Effects Of Electrical Stimulation On Swallowing Function In Stroke Patients With Dysphagia: A Systematic Review

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Abstract: Background: The most common cause of chronic dysphagia is stroke. Dysphagia can lead to malnutrition, feeding-tube dependence, aspiration pneumonia, social isolation and even death. Administration of swallowing therapy may improve swallowing and thereby reduce the risk of dysphagia but effect of electrical stimulation is still unclear. The objective of this study is to assess the efficacy and safety of electrical stimulation in stroke patients with dysphagia by systematic review and followed the PRISMA statement guidelines. Method: Scopus, PubMed, Proquest, and Science Direct database with limited year 2012 – 2018 were search for the relevant keyword. All included studies were access base on (1) randomized controled trial, (2) experimental study. Results: Nine article reported that electrical stimulation include neuromuscular electrical stimulation (NMES) using VitalStim or AMPCARE effective swallowing programme, pharyngeal electrical stimulation (Phagenyx) increase significantly swallowing function in stroke with chronic or acute dysphagia. Conclusion: Interventions electrical stimulation can be used as safety treatment method in stroke patient with acute or chronic dysphagia.

1 INTRODUCTION

The most common cause of chronic dysphagia is stroke (Beavan, 2015). Stroke survivors are estimated to be 50% dysphagia and 11-13% to chronic dysphagia (Nam et al., 2015). The ingestion process involves some sensory elements of the peripheral nerves, central nervous system coordination, and motor responses. Sensory processes of the peripheral nerves are cranial nerves V, VII, IX, X, and XII. In the central nervous system, the cortical and subcortical areas regulate the swallowing threshold and the brainstem acts as the center of swallowing, accepting input, arranging it into a programmed response and sending the response to the swallowing muscles (Lin, Hsieh and Wang, 2013). Stroke resulted neuron cells becomes tissue death resulting in malfunction. In acute stroke, patients may develop dysphagia due to cerebral edema, conscious level disorder or diaschisis and are usually reversible. But if lesions of the brainstem area will occur permanent dysphagia (Lam et al., 2013). The disorders that can occur in stroke are as follows: Oral phase: lobe coordination disorder, tongue and mandibular, weakness in the base of the tongue, decreased level of consciousness, noble dysfunction. Pharyngeal phase: superior mole and pharyngeal palatum dysfunction, muscle weakness of the pharyngeal contractor, musculary muscle disorder. Esophageal phase: abnormal wall defect, peristaltic weakness of the esophagus. The incidence of dysphagia (difficulty swallowing) reported in stroke is 30-78% (Martino et al, 2005). Based on the videofluoroscopic studies of swallowing (VFSS) the incidence of dysphagia in the acute phase is 71-78% (Daniels et al, 1998; Hamdy et al, 1998). Dysphagia can lead to malnutrition, feeding-tube dependence, aspiration pneumonia, social isolation and even death (Archer et al., 2013). Early detection in the form of screening may reduce the risk of lung complications and death (Kushner et al, 2013), early detection and management of dysphagia is expected to benefit patients not only shortening stroke recovery times but also to reduce overall rehabilitation and recovery costs (Martino, Pron, & Diamant, 2000). Good management of dysphagia proper swallowing difficulties can improve patient wellbeing through improved nutrition and hydration, ensuring they receive their medication and prevent adverse events such as choking and aspiration pneumonia (Wright & Howseman, 2013). As time goes by, intervention or therapy to improve swallowing function in dysphagia patients is increasingly variable. So research is needed as evidence based practice. One of swallowing therapy is electric stimulation. Electrical stimulation included neuromuscular electrical stimulation (NMES) using Vital-stim and AMPCARE effective swallowing programme, pharyngeal electrical stimulation (Phagenyx) (Beavan, 2015). Until now, study efficacy and safety of electrical stimulation is still unclear. The objective of this study is to assess...
The efficacy and safety of electrical stimulation on swallowing function in stroke patients with dysphagia.

2 METHODS

This systematic review followed the Preferred Reporting Item for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Liberati et al., 2009).

2.1 Search strategy

Using electronic databases, including Scopus, Pubmed, Proquest and ScienceDirect, the search was carried out with “stroke”, “dysphagia”, “electrical stimulation” as the main keywords. From this search, only papers in English language were considered. In a second step, “neuromuscular electrical stimulation (NMES)”, “Vital-stim”, “AMPCARE effective swallowing programme”, “pharyngeal electrical stimulation (Phagenyx)”.

2.2 Eligibility Criteria

2.2.1 Types of studies
(1) randomized controlled trial, (2) experimental study

2.3 Types of participants

The main inclusion criteria: 20-80 years old with acute or chronic dysphagia after stroke

2.4 Type of interventions

Neuromuscular electrical stimulation (NMES) using VitalStim or AMPCARE effective swallowing programme), pharyngeal electrical stimulation (Phagenyx).

2.4.1 Type of outcomes measures

Primary outcomes of interest were any measure of swallowing function. The timing of outcome measures was variable.

2.5 Study selection

The protocol standard for selecting research studies is suggested in the PRISMA method for systematic review followed by screening by removing duplicates, then three reviewers selecting titles, abstracts, and keywords, then deleting irrelevant quotes according to the selection criteria. Reviewers noted the reasons for choosing such research studies including selection of inclusion inclusion data. Selection of research studies that have been recorded by three reviewers and then compared to one another to be adjusted feasibility with the criteria set. Secondly, to minimize the risk of incorrect study entry in selection there are several research studies that have been applicable or can be applied in a review by one or two reviewers to be included in the next review stage. Full text of the articles is obtained if the title and abstract meet the inclusion criteria or if the feasibility study is clearly resolved by a joint discussion between the reviewers.

3 RESULTS

3.1 Literature search and study selection

A total of 9 studies were identified for inclusion in the review. The search of Scopus, Proquest, PubMed and Science Direct databases provided a total of 1,004 citations. After adjusting for duplicates 857 remained. Of these, 595 studies were discarded because after reviewing the abstract it appeared that these papers clearly did not meet the criteria. The full text of the remaining 286 citations was examined in more detail. It appeared that 250 studies did not meet the inclusion criteria as described. See flow diagram Figure 1.

3.2 Study Characteristic

3.2.1 Methods

9 studies finally selected for review were eight randomized controlled trial, one experimental study

![Flow Diagram]

Fig. 1. Flow Diagram
3.2.2 Population

3.2.2 Population
Total respondents in the selected literature were 461 respondents in the range of 20-120 respondents. Respondents are between 18-80 years old.

3.2.3 Intervention Characteristic
Table 1 represents the characteristics and content of the interventions of the 9 studies.

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Interventions</th>
<th>Design</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ebru K et al, 2017</td>
<td>Ninety-eight patients with dysphagia within the first month after ischaemic stroke</td>
<td>Sensory level electrical stimulation (SES) to bilateral masseter muscles</td>
<td>Randomized control trial</td>
<td>SES applied to bilateral masseter muscles may provide an effective treatment for both dysphagia and cognitive function in early stroke patients</td>
</tr>
<tr>
<td>Jin-Woo Park et al, 2012</td>
<td>Twenty post-stroke dysphagic patients</td>
<td>Effortful Swallowing Training Combined with Electrical Stimulation</td>
<td>Randomized control trial</td>
<td>Effortful swallow training combined with electrical stimulation increased the extent of laryngeal excursion</td>
</tr>
<tr>
<td>Sonja Suntrup et al, 2016</td>
<td>Twenty stroke patients successfully</td>
<td>Electrical pharyngeal stimulation</td>
<td>Randomized control trial</td>
<td>Pharyngeal stimulation was significantly associated</td>
</tr>
<tr>
<td>Lise Spronsen et al, 2017</td>
<td>Thirty stroke dysphagic patients</td>
<td>Ampcare Effective Swallowing Protocol (ESP Combined with NMES with swallow-strengthening exercises)</td>
<td>Randomized control trial</td>
<td>Ampcare Effective Swallowing Protocol (ESP Combined with NMES with swallow-strengthening exercises)</td>
</tr>
<tr>
<td>Anna Guillen-Sola et al, 2016</td>
<td>Sixty-two patients with stroke dysphagia</td>
<td>Inspiratory/expiratory muscle training (IEMT) and neuromuscular electrical stimulation (NMES)</td>
<td>Randomized control trial</td>
<td>Both IEMT and NMES were associated with improvement in pharyngeal swallowing</td>
</tr>
<tr>
<td>Kun-Ling Huang et al, 2014</td>
<td>Twenty acute stroke patients with dysphagia</td>
<td>Traditional swallowing (TS) combined with oropharyngeal neuromuscular stimulation (NMES)</td>
<td>Randomized control trial</td>
<td>Both IEMT and NMES were associated with improvement in pharyngeal swallowing</td>
</tr>
</tbody>
</table>
**3.3 Results of individual studies**

**3.3.1 Neuromuscular Electrical Stimulation using VitalStim**


VitalStim therapy can alleviate swallowing function in post-stroke dysphagia and thereby improve patients’ quality of life. The parameters of VitalStim surface electrical stimulation system (Chattanooga Group, USA) contained two direction square waves, with wave width being 700 μs, frequency 80 Hz, and wave amplitude 0–25 mA. The system has two channels, each being quipped with 2 discharge electrodes (Park et al., 2016). The surface electrodes were placed on the surface of swallowing muscles. Electrode position and treatment mode were selected according to VFSS scores, patient’s tolerance, and conditions of patients. Treatment was administered twice a day, lasting 30 min each time, 5 days a week, for 4 successive weeks. The above-mentioned assessments, conventional swallowing training, and VitalStim therapy were performed by experienced speech therapists blinded to the experimental design (Lin, Hsieh and Wang, 2013).

**3.3.2 Neuromuscular Electrical Stimulation using AMPCARE**

Sproson et al (2017) concluded that the pilot demonstrated successful recruitment, treatment safety and tolerability and clinically meaningful outcome improvements, justifying progression to a fully powered study. It also showed clinically meaningful treatment trends for the Ampcare ESP intervention. stimulation pulses were separated by rest periods of 25 s; producing 60 swallow attempts.

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<table>
<thead>
<tr>
<th>Study</th>
<th>Patients</th>
<th>Intervention</th>
<th>Randomized control trial</th>
<th>Key Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun et all, 2013</td>
<td>Thirty-two patient with moderate to severe dysphagia poststroke (C3 weeks)</td>
<td>Combined NMES, FEES, and traditional swallowing</td>
<td>Combined NMES, FEES, and traditional swallowing function in stroke patients with moderate-to-severe dysphagia</td>
<td>VitalStim therapy can alleviate swallowing function in post-stroke dysphagia and thereby improve patients’ quality of life.</td>
</tr>
<tr>
<td>Wengguang XIA et all, 2011</td>
<td>120 patients with post-stroke dysphagia</td>
<td>VitalStim therapy coupled with conventional swallow</td>
<td>VitalStim therapy coupled with conventional swallow</td>
<td>VitalStim therapy can alleviate swallowing function in post-stroke dysphagia and thereby improve patients’ quality of life.</td>
</tr>
</tbody>
</table>

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per session. In week 2, the periods were reduced to 20 s, producing 72 swallow attempts. In weeks 3 and 4, the rest periods were reduced to 15 s, increasing the swallow attempts to 90. This represents a gradually increasing challenge on the swallowing musculature (Sproson et al., 2017). Ampcare ESP involves NMES delivered via electrode placed under the chin, targeting the suprahypoid muscles. This electrode placement differs from that used in earlier studies and is based on work by Burnett et al (2003) to determine which muscle groups were most closely associated with laryngeal elevation.

3.3.3 Pharyngeal Electrical Stimulation

Electrical pharyngeal stimulation (EPS) has been shown to improve swallowing function and in particular decrease airway aspiration in acute stroke. Stimulation was delivered via the PhagenyxTM cathetersystem and base station (Phagenesis Ltd, UK). The system consists of a nasogastric feeding tube housing a pair of bipolar titanium ring electrodes with a distance of 10 mm in between. The electrodes were positioned in the middle pharynx. Correct positioning of the electrodes was visually confirmed by fiberoptic endoscopic evaluation of swallowing (FEES). The catheter was connected to the base station to deliver stimuli of 0.2 ms pulse duration at frequency of 5 Hz with 280 V, which had previously been found to be the most effective stimulation parameters. The current intensity (mA) was individually adjusted in every session. Therefore prior to the actual intervention the perceptual threshold (PT) and the maximum tolerated threshold (MTT) were determined repeatedly by slowly increasing the current. The average values of three trials were taken into account for the calculation of the optimal stimulation intensity according to the formula PT \( \text{MTT} \cdot 0.75 \) (MTT - PT)(Suntrup and Schro, 2015). Thresholds as well as calculated optimal stimulation intensities were documented at each session. In the treatment condition stimulation was afterwards delivered for a total of 10 min at this intensity, whereas in the sham condition the catheter was left connected to the base station for a further 10 min without current flow between the electrodes. The intervention was repeated daily for three consecutive days. The stimulation catheter remained in place over this period of time and was used as a regular feeding tube between treatment sessions (Umay et al., 2017).

The swallowing function was obviously improved in patients receiving VitalStim effective for post-stroke dysphagia. The possible mechanisms (Foley et al, 2008) are as follows: Repeated rehabilitation training and electrical stimulation help to reconstruct cerebral functions or arouse resting synapse to transmit nerve impulses, (2) elicit muscular contraction and prevent disuse atrophy, (3) accelerate the recovery of swallowing muscle power. Youngsun, Oh and Lee, (2012) reported that neuromuscular electrical stimulation can improve the swallowing function by enhancing swallowing coordination of post-stroke dysphagiapatients. Xia et al., (2011) concluded that surface electrical stimulation can help raise the hyoid bone of patients during swallowing. Park et al (2016) observed that electrical stimulation can increase the range of motion of hyoid bone if swallowing action can be actively cooperated. (Guilién-solà et al., 2016) thought that electrical stimulation yields better therapeutic effects than hot-cold stimulation. Suntrup and Schro.( 2015) reported that electrical stimulation can increase pharyngeal and laryngeal activities by increasing the contraction force of hyoid bone muscle.

EPS, apart from its central effects, also enhances restoration of peripheral sensory feedback finally leading to improved airway protection. Moreover, the treatment should start as soon as possible, to stimulation was shorter in successfully decannulated (Suntrup et al, 2015).

4.1 Limitations

The limitations in this systematic review are (1) Heterogenity of design study. (2) Primary outcomes (swallowing function) was evaluated with different instruments. (3) the sample size is small. (4) Interventions not only single electrical stimulation but also combination with another dysphagia therapy.

5 CONCLUSION

Electrical stimulation both single or combined with another therapy can be used as an alternative choice in the hospital in determining the stroke patient’s management standard with dysphagia. The existence of this Management standard is expected to help the healing process of the patient so that the quality of life of the patient increases and the burden of hospital and family will also be reduced.

4 DISCUSSION

REFERENCE
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