PMV composed of imagination of normal gait movement in visual and kinesthetic perspective being 15 min of imagination and 15 min of visual and auditory explanation, through a video of normal gait movement sent or performed by normal people.	PMV has improved walking ability
Oyster 2015[21]	30 sessions	5x	GE and GC: 150 min	All received standard physical therapy based on the Bobath concept and occupational therapy. The CG received muscle relaxation therapy in addition to standard physical therapy. Motor imaging ability of a group of healthy patients was also evaluated to provide age-related reference data.	The EG received PM sessions based on the protocol described by Dickstein et al. All sessions began with 2 minutes of relaxation before the visual and kinesthetic perspective imaging session . In the first week they were familiar with the technique, focusing on images of environmental situations well known by the patient. In the 2nd was focused on individual gait problems, during the 3rd and 4th weeks, symmetry and gait speed were tested using different walking tasks (PM). Patients were instructed to "see" and "feel" walking in different situations and environments and on different terrains.	PM has a benefit in the specific task of gait function in subacute stroke patients.
Verma 2011[22]	14th	7x	GE and GC: 50th 60 min	The CG received conventional physical therapy based on the Bobath Concept . The task-oriented training was intended to enhance walking , balance control, climb stairs , transfers and walks fast . In addition, each session consisted of practice of task -related foot is in workstations	GE understands PM hiking skills and tasks related to real situations and training oriented tasks. Participants were familiar with PM during the first session. The PM was carried out individually and patients were asked to keep one everyday of their practice to measure the frequency of the test after each session , volunteers who failed to perform the duration / repetition minimum were increased an extra 10 minutes	Task-oriented training combined with PM produced significant gait improvements in individuals with subacute stroke.
Braun 2011[23]	6 or 12	1 or 2x	CG: 20 min Physiotherapy + 10 min relaxation; GE: 20 min Physical Therapy + 20 min PM	1h sessions per week of group physiotherapy or 30 min 2 times a week of individual physiotherapy. Both groups underwent physical therapy according to the guidelines of the Dutch Society of Physical Therapy Guide for PD and oriented home activities.	CG: They were encouraged to do home relaxation using progressive muscle relaxation or listening to a relaxation CD. GE: PM was taught using four steps: explain the concept, develop imagination techniques, apply and consolidate. Its main objective was to improve tasks such as walking, getting up from the chair or the floor.	No differences were found between incorporated PM and relaxation as a treatment standard.
El Wishy 2013[24]	12 sessions	3x	GE and GC: 55 to 70 min	CG received physical therapy consisting of 1) calisthenic exercises aimed at improving trunk movement performance, flexibility, muscle strength, balance and coordination; 2) practice of specific functions designed to improve the performance of crucial motor tasks such as transfer activities, gait activities, and upper extremity instrumental skills; and 3) relaxation exercises. The GC also watched a health documentary	GE received in addition to PMV physical therapy with two different videotapes, one tape showed a normal adult on 3 views as he moved along a 10m line. This tape (6 minutes) showed an individual walking at a slow and comfortable speed and the rest of the tape (4 minutes) showed him walking at a normal speed. The second tape showed each patient in the 3 views as they walked along line 10 at a comfortable speed. In the first week the training was aimed at familiarizing with gait kinematics and identifying their own problems. During the past three weeks, patients underwent PM according to a five-phase protocol: progressive relaxation, external imaging (task sequence analysis), problem identification, internal imaging, and mental rehearsal.	PMV sessions added to physiotherapy may improve gait function in PD patients

Santiago 2015[25]	1 session	1x	Not described	Only 1 session divided 7 steps: Step 1: Patients from both groups identified their gait changes and then the researcher explained the difference between normal and PD gait; 2nd stage: both groups memorized the phases of normal walking with the aid of cards (with the image of elderly people performing the normal movement) and then performed the walking sequences for 5 consecutive times; Step 3: Keywords were created for each card where patients reported gait steps through the keywords and then placed these cards in order 3 times without assistance. Both groups were evaluated at posttest 1 after 10 minutes of mental practice and posttest 2 after 1 week.	*4th stage: performed only in the EG, patients used first person PM (eyes closed) encouraged to feel the movement, reporting the gait phase keywords using the cards. Researcher counted the number of steps imagined, totaling 240 steps, divided into 3 series; 5th stage: both groups performed the physical practice of walking, walked 3 sets of 10 repetitions, 8 steps per repetition, total 240 steps; Step 6: GE march PM on a busy street with supermarket and shops. A series of 10 repetitions, 8 steps per repetition, total 160 imagined steps. Step 7: Both groups performed the physical practice of walking on a busy street simulated with progressive obstacles. Subjects were instructed to walk along the corridor 1 series of 10 repetitions with 8 steps per repetition, total 160 steps. There was an initial assessment, posttest 1 (10 minutes), posttest 2 (1 day), retention (7 days later)*	PM showed no better effects on physical practice after one session in PD patients.
Seebacher 2016[26]	24 sessions	6x	GEa and GEb : 47 to 57 min and GC: Not described	*The GEA (music) and GEB (metronome) received familiarization phase with groups of 2 to 3 people with concepts of rhythmic stimulation, PM with its application in sport and rehabilitation in the internal and external perspectives of visual and kinesthetic type , gait PM , various ways of walking like walking, taking big steps. And the GC received usual treatment and received weekly phone calls to report their health condition.*	*After the familiarization phase The GE's studied a CD containing music and verbal instructions (group A) and metronome and verbal instructions (group B), in first person kinesthetic perspective . Weekly it changed the audio to facilitate the grip and the attention with the motor imagery. The PM was performed at home in the sitting position and the patient himself chose the time of day because of fatigue and should perform 17 minutes per day, this session should be recorded in the diary. Weekly phone calls were received during the intervention period to support mental practice and report adverse events.*	PMO (associated with rhythmic stimulation) improves gait, fatigue and quality of life of patients with MS, being the music more effective than the metronome.
Sharp 2014[27]	24 sessions	3x	GE and GC: 60 min	CG (Ground Training Group) started with 5 minutes of stretching, mainly targeting lower extremity muscle groups. Subsequent components emphasized the acquisition of skills and relearning of motor behaviors that include ambulation; repetitive practice was expected to include gait components. They listened to 1 of 3 audio tapes (about post-injury care and leg exercises) directly after therapy alternately. The reevaluation was in post test 1 after 6 weeks and post test 2 after 12 weeks.	GE: They ratified one of the components of physical practice during each MAP session. They listened to the half-hour audio recording directly after each physical exercise session. These recordings were regularly rotated so that the subjects mentally rehearsed all exercises on 3 occasions. To increase ease of clinical application, PMA compliance was monitored noninvasively by asking subjects about the content of (eg, "What did you hear?") Or about their experiences ("How was your session?") or about both; and (2) visual monitoring, during which participants were observed directly during MAP sessions to ensure that they were not performing non-PM tasks. Using a mock intervention and consistent provision of the same type between groups ensured that therapy and audio / videotape exposure remained consistent across groups. Thus, the only variable in the study was the provision of PM	Ground training was associated with significant gait speed gains and these gains were not increased by the addition of PMA

Stroke: stroke; PD: Parkinson's disease; MS: Multiple Sclerosis; ML: Spinal cord injury; PM: Mental Practice; IM: Motor Imaging; EG: Experimental group; CG: Control Group; GE1: experimental group 1; GE2: experimental group 2; GA: Experimental Group A; GB: Experimental group B .; PM: only mental practice without using a guide; PMV: video-guided mental practice; PMA: Audio Guided Mental Practice

Chart 3. Effects of MP, associated or not with other intervention strategies, on spatiotemporal gait parameters of people with neurological diseases

Neurological Diseases	Study	Spatio-temporal parameter analyzed	% studies reporting significance in intergroup analysis	PM Type	Efeito da PM
				[PMV] [PMV] [PMA]	PM effect
Stroke	15*, 16, 18*	TUG	67 (2/3)	[PMV], [PM]	+
	15*, 21*	TC10 time	100 (2/2)	PMV, PM	+
	16*, 17*, 18, 19*, 20, 22*	Velocity	67 (4/6)	[PMV], [PMO], [PMA], [PMA], [PMV], [PM]	+
	16*, 17, 18, 20*	Stride length	50 (2/4)	[PMV], [PMO], [PMA], [PMV]	?
	17, 18, 20	Stride Length	0 (0/3)	[PMO], [PMA], [PMV]	-
	17*, 18*, 20, 22*	Cadence	75 (3/4)	[PMO], [PMA], [PMV], [PM]	+
DP	23, 25	TUG	0 (0/2)	[PM], [PM]	-
	23	TC10 time	0 (0/1)	[PM]	-
	24*, 25	velocity	50 (1/2)	[PMV], [PM]	?
	24*, 25	Stride length	50 (1/2)	[PMV], [PM]	?
IN	26*	Time on T25FW	100 (1/1)	[PMO]	?
LM	27	Velocidad velocity e	0 (0/1)	[PMA]	?

Stroke: stroke; PD: Parkinson's disease; ML: spinal cord injury; MS: Multiple Sclerosis;
PM: only mental practice without using a guide; PMV: video-guided mental practice; PMA: audio-guided mental practice; PM0: mental practice associated with another intervention strategy.
"+" PM with positive effect on the variable; "-" or "?" PM had no effect. * Study whose evaluated parameter was significant. TC10: 10 meter walking test. T25FW: 25ft Time Trial for Multiple Sclerosis.
NOTE: For all studies the patient groups performed physical therapy as the basic therapy.

findings by Gomes et al.[32] in a literature review about the performance of the elderly in dual-task gait through instruments and kinematic parameters, which found 68% of their sample evaluating gait speed.

For the stroke patients, of the 6 studies found, most of them showed a significant increase in velocity, thus corroborating the findings of Santos-Couto-Paz[33] , which states that MP oriented to the specific functional task, when added to conventional physical therapy, led to Improvements in motor imagination skills, combined with increases in manual dexterity and walking speed in stroke patients. Regarding PD, despite presenting only 2 studies, 1 was considered with significant increase[24] and the other[25] not, probably because this protocol used only one session of mental practice.

In addition to these two pathologies, a finding about spinal cord injury[27] was also found, but this did not show a significant improvement in its speed either because ground training was associated with significant gains regardless of its association with mental practice.

Stride length

We found 4 studies with stroke and 2 with PD for this variable, where only half of each resulted with significant increase. The 2 stroke studies may not have achieved significant improvement because the Ji[17] study was directed at whether additional transcranial magnetic stimulation (TMS) was effective as both groups received both MP and physical practice, so it was since both groups showed improvement independent of the additional TMS and in the study by Kim & Lee[18] . Motor physical therapy was not effective in improving step length because their program was based on trunk control training to roll, sit, stand. standing and normal walking pattern.

Again among the studies with PD, Santiago[25] does not show significant step length improvement, which may be justified by the fact that his experimental approach was performed in only one session, justification used by the author where he suggests that unfortunate mental practice results may be related to the time of mental image training. However, there is insufficient scientific evidence about stride length in people with PD, as Duncan[34] states to be the first study reporting the maximum stride length in the anterior, posterior, and lateral directions in the PD population.

Length and cadence

Among the 3 studies analyzed for these two spatiotemporal variables, none of them showed a significant increase in stride length and only the Lee[20] study showed no significant improvement in cadence, which may have been due to the fact that mental practice occurred simpler with only 15 minutes of visual and auditory explanation, while Ji[17] and Kim & Lee[18] developed a more elaborate 4-step protocol.

Holtzer et al.[35] in their study states that memory was a significant predictor of cadence improvement in both single- and dual-task walking conditions. Simoni et al.[36] suggests that treadmill walking does not involve brain areas susceptible to the introduction of a cognitive task. With this relationship of memory and cognition to improve cadence, it may justify why Lee's study[20] did not have significant gains for this variable, since he used treadmill gait training as a physical practice.

CONCLUSION

MP associated or not with other intervention strategies, had positive effects on time, velocity and gait cadence parameters of stroke patients. Few studies limit the interpretation of results for PD, LM and MS.

As a limitation of this study, it is possible to cite the scarcity of literature that contemplate combinations of mental practice with spatiotemporal gait parameters. Therefore, new research is suggested to associate the effects of mental practice on spatiotemporal gait parameters with other neurological diseases besides stroke.

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REFERENCES

1. Rinaldi LA, Monaco V. Spatio-temporal parameters and intralimb coordination patterns describing hemiparetic locomotion at controlled speed. J Neuroeng Rehabil. 2013;10(1):53. DOI: https://doi.org/10.1186/1743-0003-10-53
2. Boudarham J, Roche N, Pradon D, Bonnyaud C, Bensmail D, Zory R. Variations in kinematics during clinical gait analysis in stroke patients. PLoS One. 2013;8(6):e66421. DOI: https://doi.org/10.1371/journal.pone.0066421
3. Lee NK, Son SM, Nam SH, Kwon JW, Kang KW, Kim K. Effects of progressive resistance training integrated with foot and ankle compression on spatiotemporal gait parameters of individuals with stroke. J Phys Ther Sci. 2013;25(10):1235-7. DOI: https://doi.org/10.1589/jpts.25.1235
4. Olney SJ, Richards C. Hemiparetic gait following stroke part I: characteristics. Gait Posture. 1996;4:136–48. DOI: https://doi.org/10.1016/0966-6362(96)01063-6
5. Eng JJ, Tang PF. Gait training strategies to optimize walking ability in people with stroke: a synthesis of the evidence. Expert Rev Neurother. 2007;7(10):1417-36. DOI: https://doi.org/10.1586/14737175.7.10.1417
6. Bastos AF, Souza GGL, Pinto TP, Souza MMR, Lemos T, Imbiriba LA. Simulação mental de movimentos: aa teoria à aplicação na reabilitação motora. Rev Neurocienc. 2013; 21(4):604-19. DOI: https://doi.org/10.4181/RNC.2013.21.895.16p
7. Oxendine JB. Psychology of motor learning. New York: Appleton-Century-Crofts; 1968.
8. Machado S, Pacheco M, Bastos VH, Ribeiro P. A Prática mental no contexto da fisioterapia neurológica. Rev Neurocienc. 2009;5(1):46-54.
9. Silva DM, Coriolano MGWS, Macêdo JGF, Silva LP, Lins OG. Protocolos de prática mental utilizados na reabilitação motora de sujeitos com doença de Parkinson: revisão sistemática da literatura. Acta Fisiatr. 2016;23(3):155-60.
10. Fernandez-Gomez E, Sanchez-Cabeza A. [Motor imagery: a systematic review of its effectiveness in the rehabilitation of the upper limb following a stroke. Rev Neurol. 2018;66(5):137-46.
11. Monteiro D, Silva LP, Sá PO, Oliveira ALR, Coriolano MGWS, Lins OG. Prática mental após fisioterapia mantém mobilidade funcional de pessoas com doença de Parkinson. Fisioter Pesqui. 2018; 25 (1): 65-73. DOI: https://doi.org/10.1590/1809-2950/17192425012018
12. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JP, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. BMJ. 2009;339:b2700. DOI: https://doi.org/10.1136/bmj.b2700
13. Critical Appraisal Skills Programme [text on the Internet]. Oxford: CASP [cited 2017 Jan 04]. Available from: http://www.casp-uk.net/#!casp-tools-checklists/c18f8.
14. Vancampfort D, Mugisha J, Richards J, De Hert M, Probst M, Stubbs B. Physical activity correlates in people living with HIV/AIDS: a systematic review of 45 studies. Disabil Rehabil. 2018;40(14):1618-29. DOI: https://doi.org/10.1080/09638288.2017.1306587
15. Cho HY, Kim JS, Lee GC. Effects of motor imagery training on balance and gait abilities in post-stroke patients: a randomized controlled trial. Clin Rehabil. 2013;27(8):675-80. DOI: https://doi.org/10.1177/0269215512464702
16. Hwang S, Jeon HS, Yi CH, Kwon OY, Cho SH, You SH. Locomotor imagery training improves gait performance in people with chronic hemiparetic stroke: a controlled clinical trial. Clin Rehabil. 2010;24(6):514-22. DOI: https://doi.org/10.1177/0269215509360640
17. Ji SG, Cha HG, Kim KJ, Kim MK. Effects of motor imagery practice in conjunction with repetitive transcranial magnetic stimulation on stroke patients. J Magnetics. 2014;19(2):181-4. DOI: https://doi.org/10.4283/JMAG.2014.19.2.181
18. Kim JH, Lee BH. Action observation training for functional activities after stroke: a pilot randomized controlled trial. NeuroRehabilitation. 2013;33(4):565-74.

19. Kumar VK, Chakrapani M, Kedambadi R. Motor imagery training on muscle strength and gait performance in ambulant stroke subjects-a randomized clinical trial. J Clin Diagn Res. 2016;10(3):YC01-4. DOI: https://doi.org/10.7860/JCDR/2016/16254.7357
20. Lee G, Song G, Lee Y, Cho H, Lee S. Effects of motor imagery training on gait ability of patients with chronic stroke. J Phys Ther Sci. 2011;23(2):197-200. DOI: https://doi.org/10.1589/jpts.23.197
21. Oostra KM, Oomen A, Vanderstraeten G, Vingerhoets G. Influence of motor imagery training on gait rehabilitation in sub-acute stroke: A randomized controlled trial. J Rehabil Med. 2015;47(3):204-9. DOI: https://doi.org/10.2340/16501977-1908
22. Verma R, Arya KN, Garg RK, Singh T. Task-oriented circuit class training program with motor imagery for gait rehabilitation in poststroke patients: a randomized controlled trial. Top Stroke Rehabil. 2011;18 Suppl 1:620-32. DOI: https://doi.org/10.1310/tsr18s01-620
23. Braun S, Beurskens A, Kleynen M, Schols J, Wade D. Rehabilitation with mental practice has similar effects on mobility as rehabilitation with relaxation in people with Parkinson's disease: a multicentre randomised trial. J Physiother. 2011;57(1):27-34. DOI: https://doi.org/10.1016/S1836-9553(11)70004-2
24. El-Wishy AA, Fayez ES. Effect of locomotor imagery training added to physical therapy program on gait performance in Parkinson patients: a randomized controlled study. Egypt J Neurol Psychiat Neurosurg.2013;50(1):31-7.
25. Santiago LM, Oliveira DA, Macêdo Ferreira LG, Brito Pinto HY, Spaniol AP, Lucena Trigueiro LC, et al. Immediate effects of adding mental practice to physical practice on the gait of individuals with Parkinson's disease: Randomized clinical trial. NeuroRehabilitation. 2015;37(2):263-71. DOI: https://doi.org/10.3233/NRE-151259
26. Seebacher B, Kuisma R, Glynn A, Berger T. The effect of rhythmic-cued motor imagery on walking, fatigue and quality of life in people with multiple sclerosis: A randomised controlled trial. Mult Scler. 2017;23(2):286-96. DOI: https://doi.org/10.1177/1352458516644058
27. Sharp KG, Gramer R, Butler L, Cramer SC, Hade E, Page SJ. Effect of overground training augmented by mental practice on gait velocity in chronic, incomplete spinal cord injury. Arch Phys Med Rehabil. 2014;95(4):615-21. DOI: https://doi.org/10.1016/j.apmr.2013.11.016
28. Podsiadlo D, Richardson S. The timed "Up & Go": a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc. 1991;39(2):142-8. DOI: https://doi.org/10.1111/j.1532-5415.1991.tb01616.x
29. Son M, Youm C, Cheon S, Kim J, Lee M, Kim Y, et al. Evaluation of the turning characteristics according to the severity of Parkinson disease during the timed up and go test. Aging Clin Exp Res. 2017;29(6):1191-9. DOI: https://doi.org/10.1007/s40520-016-0719-y
30. Lang JT, Kassan TO, Devaney LL, Colon-Semenza C, Joseph MF.Test-Retest Reliability and Minimal Detectable Change for the 10-Meter Walk Test in Older Adults With Parkinson's disease. J Geriatr Phys Ther. 2016;39(4):165-70. DOI: https://doi.org/10.1519/JPT.0000000000000068
31. Hall CD, Echt KV, Wolf SL, Rogers WA. Cognitive and motor mechanisms underlying older adults' ability to divide attention while walking. Phys Ther. 2011;91(7):1039-50. DOI: https://doi.org/10.2522/ptj.20100114
32. Gomes GC, Teixeira-Salmela LF, Freitas FAZ, Fonseca MLM, Pinheiro MB, Morais VAC, et al. Desempenho de idosos na marcha com dupla tarefa: uma revisão dos instrumentos e parâmetros cinemáticos utilizados para análise. Rev Bras Geriatr Gerontol. 2016;19(1):165-82. DOI: https://doi.org/10.1590/1809-9823.2016.14159
33. Santos-Couto-Paz CC, Teixeira-Salmela LF, Tierra-Criollo CJ. The addition of functional task-oriented mental practice to conventional physical therapy improves motor skills in daily functions after stroke. Braz J Phys Ther. 2013;17(6):564-71. DOI: https://doi.org/10.1590/S1413-35552012005000123
34. Duncan RP, McNeely ME, Earhart GM. Maximum step length test performance in people with Parkinson disease: a cross-sectional study. J Neurol Phys Ther. 2017;41(4):215-21. DOI: https://doi.org/10.1097/NPT.0000000000000201
35. Holtzer R, Wang C, Verghese J. The relationship between attention and gait in aging: facts and fallacies. Motor Control. 2012;16(1):64-80. DOI: https://doi.org/10.1123/mcj.16.1.64
36. Simoni D, Rubbieri G, Baccini M, Rinaldi L, Becheri D, Forconi T, et al. Different motor tasks impact differently on cognitive performance of older persons during dual task tests. Clin Biomech (Bristol, Avon). 2013;28(6):692-6. DOI: https://doi.org/10.1016/j.clinbiomech.2013.05.011