

ESTIMULAÇÃO MAGNÉTICA TRANSCRANIANA: UMA REVISÃO INTEGRATIVA

TRANSCRANIAL MAGNETIC STIMULATION: AN INTEGRATIVE REVIEW

ESTIMULACIÓN MAGNÉTICA TRANSCRANEAL: UNA REVISIÓN INTEGRAL

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RESUMO: este artigo buscou mostrar que a Estimulação Magnética Transcraniana (EMT), é uma técnica não-invasiva capaz de modular e trabalhar áreas acometidas do cérebro com baixo risco ao paciente. O objetivo deste trabalho é a sumarização das evidências científicas referentes à EMT e suas diversas aplicações. Trata-se de uma pesquisa de Revisão Integrativa da Literatura com abordagem quantitativa. Considerou-se as questões norteadoras para este estudo: “Qual a eficiência da estimulação magnética transcraniana?” “Quais as indicações da estimulação magnética transcraniana?” Com o levantamento bibliográfico usando os descritores listados, foram reunidos 41 artigos que se assemelhavam a temática descrita. Após leitura de seus títulos e resumos, 19 estudos foram excluídos, restando 22 artigos para leitura e análise na íntegra para construção desta revisão. Os estudos revelaram que a EMT é utilizada no campo da psiquiatria e da fisioterapia, sendo, nesse caso, testado principalmente nas sequelas de Acidente Vascular Encefálico e paralisia cerebral, zumbido crônico, doenças psíquicas, dentre outros. Conclui-se que a EMT é um recurso muito promissor para diversas patologias neurológicas, porém os protocolos de conduta requerem mais pesquisas para mais evidências quanto a indicação, aplicação e efeitos de forma que possa inserir a técnica para fazer parte dos atendimentos fisioterapêuticos.

Palavras-chaves: Estimulação magnética transcraniana. Tratamento. Fisioterapia.

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ABSTRACT: this article aimed to show that Transcranial Magnetic Stimulation (TMS) is a non-invasive technique capable of modulating and working on affected areas of the brain with low risk to the patient. The objective of this work is to summarize the scientific evidence regarding TMS and its various applications. This is an integrative literature review with a quantitative approach. The guiding questions for this study were: "What is the efficiency of transcranial magnetic stimulation?" "What are the indications for transcranial magnetic stimulation?" Using the listed descriptors, 41 articles related to the described theme were gathered through a bibliographic search. After reading their titles and abstracts, 19 studies were excluded, leaving 22 articles for full reading and analysis for the construction of this review. The studies revealed that TMS is used in the fields of psychiatry and physiotherapy, being tested mainly in the sequelae of stroke and cerebral palsy, chronic tinnitus, mental illnesses, among others. It is concluded that TMS is a very promising resource for various neurological pathologies, however, the protocols for its use require more research to provide more evidence regarding its indication, application, and effects so that the technique can be incorporated into physiotherapy treatments.

Keywords: Transcranial magnetic stimulation. Treatment. Physiotherapy.

RESUMEN: este artículo tuvo como objetivo demostrar que la Estimulación Magnética Transcraneal (EMT) es una técnica no invasiva capaz de modular y trabajar las áreas cerebrales afectadas con bajo riesgo para el paciente. El objetivo de este trabajo es resumir la evidencia científica sobre la EMT y sus diversas aplicaciones. Se trata de una revisión bibliográfica integradora con un enfoque cuantitativo. Las preguntas guía de este estudio fueron: "¿Cuál es la eficacia de la estimulación magnética transcraneal?" "¿Cuáles son las indicaciones para la estimulación magnética transcraneal?". Utilizando los descriptores mencionados, se recopilaron 41 artículos relacionados con el tema descrito mediante una búsqueda bibliográfica. Tras la lectura de sus títulos y resúmenes, se excluyeron 19 estudios, quedando 22 artículos para su lectura y análisis completos para la elaboración de esta revisión. Los estudios revelaron que la EMT se utiliza en psiquiatría y fisioterapia, y se está probando principalmente en las secuelas de accidentes cerebrovasculares y parálisis cerebral, tinnitus crónico y enfermedades mentales, entre otras. Se concluye que la EMT es un recurso muy prometedor para diversas patologías neurológicas. Sin embargo, los protocolos para su uso requieren más investigación para obtener más evidencia sobre su indicación, aplicación y efectos, de modo que la técnica pueda incorporarse a los tratamientos de fisioterapia.

Palabras clave: Estimulación magnética transcraneal. Tratamiento. Fisioterapia.

INTRODUCTION

Transcranial magnetic stimulation (TMS) has promising applications in various neural pathologies, especially those of a psychosomatic nature, such as schizophrenia, depression, bipolar disorder, fibromyalgia, and chemical dependency, among others. Some studies also indicate that the resources have good results in neurological diseases such as Parkinson's disease and stroke (SANTOS *et al.*, 2019).

Because it is an electrostimulation tool and is applied directly to the skull, it is often confused with the now-banned technique of electroconvulsive therapy, which consisted of

inducing shocks through high-voltage electrical current in order to induce seizures and thus calm the mental patient. But as explained above, TMS has a different *modus operandi* (MACHADO *et al.*, 2018).

The procedure consists of dividing the patient's skull into quadrants, all marked in a demarcation box, each quadrant depending on the pathology to be treated. After marking, the patient's motor sensitivity threshold is discovered through stimulation in the patient's motor quadrant. Finally, the ideal parameters for each individual are discovered (SOUZA, 2018).

The treatments that use the TMS technique last at least 20 minutes and are carried out in 20 sessions, so that it can present satisfactory results, respecting the particularity of the patient and their limitations (BARRETTO, 2015).

In Brazil, the National Health Surveillance Agency (ANVISA), in 2012, authorized the use of superficial repetitive transcranial magnetic stimulation (TMS) technology for three specific psychiatric pathologies: unipolar depression, bipolar affective disorder, and psychotic patients. However, studies have been pointing to other uses, and physiotherapy has been providing the use of this technology, which has been studied since the 1980s. In the United States, this technique has been applied since 2008 for a wider range of purposes. However, in Brazil, there are still few fields and research is still somewhat limited (COFFITO, 2022).

Despite being authorized by ANVISA and already used in depression treatments in Brazil, and pointed out by physiotherapy councils as a treatment of recognized efficiency, TMS is not yet offered by the Unified Health System (SUS) and there is also little supply of this treatment in private networks (COFFITO, 2022).

This technique aims to non-invasively induce electrical currents in cortical regions, and is an excellent method for both diagnostic and therapeutic purposes. This effect is due to the electric field that leads to neuronal depolarization; this is an electrical stimulation without electrodes. There are several techniques for using TMS, and for different types of objectives, such as the ability to map the cerebral cortex (MATSUDA *et al.*, 2019).

It has been verified that the excitability of the motor cortex can be increased for up to one hour after its application, thus generating performance during isometric exercise until exhaustion. These data suggest that TMS can likely be used as a tool in research on mechanisms involved in the development of fatigue and as a possible ergogenic resource (COSTA, 2016).

It is believed that treatment with electrostimulation is promising for some neurological pathologies. In this context, the question arises: which diseases are indicated for the use of

Transcranial Magnetic Stimulation? What are its effects? What publications are available on this topic?

With these questions, coupled with interest in the subject and believing in the benefits of prescribing TMS, it was decided to conduct studies aimed at summarizing the scientific evidence regarding Transcranial Magnetic Stimulation in its various applications and, based on the results, contributing considerably to the improvement of the health conditions of individuals with ailments, and to physiotherapists who can use this tool as a resource in various pathologies.

METHODOLOGY

This is an integrative literature review study with a qualitative approach. The guiding question for this study was: "What are the indications and effects of Transcranial Magnetic Stimulation?"

The integrative literature review is a method that aims to synthesize results obtained in research on a topic or question in a systematic, orderly, and comprehensive manner. It is called integrative because it provides broader information on a subject/problem, thus constituting a body of knowledge.

The study was constructed in six distinct stages: identification of the topic and research question; establishment of criteria for inclusion and exclusion of studies/sampling or literature search; definition of the information to be extracted from the selected studies/categorization of studies; evaluation of the included studies; interpretation of the results; and presentation of the review/synthesis of knowledge.

To carry out the research, a search was conducted in the Google Scholar, Medline, and SciELO databases, using the following associated descriptors: Transcranial Magnetic Stimulation. Treatment. Physiotherapy. Neuromodulation. Depression.

The search was limited by year of publication, defined by a 10-year time frame, in addition to articles available with full text, in Portuguese and English that discussed Transcranial Magnetic Stimulation, and articles unrelated to the studied topic and those in other languages not defined in the inclusion criteria were excluded.

The article selection process involved an initial reading of the titles and abstracts, as well as a full reading of the publications in cases where the titles and abstracts were not sufficient to define the selection, thus choosing the articles that met the previously defined inclusion criteria, eliminating the others, including those repeated in the searches. The articles

were reviewed following the perspective of thematic analysis, initially proceeding with the reading of the entire collection, the identification of thematic axes and assessing their respective cores and meaning.

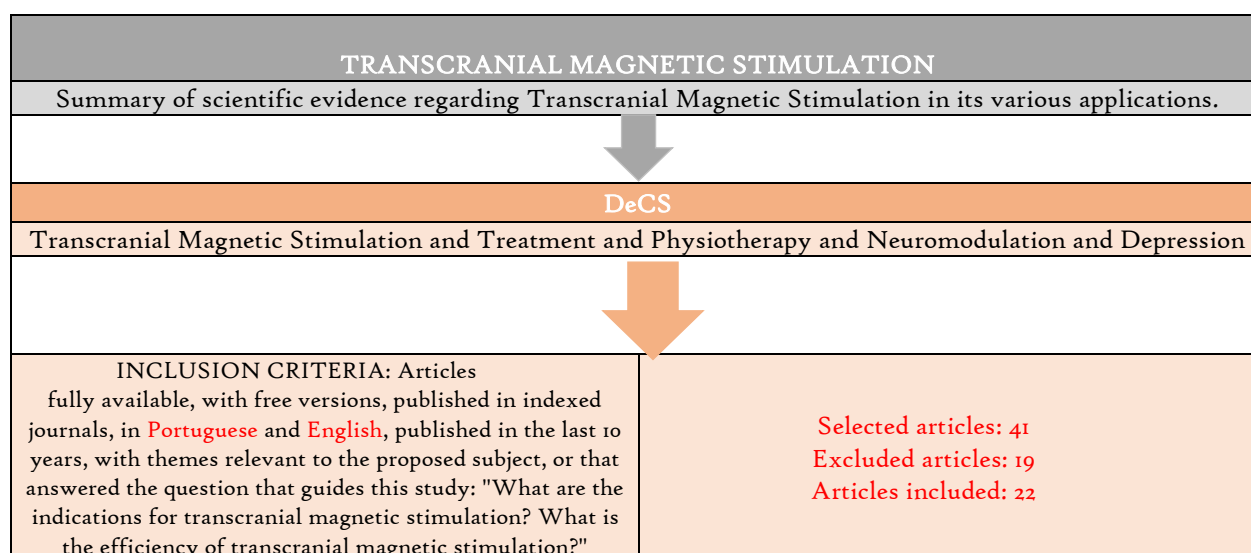
The analyzed articles were also subjected to classification of the type of methodology employed in each study. The subjects were analyzed and interpreted, being grouped considering similarities and differences in the authors' information. The text was constructed and recorded after critical and analytical reading, with the aim of selecting the main idea from the research.

RESULTS AND DISCUSSIONS

Based on the bibliographic survey using the listed descriptors, a total of 41 articles similar to the described theme were gathered for analysis. After reading their titles and abstracts, 19 studies were excluded after duplicates of their texts were identified or after being subjected to the exclusion criteria, leaving 22 articles for full-text reading. Thus, after reading the texts and applying the guiding question of this research, we had a final result of 22 studies for analysis and construction of this review, as illustrated in the diagram below represented by **Table 1**.

The articles revealed that transcranial direct current stimulation may be indicated for the treatment of sequelae of stroke and cerebral palsy, chronic tinnitus, mental illnesses, chronic pain, joint degeneration diseases, treatment of chemical dependents, and improvement of physical performance.

Table 1 - Demonstration of the data collection process for the formation of the empirical material for this review study. Fortaleza-CE, 2020.



Source: Study data. SOUSA *et al.*, 2020

Of the 22 articles selected for study, 23% showed that TMS (Transcranial Magnetic Stimulation) proved promising for sequelae of stroke and cerebral palsy, 10% for chronic pain, 10% for chronic tinnitus, 10% for improving physical performance, 5% for treating addicts, 5% for degenerative joint diseases such as osteoarthritis, 5% for mental illnesses, and 32% of the relevant articles discussed the functioning of the technique, contraindications, and method of application.

Considering the article written by Silva *et al.* (2018), which was a double-blind, randomized, controlled study with 14 patients, who underwent 20 sessions of 20 minutes on consecutive days. This study suggests that Transcranial Direct Current Stimulation (tDCS) may aid in the rehabilitation of patients with anomic or Broca's aphasia following stroke.

In this regard, Alencastro (2016) argues that TMS and tDCS can interfere with the physiological functioning of neural networks, having the capacity to generate temporary disturbances and disruptions of cognition. After analyzing several studies using various tests, such as letter and number tests or picture tests, the author concluded that elderly individuals may be a subgroup particularly susceptible to disruption of cortical neural functions by the application of tDCS.

Other health conditions and the use of electrostimulation have also been investigated, such as the research by Souza (2018), which verified through a randomized clinical study, carried out on 59 women affected by Chikungunya, aged between 28-70 years, that tDCS contributed to the improvement of symptoms in a short period, not showing efficiency in improving functionality and interfering with pain in their daily lives. The patients underwent 6 sessions on non-consecutive days. The author suggests that new studies need to be done to find better results, which is in line with what Barretto (2015).

Valente *et al.* (2019), with the aim of seeking greater safety, submitted in a case study, a patient with moderate headache, who, when subjected to TMS, aggravated her symptoms, showing that the technique has contraindications and possible side effects, albeit mild, that require further studies.

Magnetic stimulation is cited as a treatment for chronic tinnitus in adults and the elderly by Vinagre and Guariento (2018), in a study published in the Journal of the Brazilian Society of Clinical Medicine. They also point to other treatments for this pathology, whose origin is still controversial.

In patients already assisted by physiotherapy, Chipchase *et al.* (2018) mentions the efficiency of the technique, the object of this study, in chronic joint diseases and in approaches that collaborate with the maladaptive plasticity of the motor cortex.

Corroborating this, Visco (2015), in the same line of the effects of magnetic electrostimulation, points to its efficiency in hemiparetic patients and those with motor organization deficiencies.

For this reason, the Physiotherapy Council, through DECISION No. 515, of October 7, 2022, approves the use of the technique studied here and recognizes its importance in kinetic-functional prognoses in musculoskeletal, neuromuscular, and cardiorespiratory conditions.

According to Santos *et al.* (2019), the benefits of repetitive and peripheral transcranial magnetic stimulation in patients affected by stroke, especially the deleterious effects of Neuropathic Pain (NP), with remodeling in the primary motor cortex bringing a functional, social and psychological improvement.

Montenegro and Cantilino (2016) argue that transcranial magnetic stimulation can be used for functional studies and also for cortical mapping, also assisting with synapses in the stimulated neural networks.

According to Silva *et al.* (2018), TMS obtained good results in patients with chemical dependency, decreasing levels of compulsion/craving, and that the greater the number of sessions, the better the results.

The study by Santos *et al.* (2019) shows the benefits of transcranial magnetic stimulation in healthy individuals, significantly increasing their muscle performance in a short period of time, to improve the physical performance of individuals.

Neves (2022) reported in his study the neuromodulatory effects of TMS associated with group Neurofunctional Physiotherapy (NP) on respiratory muscle strength in individuals affected by stroke in the chronic phase. This is a randomized, descriptive and analytical clinical study, with a quantitative-qualitative approach. Ten individuals participated, divided equally into two groups. An increase in respiratory muscle strength was observed; however, a significant increase in Pimax was evident in individuals undergoing combined therapy. After analyzing the results, it is possible to suggest that combined therapy with TMS and FN in a group setting was able to modulate respiratory muscle strength, with an emphasis on PImax.

Jales Junior *et al.* (2015) presents a prospective, double-blind, randomized, controlled study using single-photon emission computed tomography (SECT) for the brain. The sample consisted of 20 female fibromyalgia patients, divided into two groups of 10, and assessed pain

and quality of life using the Visual Analogue Scale for pain, the SF-36 Quality of Life Questionnaire, and the Fibromyalgia Impact Questionnaire. In the effective group, a reduction in scores was observed on the Fibromyalgia Impact Questionnaire and the Visual Analogue Scale. In the sham group, no significant changes were observed in the SECT images for the brain. In the present study, it can be verified that Transcranial Direct Current Stimulation was effective in the therapeutic control of pain and promoted an improvement in the quality of life of fibromyalgia patients.

Machado *et al.* (2018) reports that Electroconvulsive Therapy (ECT) is a treatment recognized by the Federal Council of Medicine and the Brazilian Association of Psychiatry; its applicability requires compliance with the requirements established in the treatment's execution protocol. The author reveals that ECT has a history of abuse, which is not denied even by its own defenders; however, when prescribed appropriately, the treatment is effective. There is a stigma surrounding the use of electroshock that still predominates in society in general. More than a technical practice, ECT needs to be discussed as a treatment that generates rejection and carries a historical mark of punishment and social pain.

Matsuda *et al.* (2019) investigated the purpose of using non-invasive transcranial stimulation in individuals with cerebral palsy in their research. Eight studies applied transcranial magnetic stimulation for diagnosis, cortical mapping, and assessment of hand function, and four used direct current stimulation (tDCS) and verified its effect on dystonia and gait in individuals with cerebral palsy. Regarding the treatment of individuals with CP, the studies showed important results from the use of transcranial stimulation, especially when associated with physiotherapy. The research showed that non-invasive transcranial stimulation, through TMS and tDCS, has been used in CP for treatment and diagnostic purposes.

Ribeiro (2017), in his study, demonstrates four original contributions to the study of non-invasive neuromodulation of the nervous system: new, less invasive techniques with fewer side effects and promising results that have emerged with the advent of non-invasive brain stimulation (NIBS) techniques. He also notes that TMS and tDCS have therapeutic potential in neuropsychiatric disorders, mild cognitive impairment, and dystonias, in addition to being interesting tools for studying the normal physiology of the nervous system.

Santos *et al.* (2018), in their study on the use of tDCS as a therapeutic option for tinnitus, presents a systematic literature review. 4,165 studies were found, and after applying the inclusion criteria, a total of six were selected, resulting in a sample of 602 patients. Based on

the defined criteria, there was a positive response to transcranial direct current stimulation in 14.86% of the participants.

The technique has also proven important in the recovery of gait in patients with spinal cord injury. This resource, associated with treadmill gait training with weight-bearing elimination, requires combined therapies that can help eliminate gravitational force. Thus, by relieving body weight and correctly modulating electrostimulation, we contemplate the possibility of enhancing results in patients with this condition (NOGUEIRA, 2019).

Generally, when the primary motor cortex is stimulated, it responds with an interhemispheric imbalance, where after the affected hemisphere is compromised, it shows a decrease in its excitability (SANTOS *et al.*, 2019).

Transcranial magnetic stimulation (TMS) has proven effective in pathologies such as stroke, pain, depression, and all their comorbidities, which directly affect the quality of life of individuals due to the severity of the lesions and the degree of disability they represent. TMS, as already mentioned, generates brain currents from electromagnetic fields with depolarization capacity, and there may be alterations to both increase and decrease cortical excitability (MONTENEGRO and CANTILINO, 2016).

Even though it stands out as one of the safest treatments, for the most diverse forms of application, TMS can cause some rare side effects, such as migraine, loss of sleep quality, and in even more serious cases, seizures may occur. Although not common, it is necessary for the professional applying the technique to be prepared for these eventual cases (RIBEIRO, 2017).

According to Santos *et al.* (2018), TMS has been a tool used as an alternative for drug-resistant mental health patients, or as an option for a more conservative treatment. Given that medications used in patients, especially psychiatric patients, leave a number of side effects and cause dependence.

CONCLUSION

This study concludes that Transcutaneous Magnetic Stimulation (TMS) is a very promising resource for various neurological pathologies and may be indicated for other health conditions, being a valuable tool for Physiotherapy.

TMS has other indications, still little explored, such as in the treatment of chronic pain, fibromyalgia, chronic tinnitus, degenerative joint diseases such as osteoarthritis, as well as in the treatment of addicts and in improving the physical performance of athletes.

The protocols for the use of TMS require more research so that solid evidence can emerge on its application, and thus the technique can be widely used respecting the indications, contraindications, effects and therapeutics.

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