

Rehabilitation Techniques in Dysphagia Management among Stroke Patients: A Systematic Review

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Abstract

Several studies have assessed the efficacy of old and recent rehabilitation techniques in swallowing such as thermal stimulation, electrical stimulation, acupuncture, oral strengthening, air pulses, Transcranial Direct Current Stimulation (tDCS) and Transcranial Magnetic Stimulation (TMS).

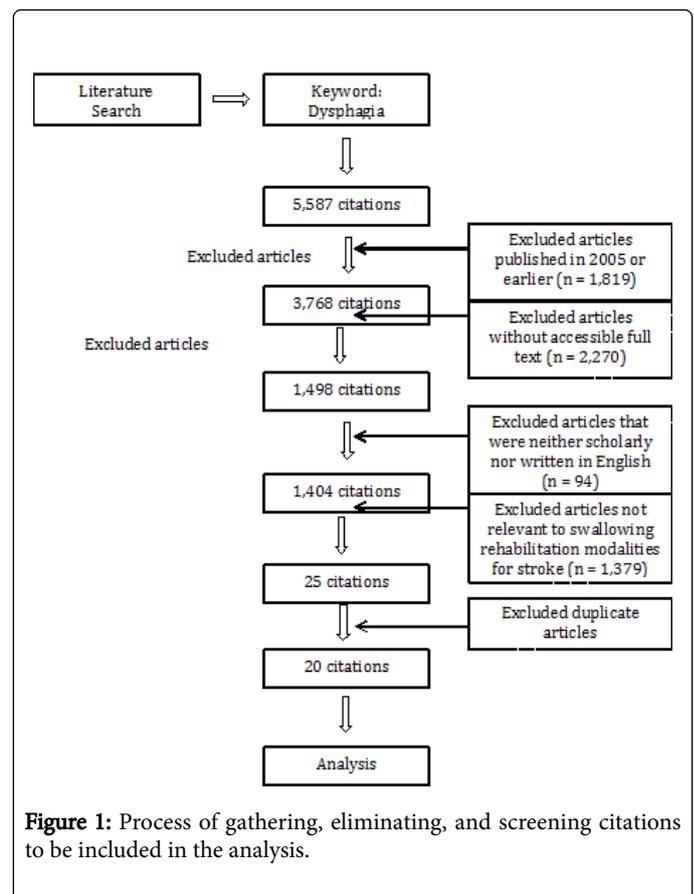
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Introduction

The Philippine Academy of Rehabilitation Medicine recognizes the impact of dysphagia, or impaired swallowing, as a significant alteration in body structure and function post-stroke. Among patients suffering from cerebrovascular disease regardless of etiology and location, difficulty in oral feeding is experienced by 29 to 67% [1]. Dysphagia can range from the most transient to the most persistent and disabling, and its sequelae can be cascading (from pneumonia and malnutrition to respiratory failure and death in the most devastating cases).

According to the Stroke Society of the Philippines, patients should be screened for dysphagia before given any food or drink within the first 24 hours post-ictus, or upon regaining full consciousness and ability to follow command [2]. After detecting dysphagia on bedside swallowing evaluation, and preferably supported later by a comprehensive diagnostic workup to determine etiology (such as modified barium swallow or video fluoroscopy), the patient who is evaluated to have limited ability to perform safe and effective oral feeding is recommended to undergo a swallowing rehabilitation program.

Foremost in the dysphagia program are oropharyngeal restorative exercises that aim to improve motor control of muscles involved in swallowing (Level of Evidence: B), in addition to compensatory techniques (such as chin tucking and head rotation), and dietary modification (such as gradual progression in consistency, amount, and frequency) [2]. The advent of medical technology, however, has enriched the rehabilitation techniques available as treatment options for dysphagia, including ice massage, electrical stimulation, acupuncture, air pulses, transcranial direct current stimulation, and transcranial magnetic stimulation. These techniques have their distinct mechanisms of action, protocols, advantages, and disadvantages, which are beyond the scope of this paper. It was, therefore, the aim of this study to systematically review the evidence of efficacy of these strategies.



Methods

The main interest of this study is dysphagia, which was used as the search word during literature review. In order to capture as many relevant citations as possible in the EBSCO Host engine, different health sciences databases, including those indexed in MEDLINE and

CINAHL, were searched. In addition, other electronic search engines were looked into. These methods resulted in 5,587 citations from which studies considered relevant (swallowing rehabilitation modalities for stroke patients) and relatively recent (within past 10 years) were selected for review Figure 1.

As a result, 1,819 citations were excluded as outdated publications (published in 2015 or earlier). The search further excluded 2,270 citations in order to include only those with available full text for review, and 94 more to include only scholarly articles in English language. Hence, 1,404 remaining citations were screened for relevance to stroke rehabilitation strategies, resulting in 25 studies, where 5 of which were duplicates. A total of 20 randomized clinical trial or meta-

analysis studied the efficacy of one or more of the following: ice massage, electrical stimulation, acupuncture, air pulses, transcranial direct current stimulation, or transcranial magnetic stimulation. The full text of the remaining citations was then downloaded and analysed.

Results

The earliest study that was included in the initial search was published in 1962, while the latest was from 2016. Of the 5,587 articles, only 20 were included in the final analysis; the earliest of which was published in 2007. The salient points of these studies are presented in Table 1.

Authors	Country	Study Design	Population	Intervention	Dosage/ settings
Nakamura T, et al. [3]				Ice massage	
Carnaby-Mann G, et al. [4]		Meta-analysis	Stroke patients	Neuromuscular electrical stimulation	
Xia W, et al. [5]			Stroke patients	Conventional swallowing training with Vitalstim therapy	
Permsirivanich W, et al. [6]	Thailand	Randomized controlled trial	23 stroke patients with persistent pharyngeal dysphagia	Rehabilitation swallowing therapy (n=13) versus neuromuscular electrical stimulation (n=15)	60 minutes for 5 consecutive days
Xia W, et al. [5]	China	Single-blind randomized controlled trial	124 patients with dysphagia after stroke	Standard swallowing treatment with acupuncture versus Standard swallowing treatment without acupuncture	6 days of therapy per week for a 4-week period
Long YB, et al. [8]		Meta-analysis		Acupuncture	
Theurer JA, et al. [9]		Proof-of-principle pilot study		Oropharyngeal air-pulse application	
Yang EJ, et al. [10]				Transcranial direct current stimulation	
Kumar S, et al. [11]		Pilot study		Non-invasive brain stimulation	
Shigematsu T, et al. [12]				Transcranial magnetic stimulation	
Rossini PM, et al. [13]				Transcranial magnetic stimulation	
Khedr EM, et al. [14]			Patients with lateral medullary syndrome and brainstem infarct	Repetitive transcranial magnetic stimulation	
Khedr E, et al. [15]				Repetitive transcranial magnetic stimulation	
Chen Y, et al. [16]	Taiwan	Systematic review and meta-analysis	8 studies	Swallow treatment with neuromuscular electrical stimulation versus Swallow treatment without neuromuscular electrical stimulation	Varied
Verin E, et al. [17]	France	Non-controlled pilot study	7 patients with hemispheric or subhemispheric stroke	Repetitive transcranial magnetic stimulation (rTMS)	rTMS on the contralateral hemisphere at 1 Hz x 20 min once a day for 5 days hemisphere
Martin RE, et al. [18]	London	Randomized	23 in-patients with dysphagia due to stroke regardless of location (majority: right middle cerebral artery infarct)	Air-pulse trains, delivered in 4 levels of duration (single pulse, doublet or two successive pulses, 2 second train, and 3 second train); 4 levels of amplitude (2, 4, 6, and 8 psi); and 4 levels of pulse frequency (2, 4, 8, and 12 Hz), compared with sham	Pulse duration of 50 msec, and duration between pulse trains of 20 sec

Vose A, et al. [19]	USA	Review article on traditional dysphagia therapies, including ice massage	For the study on ice massage: 27 dysphagic patients with hemispheric stroke	Ice massage	Massage with ice stick applied to various areas of the mouth for 10 seconds with rubbing and light compression
Cai H, et al. [20]	China	Randomized controlled trial	180 patients with post-stroke dysphagia	Tongue acupuncture on the basis of conventional medication (n=90) versus Conventional acupuncture group on the neck and wrist (n=90)	Needling on tongue or neck and wrist acupoints, twisting 12 times, for 1-2 mins, 1 x/day, 5 x/week for 4 weeks
Rofes L, et al. [21]	Spain	Randomized double-blind, parallel group study	20 chronic post-stroke patients with oropharyngeal dysphagia	Surface electrical stimulation: Group 1: Sensory electrical stimulation (n=10), versus Group 2: Motor electrical stimulation (n=10)	Group 1: 75% of motor threshold, electrode on thyro-hyoid; Group 2: motor threshold, electrode on supra-hyoid; Both treated 1 h/day for 10 days
Sun SF, et al. [22]	Taiwan	Prospective case series	29 patients with moderate to severe dysphagia at least 3 weeks post-stroke	Combined neuromuscular electrical stimulation (NMES) and traditional swallowing rehabilitation, guided by fiberoptic endoscopic evaluation of swallowing (FEES) before and after rehabilitation	12 sessions of NMES for 1 h/day, 5 days/week for 2-3 weeks; followed by 12 sessions of conventional swallow-wing program (50 min/day, 3 days/week for 4 weeks)

Table 1: Summary of the 20 citations that qualified for analysis.

Discussion

The study by Nakamura et al. on ice massage found statistically significant improvements in dysphagia scores [3]. Twenty-four patients were included in a cross over trial consisting of four rounds of swallowing commands, alternating between a swallow command after ice massage and a swallow command after no ice massage. For 14 patients who swallowed in all four rounds, there was a statistically significant shorter time to swallow in the group who received ice massage. The swallowing time, however, was dependent on the location of lesion. Those individuals with nuclear lesions did not experience statistically significant improvements in swallowing time compared to those individuals with supranuclear lesions.

Electrical stimulation of laryngeal muscles using Vitalstim has been recognized in the Philippines. However, no published local studies are known to the authors at this time, although international data have been widely available. It has been studied that electrical stimulation during oral intake facilitates observable and palpable hyolaryngeal excursion. Stimulation combined with swallowing of different consistencies of food and liquid provides improved and safer swallows [4].

The potential benefit of electrical stimulation (ES) in the rehabilitation of swallowing was evaluated in several randomized clinical trials. These included electrical stimulation vs. sham stimulation, electrical stimulation vs. conventional therapy, and electrical stimulation combined with conventional therapy vs. conventional therapy vs. electrical stimulation only. In the largest study, the use of two co-interventions (ES+therapy) improved swallowing function compared to either of the two interventions given in isolation [5].

In a study by Permsirivanich et al., 23 stroke patients with dysphagia persisting for greater than 2 weeks were randomized to receive either rehabilitation swallowing therapy (RST) or neuromuscular electrical stimulation therapy (NMES). The subjects received 60 minutes of

either RST or NMES treatment for five consecutive days, had two days off and then five more consecutive days of treatment for a four-week period or until they reached functional oral intake scale (FOIS) level 7. Before therapy, 73% of the RST group and 83% of the NMES group required non-oral feeding (FOIS levels 1-3). At the end of the study, 75% of the RST group and 90% of the NMES group was able to manage oral intake [6].

In 2015, Xia assessed the effects of acupuncture to standard swallowing training for patients with dysphagia after stroke [7]. There were 124 patients who received acupuncture plus swallowing training. The outcome measures used were the Standard Swallowing Assessment and the Dysphagia Outcome Severity Scale. This study concluded that acupuncture combined with swallowing training might be beneficial for stroke patients.

Meanwhile, Long and Wu included 72 clinical trials in their meta-analysis. All studies that compared acupuncture treatment with any therapy were included. The odds of an improved outcome were statistically greater in the acupuncture group compared with the non-acupuncture group (OR 5.17; 95% CI 4.18 to 6.38) [8].

The study by Theurer and colleagues ushered the use of air pulses for swallowing [9]. Eight patients diagnosed with dysphagia following stroke received 5 air-pulse trains; each of which lasted 5 minutes in duration. Air pulses were directed to the oropharyngeal region using a mouthpiece positioned along the alveolar ridge of the mandible. Unilateral and bilateral air-pulse applications were made, as well as sham applications for five of the eight patients. Swallowing rates (swallows per minute) were compared before and after the administration of air-pulses, using standard deviation bands as thresholds for significance. Four (50%) of subjects were found to have significantly greater swallowing rates following the administration of air pulses.

Transcranial direct current stimulation works by sending constant, low direct current through electrodes. When these electrodes are

placed in the region of interest, the current induces intracerebral current flow. This current flow then either increases or decreases the neuronal excitability in the specific area being stimulated based on the type of stimulation being used. It can either be applied on the unaffected hemisphere to produce inhibition, or on the affected extremity to produce excitation. These include two electrodes and a battery-powered device that delivers constant current. Each device has an anodal, positively-charged electrode and a cathodal, negatively-charged electrode. Current is described as flowing from the positive anode, through the intervening conducting tissue, to the cathode, thus creating a circuit. Applied on the pharyngeal cortex, the modality is able to both excite and inhibit the pharyngeal motor cortex, depending on the placement of electrodes. The optimal parameters for anodal stimulation were found to be 1.5 mA for 10 minutes, or 1 mA for 20 minutes [10].

Kumar et al. studied 14 patients within one to seven days of unilateral hemispheric infarction who were randomized to either anodal transcranial direct current stimulation (tDCS), or sham stimulation for the unaffected hemisphere over 5 consecutive days with standardized swallowing maneuvers [11]. The Dysphagia Outcome and Severity Scale (DOSS scale: 1-7) was assessed before patients who received anodal tDCS gained more points on the DOSS. Six out of 7 (86%) patients in tDCS group gained at least 2 points of improvement compared with 3 out of 7 (43%) patients in the sham group.

Shigematsu et al. studied 20 patients, who were randomized to receive either active anodal transcranial direct current stimulation (tDCS) (n=10), or sham treatment (n=10), which lasted for 20 minutes, 5 times a week for 2 weeks [12]. The intervention group received anodal tDCS over the affected pharyngeal motor cortex (with the cathode placed on the opposite hemisphere in the supraorbital region) and conventional swallowing therapy. Dysphagia Outcome and Severity Scale (DOSS) was assessed pre- and post-intervention, and at 1 month follow-up. Patients receiving anodal tDCS experienced statistically greater improvements in swallowing function based on DOSS score from pre-intervention to 1 month post-intervention compared with controls.

Furthermore, transcranial magnetic stimulation (TMS) is also used as a treatment option for dysphagia, wherein a magnetic field generator, or "coil" is placed near the head of the person receiving the treatment. This produces small electric currents in the region of the brain just under the coil via electromagnetic induction. The coil is connected to a pulse generator, or stimulator, that delivers electric current to the coil [13].

Kedr et al. published a study of twenty patients with post-stroke dysphagia due to single hemispheric stroke [14]. Patients were randomly allocated to receive real (n=14) or sham (n=12) repetitive TMS (rTMS) of the affected motor cortex. Each patient received a total of 300 rTMS pulses at an intensity of 120% hand motor threshold for five consecutive days. Clinical ratings of dysphagia were assessed using the Dysphagia Outcome and Severity Scale before and after the last session and then again after 1 and 2 months. The baseline mean dysphagia score for the control group was 3.7 vs. 3.4 for the real rTMS group. By 2 months, the real rTMS groups' mean score was approximately 1.0 vs. 3.0 for the control group.

Lastly, Alfetoh with Kedr in 2010 did a trial on twenty-two patients with acute ischemic stroke with lateral medullary syndrome or brainstem infarction with severe bulbar manifestations. The participants were randomly allocated to receive active (n=11) or sham

(n=11) repetitive transcranial magnetic stimulation of the esophageal motor cortex [15]. Each patient received 300 rTMS pulses at 3 Hz and an intensity of 130%. There were statistically significant improvements in dysphagia scores and Barthel Index scores for the active rTMS group compared with the sham group.

Conclusion

In summary, there is strong (Level 1-2) evidence that repetitive transcranial magnetic stimulation and transcranial direct current stimulation both improve swallowing function post-stroke. However, there is conflicting evidence that electrical stimulation can improve swallowing function. There is limited (Level 2) evidence that acupuncture coupled with electrodiagnostic study can be used to improve swallowing function post-stroke.

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