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REVIEW ARTICLE

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Effects of motor imagery after cerebrovascular accident

Martínez-Misa Paula[a] | González-González Yoana [a] | Alonso-Calvete Alejandra [a,b] | Da Cuña-Carrera Iria [a]

a. Universidad de Vigo. Campus A. Facultad de Fisioterapia. Pontevedra, España.

b. Universidad de Vigo. Campus A. Facultad de Ciencias de la Educación y del Deporte. Grupo de Investigación en Rendimiento, Motricidad, Salvamento y Socorrismo (REMOSS). Pontevedra, España.

Correspondence

Alejandra Alonso Calvete. Facultad de Ciencias de la Educación y del Deporte. Universidad de Vigo. Campus A. Xunqueira s/n, C.P. 36005, Pontevedra, España.

alejalonso@uvigo.es

Abstract

Introduction: After a cerebrovascular accident, approximately 80% of patients suffer from different types of motor disorders. The rehabilitation of these injuries is a therapeutic challenge for which there are different therapies, some of them emerging, among which motor imagery stands out. This treatment presents potential benefits for the early rehabilitation of acquired motor deficits. Since motor imagery is a recent therapy, the objective of this work is to gather the most current scientific literature about motor imagery in patients who have suffered a stroke.

Methods: A literature search has been carried out according to PRISMA standards in the databases PubMed, Cinhal, Cochrane, Medline, Scopus, PEDro, Web of Science and SPORTDiscus with the keywords "Stroke", "Imagery" and "Physical Therapy".

Results: 15 articles were finally selected for the review, with similar results regarding the benefits that motor imagery brings to the rehabilitation in post-stroke patients, analyzing the effects of this treatment in both upper and lower limbs or in walking.

Conclusions: Motor imagery has significant benefits in the rehabilitation of post-stroke patients, either alone or in combination with other conventional therapies

Keywords: physical therapy, rehabilitation, motor Imaginery, neurology, stroke.

Introduction

According to the *World Health Organization*, a cerebrovascular accident (CVA), also known as a stroke, is the second leading cause of death in the world, as well as the third leading cause of disabilities in adults[1]. This impairment is defined as a sudden onset of clinical signs based on focal or global alterations to the brain function that lasts more than 24 hours with no apparent cause other than a vascular origin, and typically leaves behind physical sequelae, both sensory and motor, in subjects who suffer from it[2]. After a CVA, approximately 80% of patients suffer from motor deficiencies or alterations [3,4], whose onset greatly depends on the speed at which the CVA was treated. Likewise, its recovery requires an early rehabilitation, which has been shown to minimize the damage and even fully eliminate it, achieving the return of personal autonomy and family and socio-professional reinsertion[2,3,5]. The management of the post-stroke patient is based on different therapies and techniques that have been developed over time, such as neurological physiotherapy, mirror therapy, or electrical muscle stimulation, and even the use of specific therapies like pelvic muscle work for urinary incontinence[3]. These have all shown great benefits in post-stroke recovery, but the constant evolution of neurological therapies, usually aided by technology, makes it so new therapeutical options with potential benefits are constantly developed. Specifically, the recent discovery of mirror neurons has generated a new research line based on cognitive strategies that has allowed a development of new therapies based on noninvasive brain stimulation as a method for the recovery of functional capabilities [6]. One of the techniques that seems to have significant benefits in post-stroke patient recovery is motor imagery (MI), which looks to activate motor cognitive processes through the imagination without really doing the movement [4]. Previous studies on both neuroimaging and neurophysiology have shown that there is a relationship between imagined movements and those that are really developed, generating a "backdoor effect" to access the motor system and improve its rehabilitation [4,7]. Different research proves that MI shows positive results on the recovery of limb functionality after a stroke, increasing their functionality and usage in everyday activities, as well as improvements in gait and the transition from sitting to standing or vice versa [8]. This therapy is normally carried out together with conventional treatments, acting as a complement, but its solo application is beginning to be studied in patients who cannot receive conventional treatment [6,8].

Objetive

Even though MI is an emerging therapy, there is numerous research that analyzes its effects on post-stroke rehabilitation, which is why the goal of this review is to compile the most relevant studies on the use of MI in post-stroke patients.

Development

Methodology

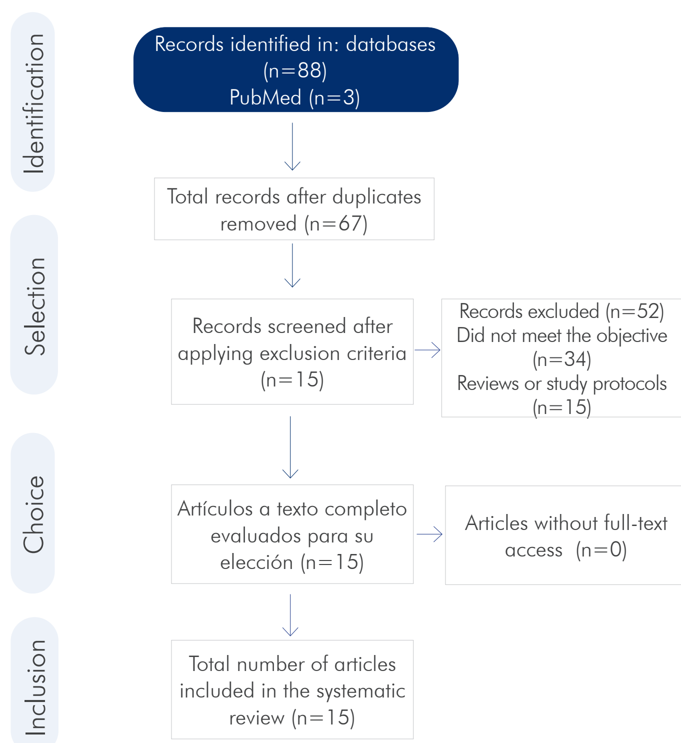
To carry out this work, a literature search was conducted in accordance with PRISMA guidelines during the months of February and March of 2020 in the following databases: PubMed, Cinhal, Cochrane, Medline, Scopus, PEDro, Web of Science, and SPORTDiscus. On this search, the keywords "Stroke", "Imagery", and "Physical Therapy", extracted from the Medical Subject Headings (MeSH, and put together by Boolean operator AND. The obtained search equations are presented in Table I.

Table I. Search equations

DATABASE	EQUATION
PubMed	(("Stroke"[Mesh]) AND "Imagery, Psychotherapy"[Mesh]) AND "Physical Therapy Modalities"[Mesh]
Cinhal	(MH "Guided Imagery") AND (MH "Stroke") AND (MH "Physical Therapy")
Cochrane	Imagery in Title Abstract Keyword AND "physical therapy" in Title Abstract Keyword AND stroke in Title Abstract Keyword
Medline	(MH "Imagery (Psychotherapy)") AND (MH "Stroke") AND (MH "Physical Therapy Modalities")
Scopus	(TITLE-ABD-KEY (stroke) AND TITLE-ABS-KEY (imagery) AND TITLE-ABS-KEY ("physical therapy"))
PEDro	Imagery; stroke; physical therapy
Web Of Science	Tema: (imagery) AND TEMA: (stroke) AND Tema: (physical therapy)
SPORTDiscus	((DE "IMAGERY (Psychology") AND (DE "STROKE")) AND (DE "PHYSICAL therapy")

Once the search was carried out according to the aforementioned terms, 346 articles were obtained, and after eliminating duplicated works, there was a total of 91. Selection criteria were established to filter the results, leaving only those appropriate for this review. Regarding inclusion criteria, only works in English or Spanish that have been published within the last 5 years (2015-2020) will be included to compile the latest scientific literature, which in the case of neurology, is constantly changing and evolving. As exclusion criteria, works that are reviews or protocols, that do not meet the objective of the work, or that are repeated in the databases will be eliminated. The selection process for articles, from the search to the final selection, is shown in Figure 1 through a flow diagram in accordance with PRISMA guidelines.

Figure 1. Selection process according to the PRISMA flow diagram



Methodological quality

To evaluate the methodological quality of the works, the Jadad scale was used, which analyzes the quality of randomized clinical trials (RCTs). This scale gives a score between 0 and 5 to each article, 5 being the highest quality, depending on whether they meet randomization or blinding requirements [9].

Results

A literature search was carried out with the objective of analyzing the effectiveness of motor imagery on the rehabilitation of post-stroke patients, obtaining a total of 15 studies that meet selection criteria. The results are shown in tables to ease their reading and understanding. In Table II are the methodology and results of the works, and in Table III, the procedures and results of each one.

Discussion

After analyzing the results of the articles selected for this review on the effects of MI on the rehabilitation of post-stroke patients, it can first be observed that they are very heterogenous regarding MI sessions, both in terms of duration and temporality. However, the application of the treatment through MI is combined in all of them with other therapies such as physical therapy or strength training, obtaining significant improvements in all cases.

MI emerges as a new therapy dedicated to the management and rehabilitation of sequelae result of a stroke, but in no way excludes other treatments such as conventional individual physical therapy [10,12-17,20-22] or the usage of exoskeletons or other motor rehabilitation devices[18,19], but rather complements it. Works that combine MI with conventional therapies show significant improvements in comparison to conventional therapies only. The work of Bajaj et al. [23] shows how MI alone yields benefits to the motor function that are also significantly greater when physical therapy is added to the MI treatment. This is why MI seems to be another therapy in the rehabilitation of motor functions, but it does not exclude the use of other conventional therapies that yield good results on their own. Rather, it seems to be an additional tool to help the central nervous system regain lost capabilities [18,19,20]. As experts in neurological rehabilitation explain, every patient will benefit from one or another therapy depending on their impairment, sequelae and recovery process, as well as on their previous knowledge of the movement and function.

Table II. Characteristics of the studies

Author	Type of study	Sample	Jadad	Time after ACV	Goal
Alves et al.10	RCT	42	3	>6 month	Effects of MI + virtual reality
Polli et al. 11	CT	28	-	> 1 year	Effects of graded MI
Page et al.12	RCT	27	4	>3 months	Effects of gross MI vs distributed MI
Kim H. et al.13	RCT	14	3	≥3 months	Effects of MI with and without motor induction
Oh et al.14	RCT	12	3	≥6 months	To evaluate trunk control and proprioception after MI treatment
Park et al.15	RCT	26	4	>6 months	To compare MI to motor induction
Grabherr et al.16	CT	25	-	>3 months	To compare MI effects to motor execution
Kim et al.17	RCT	24	3	6-12 months	MI effects
Frolov et al.18	RCT	74	5	±8 months	To compare passive motion to MI
Kim et al.19	Pilot study	8	-	2-5 months	MI effects + electrical stimulation
Pheung-Phrarattanatrai et al. 20	CT	14	-	2-4 months	MI effects on gait and falls
Kumar et al. 22	RCT	40	4	≥3 months	MI effects on strength and gait
Bae et al.22	Pilot study	20	-	<3 months	Balance training + MI on gait
Bajaj et al.23	RCT	10	3	1-54 months	To observe MI effects on brain connectivity
Carvalho et al.24	Case series	3	-	14-37 months	To evaluate neuroplastic changes on the brain after MI

CVA: cerebrovascular accident, MI: motor imagery, CT: controlled trial, RCT: randomized clinical trial

In this case, MI seems to be of more help to people with a better perception of the movement or a better capacity to understand it [18,20,21].

Regarding the frequency and duration of MI-based treatment, a greater heterogeneity can be observed in the studies included in this review. Firstly, works that only use MI have longer sessions than those that combine MI with other therapies, probably due to time optimization. However, a maximum duration of 30 minutes has been established for each MI session. Due to the characteristics of post-stroke patients, more time could generate a loss of effectiveness, mainly caused because of the fatigue in affected areas [10,11,19,22].

However, MI shows some limitations for its application in post-stroke patients, the main one being the requirement of a minimum understanding capacity on the patient's side, as they must first understand the movement and then imagine it at the same time as they try to do it. In this case, the therapist in charge of leading the MI session must ensure that the patient understands the given instructions to make sure that the technique is effective and generates changes on a brain level, as previous studies claim [23,24].

On the other hand, the age of the subjects can also be a limitation when it comes to defining the effects of MI. Taking Spain as a referent, the predominance of post-stroke cognitive and gait impairment covers 8% of the population over 65 years of age, reaching 25% of the population over 85 years of age[25], and, in the case of this review, the subjects that make up the samples of each of the studies range between 55 and 66 years of age. On one hand, this range is within what is expected, as it is not usual for younger patients to suffer from strokes[25]. Nonetheless, it is a necessary condition for the patients to have minimum cognitive capabilities, such as balance and understanding orders, which surely excludes subjects of more advanced age and those with massive stroke sequelae. In this context, the time of evolution since the stroke must also be taken into consideration, with an average time of over 6 months since the event. On one hand, it is normal to wait a while before the sequelae stabilize and it can be determined if the patients are suitable for MI-based treatment[26]. On the other hand, previous studies have determined that the earlier the treatment, the bigger the possibility of sequelae going away[3,4], which is why a balance between both situations should be the goal, always studying the specific case of each patient. This is why age and time after a stroke must be considered when interpreting results or extrapolating them to other subjects, as not everyone who suffers from a stroke could equally benefit from MI.

Table III. Results

Author	Sessions/duration	Test/scales	Results
Alvés et al.10	75 minutes a day for 2 wk	FM-MS	Both MI and virtual reality significantly improve upper limb function compared to CG
Polli et al.11	20 hour sessions for 4 wk	WMFT and FM	Significant improvement with MI compared to CG
Page et al.12	EG1: 60 minutes of MI 3 days/wk EG2: 20 minutes of MI 3 times/day 3 days/wk for 10 wk	FMA and ARAT	Both improve, but EG2 improves more than EG1
Kim H. et al.13	10 minutes for 2 wk	FM	Movement and functional capacity improve on the EG vs the CG
Oh et al.14	EG: MI / CG: neurodevelopment	EMG	Both groups significantly improve, but EG improves more
Park et al.15	EG: 30 minutes of conventional therapy + 10 minutes of MI CG: 30 minutes of conventional therapy	FM, ARAT and KMBI	Both groups significantly improve, but EG improves more
Grabherr et al.16	6 MI sessions vs. no treatment	FMA, memory, and functionality	Significant improvement on all aspects of the EG
Kim et al.17	Conventional treatment + MI	FMA and WMFT	Significant improvement overall
Frolov et al.18	10 30-minute MI sessions	ARAT and FMA	All values significantly improve for the EG, only the motor function improves for the CG
Kim et al.19	20 minutes for 4 wk	TUG and 10MW	Both tests significantly improve after intervention
Pheung-Phrarattanatrai et al.20	EG: 12 sessions of physical therapy + MI CG: 12 sessions of physical therapy only	PSM and FES-I	Gait significantly improves on the EG vs CG
Kumar et al.21	45-60 minutes of MI for 3 wk	Grip strength	Both strength and gait improve after MI
Bae et al.22	EG: balance + MI CG: balance	BBS, TUG, FRT, FSST	Balance improves and fall risk decreases in both groups
Bajaj et al.23	MI treatment vs. MI + physical therapy treatment	RMN	Combined MI treatment + physical therapy has a bigger influence on brain conductivity than MI only
Carvalho et al.24	50 minutes of MI for 2 wk	FMA and ARAT	MI treatment improves ME

ARAT: Action Research Arm Test; BBS: Berg Balance Scale; FES-I: Fall Efficacy Scale; FMA: Fugl-Meyer Assessment; FMA-UE: Fugl-Meyer Assessment for Upper Extremity; FRT: Functional Reach Test; FSST: Four Square Step Test; CG: Control group; EG: Experimental group; ME: motor execution; MI: motor imagery; KMBI: Korean Version of Modified Barthel Index; MAS: Motor Assessment Scale; TUG: Timed Up-and-Go; WMFT: Wolf Motor Function Test; 10MW: 10 meter walk; WK: weeks; EMG: electromyography

If we observe the average sample size of the included works, it stands out in comparison to the sizes normally used in RCTs and works in health sciences, which is why the results should be interpreted with caution [27]. However, this sample size can be justified, as it is an emerging therapy that is still beginning to be researched, which can be seen in the number of published studies and the difficulty of reaching patients and applying this therapy to them. Given the potential benefits that MI seems to have in post-stroke patient recovery, further studies with a bigger number of patients should be encouraged, as well as their follow-up to know more in depth about the medium- and long-term benefits of MI.

Conclussion

MI has significant benefits in the rehabilitation of post-stroke patients on its own and together with other therapies, as long as the patient retains the minimum capabilities to understand and execute this technique.

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