

Review articles

Motor imagery and swallowing: a systematic literature review

Ada Salvetti Cavalcanti Caldas⁽¹⁾Weldma Karlla Coelho⁽¹⁾Roberta Gomes Ferreira Ribeiro⁽¹⁾Daniele Andrade da Cunha⁽²⁾Hilton Justino da Silva⁽²⁾

⁽¹⁾ Instituto de Medicina Integral Professor Fernando Figueira – IMIP, Recife, Pernambuco, Brasil.

⁽²⁾ Universidade Federal de Pernambuco – UFPE, Recife, Pernambuco, Brasil.

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ABSTRACT

Objective: to identify, in the literature, studies that address the use of motor imagery of swallowing.

Methods: a systematic review in SCOPUS databases, Science Direct and Medline, with descriptors and free terms “Motor Imagery”; “Swallow”; “Feeding”; “Stomatognathic System”; “mastication”, “Chew”; “Deglutition”; “Deglutition Disorders”; and “Mental Practice”. Original articles using the motor imagery of swallowing were included, while reviews were excluded. For data analysis, at the first and second steps, the reading of titles and abstracts of the studies was carried out. In the third step, all studies that were not excluded were read in full.

Results: Four manuscripts were selected. The use of motor imagery in the rehabilitation of swallowing shows to be a recent proposal (2014-2015). The sample was reduced and comprised mainly healthy individuals. The EMG of the supra-hyoid muscles was used in two manuscripts. The most used neuroimaging technique was the Near-Infrared Spectroscopy, demonstrating the occurrence of hemodynamic changes during motor imagery and motor execution of swallowing.

Conclusion: the motor imagery produces brain response in the motor area of the brain, suggesting that mentalization of actions related to swallowing is effective. However, further studies are needed for the application of this approach in the swallowing rehabilitation.

Keywords: Stomatognathic System; Swallow; Mastication; Deglutition Disorders; Feeding

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Mailing Address:

Ada Salvetti Cavalcanti Caldas
Pós-graduação em Neuropsiquiatria
e Ciências do Comportamento -
Universidade Federal de Pernambuco
– UFPE
Av. Prof. Moraes Rego, s/n Cidade
Universitária
CEP: 50670-420 – Recife, Pernambuco,
Brasil
E-mail: adasc@hotmail.com

INTRODUCTION

Swallowing is an essential function for the maintenance of life, fundamental in the intake and absorption of nutrients by the body. Thus, during swallowing smooth and safe passage of food and saliva from the oral cavity to the oropharynx occurs through a sequence of coordinated muscle contractions. And thus swallowing can be classified as oral, pharyngeal and esophageal depending on the location of the food bolus ¹. This scheduled activity can be initiated voluntarily or synergistic awakened by movements triggered by sensory impulses from the posterior pharynx ².

This whole process has underlying complex neurophysiological mechanisms that require the activation of 55 muscles through six pairs of cranial nerves ³ and while it may initially be either conscious or unconscious, the final phase of swallowing occurs through blood pressure changes and contractions of contractile muscles of faringe1. These changes are part of a pre-programmed sequence motor suffering specific modulations that rely on sensory feedback arising from the oropharynx, considering the consistency and food size ⁴.

In the cortex, swallowing can be represented in the areas of the insula, the premotor cortex and the sensorimotor cortex ⁵. This is a complex function, integrating numerous systems: sensory (tactile, olfactory, gustatory and proprioceptive); motor (oral-pharyngeal motor coordination, integration between the components of mastication and breath; tone, range of motion, muscular strength) as well as cognitive components ⁶.

The inability or difficulty to swallow can be commonly detected in patients with neurological disorders ⁴ and requires motor trainings to favor functional recovery ⁶.

In recent years have intensified research with innovative techniques, and conventional approaches, particularly in the field of neurological disorders ^{7,8}, highlighting the motor imagery (MI).

The MI can be conceptualized as a dynamic state during which the representation of a specific motor action is internally activated within a working memory without any motor response ⁹, in other words, the individual imagines an action to be performed, describing the sequence of movements needed to perform this task without actually performing any movement. This technique, therefore, is a cognitive strategy that can benefit the acquisition of motor abilities and the functional performance of subjects undergoing rehabilitation ¹⁰⁻¹², still little used to facilitate the feeding activity.

The literature suggests that the MI can be an important therapeutic tool to facilitate individuals motor recovery after neurological injury ^{9,12}. Since MI allows you to activate the motor repertoire in all rehabilitation levels, namely acute, sub-acute or chronic disease⁹ fase, can be used as a training strategy for the relearning of Activities of Daily Living (ADL) ¹³. This approach is considered as a mental test of kinesthetic properties and / or visual movements ⁹ being directly related to the activation of the motor area and areas of the somatosensory cortex ¹².

Studies have shown that MI generates changes in motor performance ^{10,11} and can be used as a preparatory approach, since it increases the efficiency of subsequent physical training ⁹. The hypothesis of these changes in functional performance may be related to the possibility of neural training establishing, in the first phase of muscle training, the increase of muscle strength, caused by adaptive changes in central processes and not by muscle hypertrophy, suggesting that the gains observed after MI are due to neural changes in levels of programming and planning of motor system¹⁰.

From a neurological point of view, it is already well diffused in the literature that the primary motor area, primarily responsible for the motor, and the motor additional area involved in planning complex sequences are activated during movement execution ¹⁴.

Studies suggest that the pre-motor cortex and primary motor are essential during MI as well as in motor execution. Also propose that the primary motor cortex cause more changes in the motor areas during the motor execution (ME) than in the MI due to interaction with supplementary motor area ¹⁵⁻¹⁷. In summary, the results of different studies have shown that MI can increase the performance of motor tasks and that this increase may be associated with physiological and plastic changes of the Central Nervous System.

In this context, MI directed to the swallowing function can be thought from the understanding of neuroplasticity. Study on the plasticity of the central nervous system after ischemic or mechanical injury discloses that neurological recovery in dysphagia is disrupted from the recruitment of adjacent neurons to the injured brain area, as well as through the activation of distant areas of primary focus with neuronal organization and alignment ipsi- and contralateral ¹⁸, since the cortical representation of the normal swallowing is bilateral¹⁹.

Thus, the literature indicates that the shared brain activation by areas of swallowing and speaking

elevation suggest the possibility of using the motor imagery of the tongue protrusion movement as a means of practicing the motor imagery swallowing, revealing even that the input sensory language and swallowing are similar ⁶. In this way, the MI of the swallowing is based on the principles of neuroplasticity, considering also the oral phase of swallowing, in which the position of the alimentary bolus in the tongue occurs and the ejection of the bolus into the pharynx voluntarily, in a coordinated sequence of muscular contractions ².

Understanding the association between MI and feeding activity can enhance the swallowing rehabilitation process of individuals after stroke, contributing to the clinical practice of professionals, and highlighting speech therapists involved in treating these individuals. In this context, this study aims to identify the literature studies that address the use of motor imagery function during the swallowing function.

METHODS

The systematic review of the literature was performed using the SCOPUS, Science and Medical Literature Direct Analysis and Retrieval System Online (Medline) databases, through the PUBMED platform. The data search was performed by three independent researchers, having occurred from September 2016 to January 2017. A specific strategy has been drawn up to the intersection of the descriptors (DeCS / MeSH) - keywords for the scientific literature subjects recovery and Free-Terms (FT) - terms not found in DeCS and MeSH, but of relevance to the search.

In all databases, a strategy of search was performed with the syntax: "Motor Imagery" (FT) AND "Swallow" (FT); "Motor Imagery" (FT) AND "Feeding" (DeCS); "Motor Imagery" (FT) AND "Stomatognathic System"(MeSH); "Motor Imagery" (FT) AND "mastication "(MeSH); "Motor Imagery" (FT) AND "Chew "(FT); "Motor Imagery" (FT) AND "Deglutition "(MeSH); "Motor imagery" (FT) AND "Deglutition Disorders "(MeSH). The crossings above were also performed with the free term "Mental Practice" by replacing the term "Motor Imagery" (FT).

The inclusion criteria for the studies found by searching the databases were: original articles; address the use of motor imagery rehabilitation of swallowing, the feeding activity and / or stomatognathic

system components related to this activity, without language and period restriction. Systematic reviews were excluded, as well as articles that addressed the attempted rehabilitation of other parts of the body, without focusing in the activity of swallowing, the feeding or the stomatognathic system components.

This review followed the methodology adopted by Cochrane Brazil, and no filters were added during the search of manuscripts, with no restriction of age, gender or year of publication. According to Cochrane criteria, a systematic review should have a broad literature search in order to identify the greatest number of studies related to the issue, gathering similar data and evaluating it critically the methodology employed, promoting evidence-based practice ²⁰.

Articles should meet the selection criteria, allowing, on the part of the evaluators, three answers: Yes, No and Maybe. The article that just got «yes» and / or «maybe» by two evaluators was included. On the other hand, the publication with reply «no» by two evaluators deleted the item analysis. The results of the two evaluators were compared and, in the case of disagreement over the article selection, it was requested that the article be assessed by a third expert (judge).

The selection of the articles was conducted in three stages. In the first stage, reading the titles and excluded those who did not fit any of the selection criteria. In the second stage, reading the abstracts of the studies and in the third stage, all the studies that were not excluded were read in full for the selection of those to be included in this review.

LITERATURE REVIEW

In the Medline database, via PubMed, crossing the keywords and free terms, 387 articles were found, of which, 57 were excluded by repetition. In the SCOPUS database, 476 articles were found (119 repeated articles). In Science Direct database, 77 articles were found, excluding 13 by repetition.

Considering the criteria of inclusion and exclusion, 4 articles were selected for this systematic review ^{6,21-23}. The flowchart, which shows on detail, this process, follows the model of the Preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA) ²⁴ (Figure 1).

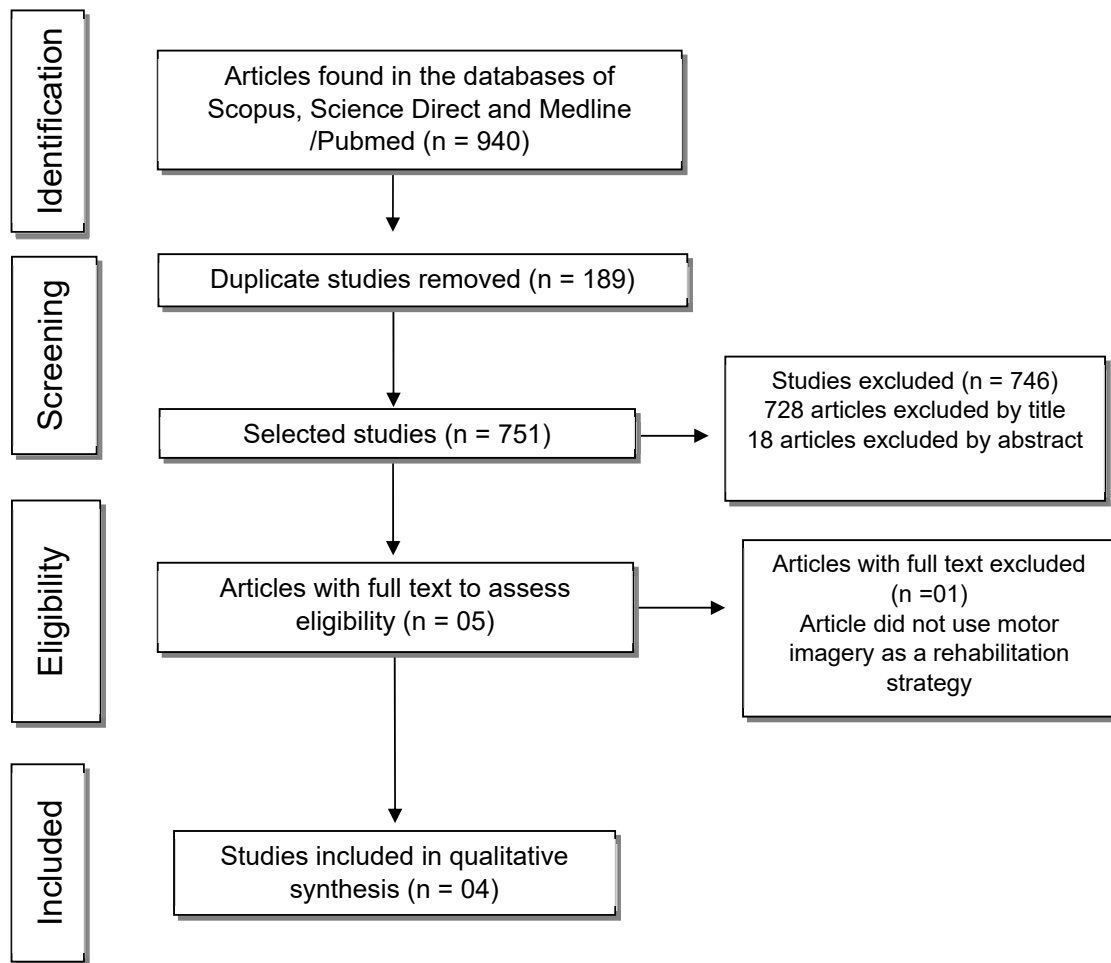


Figure 1. Flowchart and criteria for selection and inclusion of articles

For a better presentation of the results, the following variables of the selected articles were considered: author (year); country (sector); objective; subject; age; Inclusion criteria; Exclusion criteria; pathology (time,

area, and side of brain injury); functional assessments; technique (imaging); strategy (motor imagery); major brain areas investigated; and results (Figures 2 and 3).

Authors (year)	Country (Sector)	Objective	Subjects – P: M/W	Age (average-standard deviation)	Inclusion Criteria	Exclusion Criteria	Pathology - Time, area and side of the brain lesion
Kober; Wood (2014)	Austria and Netherlands (Psychology)	Investigating cerebral hemodynamics in response to ME and MI during swallowing	14 healthy individuals (7/7)	31.86 years	Right dominant hand; normal vision or corrected normal vision	Alterations: neurological, psychiatric, respiratory or swallowing disorders	Does not show
Yang et al., (2014)	Singapura (Reabilitação)	To investigate cerebral hemodynamics in response to ME and MI during swallowing and MI of tongue protrusion, in order to find a proposal for the rehabilitation of post-stroke dysphagia	Group 1 - 10 (8/2) healthy individuals Group 2 - 01 man with dysphagia due to chronic stroke	Group 1 - 35.9 ± 7.7 years Group 2 - 56 years	Group 1 - Healthy individuals; Group 2 - Patient with dysphagia after stroke	Healthy individuals: respiratory, swallowing and neurological disorders; feeding and nutrition problems	Stroke - 01 year of hemorrhagic trunk lesion (right and midbrain bridge)
Kober et al., (2015b)	Austria (Psychology)	To evaluate the effects of NIRS based on neurofeedback training on the patterns of cortical activation underlying the swallowing function	20 healthy individuals (10/10)	Group 1 (oxy-Hb): 23.8 ± 0.47 years Group 2 (desoxy-Hb): 25.7 ± 1.20 years	Present normal swallowing rate > 10 mL/s; normal vision or corrected normal vision	Alterations: neurological, psychiatric, respiratory or swallowing disorders	Does not show
Kober et al., (2015a)	Austria (Psychology)	To examine cerebral hemodynamic changes in response to ME and MI of swallowing in patients with dysphagia compared to healthy individuals	Stroke group: 04 (1/3); Control group: 02 healthy individuals (1/1)	Stroke group: 75 ± 5.29 years Control group: 67 year old male and 64 year old female	Stroke group: Neurological abnormalities; injury to any part of the brain; motor deficit; injury time of at least 4 weeks; Good vision and hearing; understanding and ability to give information; presence of family support. Control group – No swallowing problem.	Stroke group - Other concomitant neurological disorders; dementia (MMSE <24); insufficient understanding and communication; psychiatric disorders; heminelect.	Stroke: trunk lesions (71 days); Right oblong marrow (114 days); right middle cerebral artery (254 days and 71 days)

Legend: ME: Motor Execution; MI: Motor Imagery; NIRS: Near-Infrared Spectroscopy Study; Oxy-Hb: Oxyhemoglobin; Desoxy-Hb: Deoxyhemoglobin; MMSE: Mini-Mental State Examination; P: study population; M: Men; W: Women; mL/s: Milliliter per second.

Figure 2. Characterization of the studies that performed the motor imagery of the deglutition activity

Authors (Year)	Functional Evaluations	Technique/Image	Motor Imagery Strategy	Brain Areas Studied	Results
Kober; Wood (2014)	Use of EMG in suprahyoid muscles during MI, ME and rest	NIRS	MI/ME swallowing: Water use; Use of flexible tube (3mm diameter contained in a 1L bottle of water). ME of 15s; 15s IM; Rest from 28s to 32s. On the screen of a computer indication of action or rest.	Areas of Brodmann;	Topography: Change of oxy-Hb and desoxy-H during MI and ME. Signal in the lower frontal gyrus, including the Broca area; Oxy-Hb higher during rest than during ME; - Oxy-Hb increased during MI and decreased during ME; Desoxy-Hb with higher concentration in tasks than at rest; Desoxy-Hb demonstrates positive correlation between MI and ME, mainly in the kinesthetic strategy of MI; Pre-motor; Supplemental motor area and subcentral area were involved in MI and ME; It involves the involvement of the insula during swallowing, not captured by the NIRS;
Yang et al., (2014)	EMG of the submental and infrahyoid muscles	EEG	03 experimental sessions, each with two steps for healthy individuals: Sessions 1 and 2 with the MI of swallowing and rest; Session 3 with language MI and home; 02 experimental sessions, each with two stages for the patient with stroke: one of MI of swallowing versus rest and another of MI of tongue versus rest Swallowing MI: Use of water, juice or food (noodles or large pill); MI of the tongue: Protrusion of the tongue as far as possible and by several times; Visual track through a screen and auditory indicating the beginning of the task to be imagined;	No specific area was flagged	Accuracy in the classification of 70.89% and 73.79% for MI of swallowing and tongue MI respectively in healthy individuals; Cross-validation on average of 66.40% and 70.24% for MI of swallowing and MI of tongue for patients with stroke; Strong correlation in the classification between the MI of swallowing versus rest; and MI of tongue versus rest; it is possible to perform the swallowing MI to enable the rehabilitation of dysphagia in post-stroke patients;

Authors (Year)	Functional Evaluations	Technique/Image	Motor Imagery Strategy	Brain Areas Studied	Results
Kober et al., (2015b)	MIQ-R	NIRS	Deglutition test with 100 mL of water at room temperature; Measurement of swallowing time; Seven sessions with NF were performed three to five times a week for 20 min; Changes in NIRS concentrations were shown by moving a white spot vertically on the feedback screen depending on the level of oxy- or deoxy-Hb; Green or gray areas moved horizontally at constant speed; When the white point passed through the gray part the volunteers were instructed to relax; When the point reached the green area, they were instructed to imagine swallowing; Before and after the NF evaluation with NIRS; ME: swallowing water with small sips using a 3mm diameter flexible tube immersed in a 1L bottle (During the first 15s they ingested 5 to 6 sticks); In MI, the volunteers imagined swallowing 5 to 6 sticks of water such as ME;	Bottom frontal rotation bilaterally	Participants had an increase in oxy- or deoxy-Hb levels relative to motor areas during swallowing MI. Participants who trained the modulation of desoxy-Hb obtained an increase in the level of desoxy-Hb in the inferior frontal gyrus during NF training; The voluntary modulation of desoxy-Hb had pronounced cortical activation during MI and swallowing ME in the posterior evaluation; In the oxy-Hb group there were no cortical changes comparing the pre- and post-NF evaluations.
Kober et al., (2015a)	The Bogenhauser Dysphagia Score - BODS	NIRS	10 swallowing MI sessions and 10 swallowing ME sessions in randomized order; Swallowing ME: Instructed to swallow their saliva two to three times; In MI, they are instructed to imagine swallowing; Each task lasted 15s; Between each session, there was a resting moment signaled by the computer lasting between 28s and 32s	Inferior frontal rotation bilaterally; Areas of Brodmann	There were changes in cerebral hemodynamics in the association between MI and ME during swallowing of dysphagic patients. Compared with healthy subjects, there were greater changes in hemodynamics in the lower frontal gyrus during ME and MI of patients

Legend: EMG: Surface electromyography; MI: Motor imagery; ME: Motor performance; NIRS: Near-Infrared Spectroscopy Study; mm: millimeters; L: Liter; s: seconds; Oxy-Hb: Oxyhemoglobin; Desoxy-Hb: Deoxyhemoglobin; EEG: Electroencephalogram; mL: milliliter; NF: Neurofeedback; min: minutes; MIQ-R: Motor Imagination Questionnaire in the revised version.

Figure 3. Functional evaluations, neuroimaging techniques, motor imagery and brain areas studied in the selected articles

In the search for data in the literature, the selected studies proposed searching the motor imagery of swallowing through different methodologies, and it was not possible to group data by means of statistical analysis. Given this heterogeneity, the results of this study are in the form of a systematic review, without meta-analysis.

The use of motor imagery rehabilitation of swallowing shows to be a recent proposal, since the four selected articles are between the years 2014 and 2015^{6,21-23}. The literature clearly indicates the efficacy of MI as an adjuvant in motor rehabilitation of the upper limb in individuals with some neurological disorder²⁵⁻²⁷. But it is incipient the number of articles that suggest this technique correlate with tongue movements, and yet such research does not focus on rehabilitation of swallowing^{28,29}.

The countries which have published the research in question are different, however scholars of Austria and the Netherlands give signs that are involved in longitudinal research, improving topic²¹⁻²³. In 2014²¹ these researchers approached the use of MI by

neuroimaging technique, checking changes in cerebral hemodynamics. In 2015²³, this same group deepens the methodology with neurofeedback strategies, with training modulation of brain oxygen levels during MI swallowing. In the other hand, the authors of Singapore⁶ proposed to investigate the detection of swallowing MI as a proposal for rehabilitation through the MI of tongue movements (protrusion).

Certainly it is presumed that in South American countries, such as Brazil, where the rehabilitation of dysphagia is already consolidated^{30,31}, possibly was not yet aroused the intention to enter the MI approach in clinical practice for the treatment of swallowing changes. Perhaps the limited number of studies will be a barrier to the expansion of this technique in Latin countries.

It is believed that the understanding of the therapeutic approach of the MI by the speech therapist would enhance new perspectives in dysphagia rehabilitation, considering that the involvement of complex brain functions and knowledge of swallowing field requires an interdisciplinary action. This is another

point to be reflected when looking at the departments in which the four studies of this review were subordinated (rehabilitation and psychology).

This question is also anchored in the complexity of methodological approaches outlined in each manuscript, different from the selection of the sample to the choice of instruments and stages of MI execution.

In the sampling, the number of participants in the trials ranged from 6 to 20 individuals, composed mainly of healthy individuals aged up to 35 years. It was assumed that as a recent technique in swallowing rehabilitation, there was the interest of initially study a healthy population, in an attempt to better understanding this therapeutic proposal.

Two studies involved neurological dysfunction^{6,21}, wherein 05 patients with stroke, divided into brainstem lesion (03-60%) and the middle cerebral artery lesions (02 - 40%). The time after the event has been described with a range 71-254 days in the study series of cases²², and, then considering a sample yet in subacute phase of the disease. Already in the manuscript with a single case of stroke⁶, the patient had chronic injury a year ago.

Lesions in the brainstem often brings changes in swallowing, as well as the interruption of blood flow in the middle cerebral artery can lead to various motor-sensory changes, affecting the face and the upper and lower members movements in the contralateral side of encephalic injury³². In both studies the focus has permeated to investigate the brain behavior of people with dysphagia during the MI and ME of swallowing, comparing them to individuals without neurological disorders.

In eligibility, for healthy individuals were ruled out any neurological and psychiatric were discarded, as well as sensorial or motor deficit. Moreover, it wouldn't be possible the admission of people with swallowing disorders^{6,21-23}. In the other hand, in the participants group with stroke, there was the requirement of dysphagia^{6,22}, however with no others neurological and psychiatric disorders, with preserved capacity for understanding and communication²².

To check the swallowing function, only one article used standardized assessment Bogenhausen Dysphagia Score (BODs)²² to determine the dysphagia degree of the 04 participants with stroke sequelae, classifying them into mild (score 4), moderate (score 5), moderate-severe (score 9) and severe (score 11).

The Bods is a German evaluation used by speech therapists in Europe, which assesses the ability to

swallow saliva and food intake³³. The stratification of the population in degree of dysphagia commitment, besides to identify the variability of the sample, raises the researcher concern in the risk analysis, referring the choice of safe intervention strategies to work swallowing rehabilitation. In the survey concerned the water was not used.

The surface electromyography (EMG) of the supra-hyoid muscles was used in two manuscripts during MI swallowing, bringing quantitative data on the electrical activity of these musculature^{6,21}. This information was used as a control of active movement (motor) during MI in the swallowing oral phase.

In the analysis of the supra-hyoid muscles²¹, the researchers identified that the electrical activity of these muscles increased during the execution of the movement compared with the MI and rest. There was also a numerical increase (not statistically significant) in electrical activity during the MI when compared with rest. In discussion, it quotes the hypothesis that the reducing of the electrical signal magnitude during the MI has roots in cortical inhibition of movement (motor control) while the MI.

Studies show similarity in activation of brain areas during ME and MI, highlighting the Primary Motor (M1), Supplementary Motor Area (SMA), Pre-Motor and somatosensory cortex in the parietal lobe^{15,16}. However, the suppression exerted by the SMA to the M1 during MI has also been reported in other studies^{15,17}. It is believed that this inhibitory effect is a physiological mechanism to prevent movement during the MI.

To find out if the study population was understanding the technique of motor imagery, a single article used the Motor Imagination Questionnaire in the revised version - MIQ-R²³. This questionnaire is the most used to verify, through scores, the ability to imagine a movement through a visual or kinesthetic strategy, involving movements of the leg, arm and whole body³⁴.

The neuroimaging technique most widely used was the Near-Infrared Spectroscopy - NIRS (03-75%)²¹⁻²³ by the researchers group from Austria and Netherlands. The infrared spectroscopy (NIRS) is one of the main techniques used to observe tissue oxygenation, most specifically the oxyhemoglobin flow (Oxy-Hb) and deoxyhemoglobin (Hb-Desoxy) in muscle and brain regions³⁵. The change in blood oxygenation response to a stimulus reflects in a higher level of brain activation, that is, in the area where most cortical activation occurs there is alteration in blood flow and volume, can be

monitored, by NIRS, the concentrations of oxy- and deoxyhemoglobin. In this review, the authors proposed verify this change of cerebral hemodynamics in Brodmann areas, focusing on the inferior frontal gyrus, during the execution and imagination of the swallowing movements.

With healthy individuals²¹, the NIRS results corroborate other neuroimaging studies about activation of premotor areas and SMA during the ME and MI^{15,17}. There was an increase of oxy-Hb during ME (swallowing water) and Desoxy-Hb had greater concentration during the tasks than in the rest. During the motor execution would be expected the increase of the oxy-Hb flow and the inhibitory mechanism during MI, discussed above, may be a hypothesis for these hemodynamic changes. On the other hand, it was not possible on these results make inferences for the population with neurological alterations nor propose ways of treatment.

The oxygen flow modulation was aimed through the use of NIRS and neurofeedback²³. The participants were divided into two groups (oxy- and desoxy-Hb) and instructed to observe a white dot on a computer screen with green and gray color stripes. The volunteer should imagine swallowing water depending on the color of the stripe in which the white point it was positioned.

For neurofeedback training, different values of oxy- or desoxy-Hb (respectively in each group) were achieved in the inferior frontal gyrus, being represented by changes in the vertical direction of the white spot on the screen. The results showed that levels of oxy- and desoxy-Hb increases during both MI and ME. In the group of individuals who have trained the desoxy-Hb modulation, obtained an increase in the desoxy-Hb level in the inferior frontal gyrus. This study proposed intervention and the possibility of cortical reorganization, although it was carried out with healthy individuals.

In 2013, a pilot study used the NIRS with the neurofeedback proposal in motor imagery of post-stroke patients, confirming to be possible a cortical reorganization in neurological patients, with enhancement of functional recovery during rehabilitation. However, in this study the imagined movements were restricted to the upper member and has not been further analyzed the swallowing function³⁶.

The NIRS study with neurological patients²² showed the occurrence of hemodynamic changes in the MI and ME of swallowing in patients with dysphagia and in a more pronounced form, in the inferior frontal gyrus, reinforcing the possibility to rehabilitate this function

through the MI. In the inferior frontal gyrus is located the Broca's area, largely responsible for the language, and is also situated the control of orofacial sensory motor movements unrelated to speech, going on activation during swallowing³⁷.

The authors of Singapore⁶ corroborate the idea of rehabilitating dysphagia through swallowing of MI. In this study with electroencephalogram (EEG), the MI of tongue movements was used as a model for the detection of MI swallowing. The study has proposed that brain areas responsible for swallowing are activated during the lifting movement of the tongue and quotes the cingulate cortex and the supplementary motor area.

The literature points out that the extent and distribution of brain activations may differ in MI and ME, however in both the MI and the execution activities, the neural networks involving central motor areas are activated. These areas participate in the planning, initiation and execution of motor commands³⁸. The supplementary motor area along with pre motor cortex send neural impulses to the primary motor cortex and are constantly activated during MI and ME. In addition, the synchronization and coordination of the swallowing movements, is already evident in the literature the association of cortical areas such as the insula and pre motor cortex⁵.

In consonance, study about the brain activation and connections that occurs during motor imagery indicates that the primary motor cortex, supplementary motor area and prefrontal cortex plays a crucial role during the MI and ME. The interaction between brain areas and effective network connectivity shows the importance of relationship of treatment as a mental practice and physical therapies during motor rehabilitation³⁹.

In the event of neurological disorders, the MI associated with ME strengthens the occurrence of connections in the cortical motor area on the affected brain side and rearranges the connectivity of neural network of the contralateral cerebral side to the lesion⁴⁰, in the case of an effective strategy in dysphagia rehabilitation, since that the cortical representation of normal swallowing is bilateral¹⁹.

In this study⁶, it is suggested that in clinical practice, the swallowing or tongue MI can be used in the rehabilitation of swallowing in common situations, such as weak swallowing, for examples in patients with post-stroke dysphagia, as well as in those individuals who have late start swallowing, reducing the lag time at

the beginning of the pharyngeal phase and avoiding situations related to escape and aspiration.

However, it indicates the difficulty of accomplishing the MI swallowing due to the complexity of the movement that involves sensory processing, coordination of chewing movements, breathing and attention. As the study realized with NIRS, it requires a larger number of participants to raise inference to the general population and facilitate the incorporation of the technique as an adjuvant of the conventional ²² swallowing rehabilitation.

CONCLUSION

The studies suggest that the motor imagery may cause some brain response in the motor area of the brain, suggesting that mentalization of actions related to swallowing may be effective to improve the engine performance of this function and therefore, reflecting also, in the feeding activity. However, new studies are needed with a larger number of participants allowing introducing this technique in the clinical intervention of professionals involved in swallowing rehabilitation.

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