



Effects of tongue pressing effortful swallow in older healthy individuals



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ABSTRACT

Introduction: The risk of swallowing disorders is increased for older individuals due to weak tongue and pharyngeal muscle strength. This study was appraised the value of a preventative approach by developing the tongue pressing effortful swallow (TPES) applied using a home-based and self-administered procedure. The TPES was developed by combining two swallowing exercises: tongue strengthening exercise and the effortful swallow. The purpose of this study was to examine the effects of the TPES on maximum tongue pressure and peak amplitude of submental muscle activity in older individuals.

Material and methods: 27 older individuals (mean 73 years) performed a 4-week TPES. The exercise program was adapted to a home-based and self-administered procedure. The maximum tongue pressure was measured by the Iowa Oral Performance Instrument and peak amplitude of submental muscle activity by surface electromyography (sEMG). Statistical comparisons were made by a matched pairs *t*-test ($p < 0.05$).

Results: The results of this study showed that the TPES had statistically significant and positive effects on increasing maximum tongue pressure, but the peak amplitude of the submental sEMG did not differ between before and after exercises.

Conclusions: The TPES had a positive impact in older individuals. The TPES, a combining exercise, was possible because two exercises had common physiological events. The TPES was a more innovative and efficient approach than the tongue strengthening exercise alone. In addition, older individuals were able to perform the swallowing exercise at home and by themselves with little assistance. Future research needs to refine the TPES and apply it to patients with dysphagia.

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1. Introduction

Swallowing involves complex physiological and neurological processes (Dodds, 1989). Swallowing difficulty can occur because of dysfunctional physiological processes and/or changes in neuro-motor and sensory systems. Dysfunction in any stage of swallowing can result in presbyphagia (changes that are normal during aging) and potentially increase the risk of a swallowing disorder (Doggett, Turkelso, & Coates, 2002; Feinberg, Knebl, Tully, & Segall, 1990). Oropharyngeal structures and muscles corresponding to swallowing in older populations are vulnerable to presbyphagia because of decreased strength, tension, and endurance over time (Crow & Ship, 1996; Nicosia et al., 2000; Price & Darvell, 1981;

Robbins, Levine, Wood, Roecker, & Luschei, 1995; Wohlert, 1996). One of the most noticeable physiological changes in the oral stage is reduced tongue strength (McComas, 1998). Reduced tongue strength causes slower tongue movement and slower transport of the bolus in the oropharyngeal stage of swallowing. In the pharyngeal stage of swallowing, the older population shows slower transition of the bolus than the younger population (Im, Kim, Oommen, Kim, & Ko, 2012). The slower pharyngeal swallow results from reduced pharyngeal constriction and pharyngeal peristaltic motion as well as weakened suprahyoid muscles associated with advancing age and/or disease (Robbins, Hamilton, Lof, & Kempster, 1992; Tracy et al., 1989).

Reduced reserve and flexibility can explain the physiological and functional changes in the older population. The younger population tends to have more muscular reserve to execute the whole process of swallowing in normal circumstances than the older population. This muscular reserve also plays an important

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role in the context of disease and illness (Buchner & Wagner, 1992; Johnson, 1993; Kenney, 1995; Troncale, 1996). With adequate reserve, individuals may be able to swallow safely because of well-reserved muscular strength and flexibility after incidence of disease or accident. Nicosia and colleagues (2000) pointed out that lingual isometric and swallowing pressures were less in older participants than compared to younger participants. This result can explain reduced lingual pressure reserve for swallowing in the older population as compared to the younger population. Although the older population has age-related muscle changes and reduced reserve for swallowing, they can compensate and adjust their swallowing performances in various ways, such as different bolus placement, prolonged laryngeal closure duration, or diet modification (Tracy et al., 1989; Kim & Park, 2007). It is important for clinicians to understand and monitor swallowing performance and functions of swallowing in the older population.

The purpose of behavioral rehabilitation for dysphagia is to restore neuromuscular swallowing efficiency for patients with swallowing difficulties. Among the behavioral rehabilitation strategies, both tongue strengthening exercise and repeated effortful swallows have frequently been used for patients with oropharyngeal swallowing disorders. First, tongue strengthening exercises for patients with tongue weakness are performed by pushing the tongue against the hard palate. The tongue strengthening exercise helps patients who have difficulties transferring the bolus due to tongue weakness. The tongue strengthening exercise has an effect on competent transportation of the entire bolus without oropharyngeal residue, in addition to airway protection (Robbins et al., 2005, 2007). Robbins et al. (2005) conducted tongue strengthening exercise in older participants for 8 weeks. They report that the tongue strengthening exercise had gradually increased maximum tongue pressure every two weeks. These results suggest that tongue strengthening exercise may have a positive influence on swallowing function.

Second, repeated effortful swallows were developed to increase the strength of pharyngeal muscles. Repeated effortful swallows emphasize strong contraction of participants' oral and pharyngeal muscles during the swallow (Hind et al., 2001). In addition, participants were initially encouraged to push their tongues hard against the hard palate and then to swallow hard. Huckabee, Butler, Barclay, and Jit (2005) reported that repeated effortful swallows showed higher levels of sEMG of submental muscles and higher pharyngeal pressure as compared to non-effortful swallows. The increased contraction of the pharynx resulted in increased pharyngeal swallowing pressure which can reduce residue in the oropharynx. Repeated effortful swallows have been applied to facilitate the pharyngeal stage of swallowing and bolus transfer through the pharynx in patients with dysphagia. Bulow et al. (2001) reported changes in the pharyngeal stage of swallowing during effortful swallows in 8 patients with dysphagia. Effortful swallows helped reduce the depth of contrast penetration and aspiration in patients with dysphagia. According to the previous research, both treatment exercises have positive effects on swallowing physiology and function for patients with oropharyngeal residue and reduced laryngeal vestibule closure (Hind, Nicosia, Roecker, Carnes, & Robbins, 2001; Robbins et al., 2007). Clinically, both treatments have been used frequently for patients with dysphagia.

This study examined the effectiveness of a preventative approach by combining two highly used swallowing exercises for the older population: tongue strengthening exercise and effortful swallow. The combined exercise may be referred to as the tongue pressing effortful swallow (TPES). The TPES was developed based on the studies of Bulow et al. (2001) and Yeates, Steele, and Pelletier (2010). According to Bulow et al. (2001), patients with dysphagia performed effortful swallow poorly due

to weak tongue strength. Bulow et al. (2001) suggested, "It probably would be essential to give these patients oral motor exercises (tongue training) in combination with a before starting with effortful swallow (p. 194)." For tongue strengthening exercises, each participant pushes the tongue against the alveolar ridge for 3–5 s. For effortful swallow, each participant pushes the tongue against the alveolar ridge for 1–2 s and then swallows while squeezing hard with the neck muscles. What both the tongue strengthening exercise and the effortful swallow have in common is pushing the tongue against the alveolar ridge for an extended period of time. The investigators have developed the TPES by placing the tongue-to-palate maneuver in deliberate proximity with the effortful swallow. It is our intention to assess whether a combined exercise can help increase muscle reserve and activity for the older population and patients with dysphagia. The TPES was executed in a home-based and self-administered program for the older population. A home-based and self-administered TPES program may provide great promise to make up for an on-site intervention like the widely used traditional intervention in terms of time management, transportation, and cost (Leff et al., 2005; Wulf, Shea, & Lewthwaite, 2010).

2. Materials and methods

2.1. Participants

This study examined the effects of tongue pressing effortful swallow in 27 healthy participants who were at least 56 years old (mean 73 years, range from 58 to 85 years). Participants consisted of 23 females and 4 males. Participants were identified by a brief demographic interview that revealed any history of a neurologic disease or head and neck surgery or injury that might affect swallowing function. An oral motor and cranial nerve examination were performed. Participants met the following inclusionary criteria: a) above 55 years old, b) normal oral structure and function, c) no history of swallowing impairment, d) no history of neurologic or head and neck impairments, and e) nonsmokers or discontinued smoking for at least 5 years.

2.2. Procedures

The study protocol was approved by the institutional review board of the Ohio University. The participants were aware of the purpose of study and written informed consent was obtained for all participants. Participants participated in two on-site sessions and four weeks of home-based and self-administered sessions. The two on-site sessions consisted of orientation with data collection at baseline and data collection after the exercises.

2.2.1. Pre-exercise session

The pre-exercise session for orientation consisted of data collection at baseline, instruction of the TPES program, and setting the schedule for assessment of post exercise. For data collection at baseline, three trials of maximum tongue pressure, three trials in regular swallow, and three trials in effortful swallow of peak amplitude of submental muscle activity were obtained for each participant. To explain the TPES program, the investigator provided written instructions regarding the steps of the exercise and an exercise sheet to record exercise dates as well as demonstrated the TPES to participants. The participants practiced the TPES at least 10 times. The instruction of the exercise was "Put your tongue behind your upper teeth, and feel that ridge there? That is where your tongue normally goes when you take a swallow. The tongue pushes the food or liquid back into your throat. Put your tongue behind your upper teeth or top of

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