Effect of Vagal Nerve Stimulation on Swallowing in Subjects with Post Stroke Dysphagia

Prabhu R¹, Kumaresan A², Surya Vishnuram³, Prathap Suganthirababu⁴, Vignesh Srinivasan⁵, Priyadharshini Kumar⁶, Dhanusia S⁷

¹Post Graduate, ²,⁴Professor, ⁵Assistant Professor, ³,⁶,⁷Tutor, Saveetha College of Physiotherapy, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, India.

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Abstract

Background: The study was developed to find the effect of auricular transcutaneous vagal nerve stimulation on difficulty in swallowing in post stroke dysphagia.

Purpose: The purpose of this research is to extensively investigate and analyse how VNS impacts swallowing in people with post-stroke dysphagia.

Materials and Methods: A total, 30 individuals have been selected mainly according to the criteria of both the inclusion and exclusion, from the above-mentioned study setting. The study was explained to subjects and written consent was collected from all subjects prior to the initiation of procedure. The subjects included the study was randomly allocated into 2 groups The participants in group A will receive Transcutaneous auricular vagal nerve stimulation, which is given for 20 min with the frequency of about 25 Hz, amplitude: 1 mA, pulse width: 360 µs using clip electrode being placed in Cymba Concha, along with the conventional exercises and Group B will receive Neuromuscular electrical stimulation will be given as Interrupted direct current at 30 Hz for 100ms, and the intensity was increased until perceptible visible contraction.

Results: Auricular transcutaneous vagal nerve stimulation showed a significant effect in improving swallowing functions at 4 weeks, with a p value which is < 0.001.

Conclusion: This study showed that the transcutaneous auricular vagal nerve stimulation showed a positive effect in improving swallowing functions in patients with dysphagia.

Keywords: Dysphagia, swallowing dysfunction, Transcutaneous auricular vagal nerve stimulation, Functional oral intake scale, Dysphagia outcome and severity scale.

Introduction

A stroke is a medical emergency caused by an abrupt disruption of continuous blood flow to the brain. When a blood vessel in the brain becomes blocked or restricted, or when one bursts and flows blood into the brain, a stroke occurs. A stroke, like a heart attack, requires quick medical intervention¹. Stroke is the world’s second leading cause of
Nerve Stimulation affects swallowing physiology in differed. In the beginning, we want to see how Vagal examining its effects. The goals of this study are as a rehabilitative tool for dysphagic patients by utility of this innovative treatment intervention useful insights into the safety, effectiveness, and have post-stroke dysphagia. We require to gain on swallowing function among individuals who the possible impact of Vagal Nerve Stimulation and treatment. The need of this study is to look at require for specialized therapies for their prevention depression are extremely common and mostly fever, discomfort, dysphagia, incontinence, and problems, pneumonias, venous thromboembolism, their final prognosis. Following a stroke, cardiac stroke patients and have a significant impact on their morbidity and mortality, which also had a major effect on quality of life. After a stroke, dysphagia may be caused by a wide range of complications. In a study, 19% patients of dysphagia developed bronchopneumonia which is compared to 8% of population those without the dysphagia; however, this difference which did not have statistical significance. Aspiration of food/saliva may result in an infection of the chest. Dehydration may also be a problem for patients. After a stroke, nutritional status declines, however it is unresolved whether this is related to problems with swallowing. Dysphagia could be an independent indication of a poor prognosis following a stroke. Although dysphagia was not taken into account as an independent variable in the research, it is known that it increases mortality in people with clinically identifiable swallowing problems. Vagal nerve stimulation is a well-known treatment option for a wide range of neurological conditions. Because of the low danger of side effects, it’s also effective in clinical trials for a variety of illnesses. Non-invasive transcutaneous vagal nerve stimulation includes transcutaneous auricular vagal nerve stimulation (taVNS) and cervical transcutaneous vagal nerve stimulation. The vagus nerve transmits afferent and efferent nerve impulses that is associated with swallowing. The locus coeruleus and the nucleus
tractus solitarii are activated when the vagus nerve is stimulated in the cavum concha, according to a systematic study. The Nucleus tractus solitarii, along with its adjacent structure of reticular origin and nucleus suspicion in the medulla oblongata that is present ventrally, is the swallowing reflex’s central pattern generator and is the primary target of VNS.

FOSS is a scale that assesses functional outcomes. The FOIS is a statistically verified food and liquid intake scale for patients with stroke. It is often used to analyse the functional oral intake of post stroke patients with dysphagia. The swallowing results were classified into seven levels (scores 1–7). Tubes are required for levels 1–3. On a scale of 1 to 7, total oral consumption is measured. For the therapist, it is easy, clear, and effective. The Dysphagia Outcome and Severity Scale is a scale with 7 score that was established to rate the functional difficulty of dysphagia depending on objective assessment and give suggestions for independence level, diet level, and nutrition type.

**AIM**

The study is aimed to find the effect of Transcutaneous auricular vagal nerve stimulation on difficulty in swallowing in post stroke dysphagia.

**Materials and Methods**

**Study design:** Experimental study.

**Subjects:** Subjects were selected from Saveetha medical college and hospital.

**Sampling technique:** Concealed envelope method

**Study Duration:** The collection of data began in January 2023, and treatment sessions began in February 2023 for four weeks.

**Sample size:** 30

**Inclusion criteria:**

- Subjects of all age.
- Subjects of both genders.
- Subjects with the history of post-stroke with swallowing difficulty.
- Subjects who score 3 and less than 3 in FOIS scale.
- Subjects who score less than 3 in DOSS scale.

**Exclusion criteria:**

- Subject with swallowing difficulty caused by any other neurological disorders.
- Subjects who are not interested in participating in this study.
- Subjects with psychological disorders.
- Subjects with skin allergies.
- Trauma that occurred recently.
- Unstable vitals.
- Recent surgeries involving the neck and adjacent structures.
- Symptomatic cardiovascular diseases.

**Outcome measure:**

**FOIS:**

The Functional Oral Intake Scale is a statistically verified food and liquid intake scale for patients with stroke. It is often used to measure the oral intake functionally of poststroke patients having dysphagia. The swallowing results were classified into seven levels (scores 1–7). Tubes are required for levels 1–3. On a scale of 1 to 7, total oral consumption is measured. For the therapist, it is easy, clear, and effective.

**DOSS:** The Dysphagia Outcome and Severity Scale is a scale with points of 7 that was established to rate the difficulty in functional component of dysphagia depending on assessment and give suggestions for independence level, diet level, and nutrition type.

**Procedure**

The subjects were divided into 2 groups. Both the groups received the treatment protocol for around 4 weeks. The participants in group A received Transcutaneous auricular vagal nerve stimulation for 20 min in the frequency of 25 Hz, amplitude: 1 mA, pulse width: 360 µs using clip electrode being placed in Cymba Concha, along with the conventional exercises and Group B received NMES which was given as Interrupted direct current at 30 Hz for 100ms, and the intensity was increased until perceptible visible contraction. The patient was in a supine position with a pillow beneath his head. Inactive electrodes were implanted at the nape of the neck, while active pen electrodes were put on either side of the hyoid bone in the pharyngeal muscles along with the conventional exercises.
Data analysis

Statistical analysis was done on an Intention to treat the swallowing difficulty after the stroke. Pre and post-test values for FOIS and DOSS were noted. Wilcoxon signed-rank (non-parametric) test was used for within group analysis and Mann Whitney was used for across group analysis.

Table 1: Pre and Post-test values of Group A obtained using FOIS, indicating the improvement in swallowing functions by transcutaneous vagal nerve stimulation.

<table>
<thead>
<tr>
<th>TEST</th>
<th>MEAN</th>
<th>SD</th>
<th>W value</th>
<th>Z value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE-TEST</td>
<td>3</td>
<td>1</td>
<td>120</td>
<td>3.462</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>POST-TEST</td>
<td>6</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>

Table 2: Pre and Post-test values of Group B obtained using FOIS, indicating the improvement in swallowing functions by transcutaneous vagal nerve stimulation.

<table>
<thead>
<tr>
<th>TEST</th>
<th>MEAN</th>
<th>SD</th>
<th>W value</th>
<th>Z value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE-TEST</td>
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<td>1</td>
<td>120</td>
<td>3.542</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>POST-TEST</td>
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<td>5</td>
<td></td>
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</table>

Table 3: Post-test values of Group A and B obtained using FOIS, indicating the improvement in swallowing functions by transcutaneous vagal nerve stimulation.

<table>
<thead>
<tr>
<th>GROUP</th>
<th>MEAN</th>
<th>SD</th>
<th>T value</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GROUP-A</td>
<td>6</td>
<td>5</td>
<td>294</td>
<td>&lt;0.008</td>
</tr>
<tr>
<td>GROUP-B</td>
<td>5</td>
<td>4</td>
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Table 4: Pre and Post-test values of Group A and B obtained using DOSS, indicating the improvement in swallowing functions by transcutaneous vagal nerve stimulation.

<table>
<thead>
<tr>
<th>TEST</th>
<th>MEAN</th>
<th>SD</th>
<th>W value</th>
<th>Z value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
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<td>1</td>
<td>120</td>
<td>3.460</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>POST-TEST</td>
<td>6</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Results

In this study, we analysed the effect of transcutaneous auricular vagal nerve stimulation on swallowing difficulty in post-stroke dysphagia patients. Transcutaneous auricular vagal nerve stimulation showed a significant effect in improving swallowing functions at 4 weeks, with a p value which is < 0.001. There was an improvement in swallowing functions in both the groups, after receiving the treatment for 4 weeks. The improvement of swallowing functions in Group A (experimental group) and Group B (control group) has been analysed using Wilcoxon signed rank test, both of which showed a significance in improving swallowing functions (TABLE 1 and TABLE 4). Group B (control group), also showed a considerable improvement in improving the swallowing functions in subjects with dysphagia, was analysed using FOIS and DOSS and level of significance were calculated and tabulated (TABLE 2 and 5).

Post-test values of both the group which was obtained using FOIS and DOSS were analysed using Mann Whitney U test and were tabulated, it showed that transcutaneous auricular vagal nerve stimulation was more effective than the conventional therapy in improving the swallowing functions in patients with Dysphagia (TABLE 3 and 6).

Discussion

The goal of the study was to determine the effect of transcutaneous auricular vagal nerve stimulation on
swallowing dysfunction in patients with dysphagia. Dysphagia has a considerable negative impact on QOL in addition to increasing morbidity and mortality following a stroke. Aspiration pneumonia is the second-most feared complication of dysphagia after stroke. The frequency of lung infection increased by 17% when dysphagia was discovered on bedside clinical examination\textsuperscript{11}. Although most patients with post-stroke dysphagia recover on their own, it persists in certain patients, which has an impact on their QOL. Thus, there are certain treatment techniques used to overcome the post stroke dysphagia. Both compensatory and rehabilitative strategies are used in dysphagia treatment. While compensatory measures are adapted to bring down dysphagia symptoms without changing the function, rehabilitative methods are framed to improve the physiology of swallowing, increase swallow risk, and increase tolerance for the less restrictive diet\textsuperscript{12}. 

Subjects with cerebral infarction and swallowing difficulty received NMES treatment, a day for 20 minute with intervals of 3 seconds for the period of 12 days with a intensity of 28 mA and pulse width of 800 ms, with a a two-day break and then other 12-day treatment, according to Yanfang Zenga’s investigation\textsuperscript{13}. F Marrosu in 2007 carried out the investigation with multiple sclerosis patients and found that improvement is believed to be VNS related since the NTS, the primary brainstem, visceral component of the vagus, is involved in modifying CPGs associated to the swallowing and olive complex pathway. The data collected point to another therapeutic use for VNS and could signify a unique approach to treating patients with advanced MS\textsuperscript{14}. 

While there are certain studies suggesting about the adverse effects of the invasive method of vagal nerve stimulation, hoarseness, voice changes, dyspnea, cough, throat discomfort, neck pain and tingling and twitching in the neck muscles, headache, dysphagia and chest pain are common AE along with VNS activation. Most of VNS adverse effects were observed during the stimulations on phase and appear to be dose-dependent, making it possible to lessen them by carefully adjusting the VNS parameters\textsuperscript{15}. Thus, we made a try to overcome all this drawback by choosing a non-invasive method of stimulation of vagus nerve by transcutaneous auricular method with TENS 7000.

In 2018, A. Kumaresan conducted a quasi-experimental study in which A total of 30 post-stroke dysphagic subjects were chosen for a EMG examination of the masseter, submental, and infrahyoid muscles. For four weeks, neuromuscular electrical stimulation was applied to the Pharyngeal muscles. The values were collated and statistically examined at the last day of the fourth week after the test. He concluded that in terms of amplitude, neuromuscular electrical stimulation has a more positive effect on swallowing muscle activation in post-stroke dysphagia\textsuperscript{18}.

**Conclusion**

To conclude, the Vagus nerve plays a significant role in post-stroke patients with Dysphagia by providing a significant improvement on application of transcutaneous auricular vagal nerve stimulation for 4 weeks.

**Ethical clearance:** The ISRB committee of a private hospital and institution in Chennai has provided its clearance for the conduct of human research that complies with all applicable national laws, institutional regulations. (Application Number 01/024/2022/ISRB/PGSR/SCPT).

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**Conflict of interest:** The authors report no conflict of interest.

**References**


