Surface Electromyography (sEMG) Used as a Biofeedback Instrument During Dysphagia Therapy with a Patient Post-Stroke.

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Introduction

Swallowing disorders, also called dysphagia, can occur in patients as a result of many medical or neurological diagnoses, including a stroke. According to ASHA's Scope of Practice, the speech-language pathologist's (SLP) role is to assess and treat swallowing disorders. The SLP uses a clinical evaluation to acquire information about the individual's stages of the swallow: oral preparatory, oral transit, pharyngeal, and esophageal stages. During the swallow assessment, the SLP examines and observes any clinical signs and symptoms of abnormal swallow function that may be indicative of aspiration/penetration (e.g., including cough/throat clear after swallow, change in vocal quality after the swallow, presence of dysarthria/dysphonia, appearance of delayed pharyngeal swallow trigger, and reduced laryngeal elevation (Daniels, McAdam, Brailey, & Foundas, 1997). If the SLP suspects any oral stage deficit and/or clinical signs of

aspiration, an instrumental examination, for example a videofluoroscopic swallow study evaluation will be conducted to further evaluate the four stages of the swallow. A videofluoroscopic swallow study is an examination of the anatomy and physiology of the swallow mechanism conducted by both the speech-language pathologist and radiologist in a radiology suite. In order to view the swallow mechanism, the patient is given barium impregnated foodstuffs to swallow during the examination.

Surface electromyography (sEMG) is a record of muscle activity obtained through electrodes applied to the skin. It is a non-invasive method used during dysphagia therapy sessions to indicate muscle activity during the swallow (O'Kane, Groher, Silva, & Osborn, 2010; Vaimain, 2007). The amount of muscle activity is visually displayed to the patient on a computer screen (Steele, Bennett, Chapman-Jay, Polacco, Molfenter, & Oshalla, 2012). Steele et al. (2012) and Bogaardt et al. (2009) indicate that sEMG is be used in research studies to determine the frequency and duration of therapy sessions provided and the protocol for implementing therapy with the sEMG equipment.

There are different swallowing exercises that are beneficial to patients with swallowing disorders depending on the physiological deficit in the stage of the swallow. The effortful swallow and Mendelsohn maneuver are therapy exercises that are used to address the muscle-function abnormalities seen in patients with dysphagia. The effortful swallow exercise helps increase tongue base retraction during the swallow. Laryngeal

elevation is improved with the use of the Mendelsohn Maneuver. This study investigates if sEMG is a beneficial tool to improve a patient's performance of these two exercises.

Methodology

Participant

One 86-year old male served as a participant in this study, which was approved by the Institutional Review Board at Adelphi University. He was diagnosed with a stroke five months prior to the initiation of this study. The participant was NPO (nil per os, nothing by mouth) and received nutrition and hydration with feedings in a percutaneous endoscopic gastrostomy tube **(**PEG). The participant had previously received dysphagia therapy for 4 months consisting of dysphagia exercises, with no change in functional oral intake status. At the time of the study, the participant was alert, oriented to name, place, and time and comprehended complex questions, 3-step directions, and had good speech intelligibility. The patient wore bilateral hearing aids. The findings by the neurologist revealed that the patient exhibited symptoms of a stroke but nothing was visualized on the Magnetic Resonance Imaging (MRI).

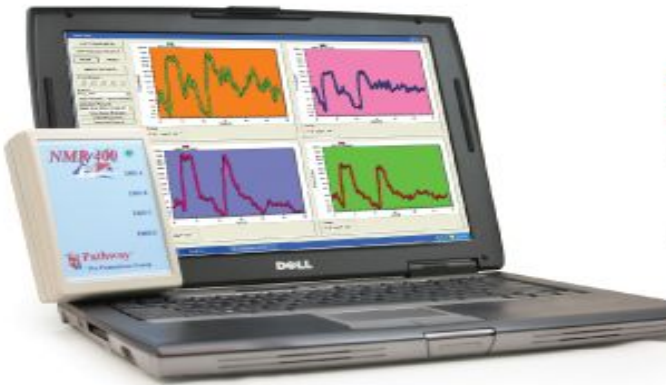
Materials

The participant received a Modified Barium Swallow Study (MBS) (videofluorographic swallow study) before beginning the treatment protocol as well as after the treatment protocol. An MBS is an instrumental evaluation which requires a physician's approval and script. The participant was asked to swallow different food

consistencies impregnated in barium. The participant underwent the following assessments prior to the treatment paradigm: the Mini Mental State Exam (MMSE), the Functional Oral Intake Scale (FOIS), and the Mann Assessment of Swallowing Ability (MASA). The MMSE is a brief screening of cognitive function, and examines the areas of orientation, attention, recall, language, and motor skills. The FOIS is a scale which assesses current functional oral intake, ranging from nothing by mouth (NPO) to an oral diet with no restrictions. The MASA is a formal examination that evaluates an individual's swallowing function. More specifically, it examines the structures and functions necessary for a functional swallow. After these tests were administered, the treatment program was initiated.

Equipment

Surface Electromyography was used in the treatment sessions. During the treatment sessions, electrodes were attached under the participant's chin with the positive and negative electrodes positioned from lateral to midline, anterior to the hyoid bone. A record baseline series of five saliva swallows was recorded by sEMG measurements. The reference range was determined from the baseline task.



This study used the Pathway NMR 400 Quad Channel EMG System (Image 1) and the Pathway MR-20 Dual Channel EMG System with Alpha/Numeric LCD displays (Image 2).

Image 1

Image 2

Procedure

The intervention program required the participant to attend 60-minute sessions once weekly for eight weeks. The participant was seen for a Modified Barium Swallow (MBS) three months prior and at the conclusion of the therapy regimen. The protocol involved a hierarchical progression of tasks from a saliva swallow to effortful saliva swallows and, where indicated, Mendelsohn maneuver saliva swallows. The effortful swallow is designed to increase the posterior motion of the tongue base and anterior motion of the posterior pharyngeal wall, thereby increasing pressure for swallowing while decreasing oral residue. For the effortful swallow, the participant was provided with the verbal instructions: “as you swallow, push your tongue really hard against the roof of your mouth.” The Mendelsohn maneuver is designed to increase the opening of the upper esophageal sphincter muscle by prolonging laryngeal elevation during swallowing. For the Mendelsohn maneuver, the participant was provided with the verbal instructions: “swallow normally and in the middle of your swallow when you feel your Adam’s apple lift, hold it up for two-three seconds with your throat muscles before

finishing the swallow" (Fukuoka et al., 2013). The treatment session included 60 swallows executed in 12 sets of 5 swallows.

Results

The results of the MMSE revealed that the participant had no cognitive impairment, scoring 25/26 points. The participant scored a "1" on the FOIS, which indicated that he was NPO and has no oral intake. Due to the participant having a PEG placement, the MASA could not be scored. Informally, the results revealed that the participant presented with adequate labial and lingual range of motion and strength, a positive gag reflex, and a volitional cough. Laryngeal elevation and excursion was observed as weak. Vocal quality appeared hoarse and was characterized by intermittent wetness. The participant could not control his secretions consistently during the study. He eliminated his oral secretions at times, which resulted in improved vocal quality.

During the eight-week study, and as seen in Tables 1 and 2, there were reports of sporadic increases in muscle activity while performing either the effortful swallow or Mendelsohn maneuver exercises. The participant reported, on multiple occasions, that the biofeedback screen was a distraction to him; he found it easier to swallow on command while not viewing it. During trials 3, 7, and 9, the participant was noted to have increased

oral secretions. During these sessions, swallowing amplitudes were significantly higher and not able to be recorded. Results can be seen below in Tables 1 and 2.

At the conclusion of the study the MBS revealed no changes. According to the study reports, the participant aspirated on all food consistencies and continued to demonstrate reduced laryngeal elevation and poor tongue base retraction.

Table 1: Amplitudes Achieved During Effortful Swallow Maneuver using sEMG

Trial	Amplitude (MicroVolts)
1	58.3
2	67.8
3	-
4	21.3
5	47.5
6	32.2
7	-
8	-

Table 2: Amplitudes, Duration, and Quality Achieved During Mendelsohn Maneuver using sEMG

Trial	Amplitude (MicroVolts)	Duration (Seconds)	Quality*
1	17.6	2.5	~
2	41.3	1	↓
3	-	-	-
4	17.7	.8	↓
5	26	2.8	↓

6	13.9	1.7	↓
7	55.8	1.9	↓
8	-	-	↓
Key = √ for good; ↓ for dropped; ~ for shaky; X for incomplete.			

Discussion and Conclusions

sEMG did not benefit the patient post-stroke in performing the swallowing exercises. The participant inconsistently performed the therapy exercises as evidenced by the differences in amplitude of the muscle activity during the swallow. According to O'Kane (2010), sEMG as a biofeedback tool needs to involve larger sample sizes. Stepp (2012) and Crary (2000) state that current studies do not include consistent specific placement of electrodes, which may ultimately affect the results displayed on the biofeedback screen. Boogardt (2009) also concurs that current studies do not involve specific protocol for conducting the dysphagia exercises. In addition, there is also a lack of specific knowledge regarding the appropriate amount of amplitude necessary for this treatment method (Steele, 2004).

This study showed that sEMG was not as effective for this client as documented in previous studies. Future research should include larger sample sizes while performing a structured dysphagia therapy program.

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