

## The Effectiveness of Tongue Palatal Resistance Exercise for Increasing Suprahyoid Muscle Strength in Patients with Oropharyngeal Dysphagia: A Home Exercise Program During the COVID-19 Pandemic

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### ABSTRACT

**Objectives:** This study aimed to assess the effectiveness of a tongue palatal resistance exercise (TPRE) home exercise program for patients with oropharyngeal dysphagia.

**Study design:** One-group pre- and post-test.

**Setting:** Cipto Mangunkusumo Hospital, Jakarta, Indonesia.

**Subjects:** Five patients with the following inclusion criteria: (i) oropharyngeal dysphagia, (ii) able to follow instructions, (iii) blood pressure < 160/110 mmHg, and (iv) never participated in a home oromotor exercise program.

**Methods:** The patients were trained to perform TPRE and were instructed to do 30 repetitions of the exercise per session, 3 to 5 sessions a week, for 2 weeks. Suprahyoid muscle strength was assessed using a surface electromyographic (EMG) biofeedback instrument before and then weekly after starting the home exercise program.

**Results:** The EMG activity of the suprahyoid muscle increased in all patients with a mean of 8.56 (SD 3.456)  $\mu$ V at baseline, 15.26 (SD 3.19)  $\mu$ V after the 1<sup>st</sup> week, and 17.44 (SD 3.922)  $\mu$ V after the 2<sup>nd</sup> week of TPRE.

**Conclusions:** A 2-week home program of tongue palatal resistance exercise can increase EMG activity, an indirect indication of increased suprahyoid muscle strength in individuals with oropharyngeal dysphagia. This home exercise program seems particularly appropriate during the current COVID-19 pandemic while hospital-based dysphagia rehabilitation services are limited.

**Keywords:** oropharyngeal dysphagia, tongue, resistance exercise, COVID-19 pandemic, rehabilitation

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### Introduction

Swallowing is an essential process for survival as a source of nutrition, hydration, and alimentation and which provides other contributions to the quality of life.<sup>1,2</sup> The tongue is a structure that works in mastication and is important in the

formation, manipulation, and propulsion of boluses to the pharynx. It also helps in respiration and speech. Neurogenic disorders such as strokes can weaken the tongue muscles, thereby reducing mastication and reducing the ability to form boluses and divert them to the pharynx, increasing the accumulation of food residues in the oral cavity, and resulting in fluid leaks from the lips during aspiration, changes that are very significantly associated with morbidity and mortality.<sup>3,4</sup> Oropharyngeal dysphagia, the penetration of food, drink, or saliva into the larynx, their aspiration into the trachea and the accumulation of oropharyngeal residue,<sup>5</sup> affects 30% of patients with a cerebrovascular injury, 52-82% of patients with a neurodegenerative disease, and more than 60% of geriatric patients.<sup>5</sup>

Since 2020 the world has faced a COVID-19 pandemic which has changed how patients with dysphagia are treated. Rehabilitation procedures recommended by the Dysphagia Research Society require special precautions because of aerosol production while conducting clinical evaluations of swallowing and during dysphagia management, including oromotor or cranial nerve examination, cough reflex examination, and suctioning procedures as well as swallowing exercises,<sup>6</sup> but it has become difficult for health care facilities to provide those services due to the pandemic.

Swallowing exercises have been demonstrated to improve swallowing and breathing functions.<sup>1,7</sup> One recently developed training approach for individuals experiencing swallowing disorders involving tongue weakness is tongue palatal resistance exercise (TPRE).<sup>8</sup> Previous studies have reported on the implementation of TPRE in a hospital setting.<sup>3,8,9</sup> However, during the COVID-19 pandemic, hospital services, including dysphagia rehabilitation at our hospital, have been limited, with only emergency or urgent visitations allowed. In response, we decided to modify our TPRE practice from hospital-based to home-based, and to use an electromyographic (EMG) biofeedback device only for training

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patients on how to perform the exercises correctly. At home, the patients performed the exercises by themselves, without EMG biofeedback. This study was carried out to evaluate the effectiveness of a two-week home-based TPRE program in increasing suprahyoid muscle strength in patients with swallowing problems.

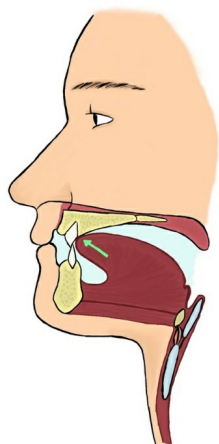
## Methods

This one-group pre-test and post-test design study was approved by the Research Ethics Committee, Faculty of Medicine, University of Indonesia (20-07-0841).

After receiving informed consent, patients with oropharyngeal dysphagia which had been confirmed by a fiberoptic endoscopic evaluation of swallowing (FEES) test, were able to follow the exercise program instructions, had blood pressure controlled below 160/110 mmHg, and had never participated in a home program of oromotor exercise were recruited into the study. Exclusion criteria were uncontrolled hypertension, inability to conduct suprahyoid muscle strength measurements, and inability of the patient to carry out the exercises. The dropout criterion was not doing the exercises for more than 2 consecutive days.

TPRE is designed to produce tongue pressure by lifting the tongue against the palate near the alveolar ridge and elevating the floor of the mouth (Figure 1).<sup>9,10</sup> All participants were trained to perform the exercise using surface EMG biofeedback. They were then instructed to do 30 repetitions of the exercise holding each muscle contraction for 10 seconds, repeating the exercise 3 to 5 times a week for two weeks without EMG biofeedback.

EMG biofeedback measurement of tongue pressure, a representation of suprahyoid muscles strength, was done using a surface EMG biofeedback device (Chattanooga VitalStim® Plus Four Channel Electrotherapy System (Chattanooga Group, Inc., Austin, TX, USA). Surface electrodes with a diameter of 2 cm were placed over the suprahyoid area (Figure 2). During the 10 seconds of sustained contraction of TPRE, EMG activity was monitored and measured in



**Figure 1.** Tongue palate resistance exercise (TPRE) (modified from Bae Y, 2013)<sup>13</sup>

$\mu\text{V}$ ,<sup>11</sup> representing the suprahyoid muscles strength. Baseline data was recorded during the TPRE training. A follow-up assessment was conducted at the clinic twice: after the first and second weeks of practicing the home exercise program.

The patients' demographics, clinical data including the Dysphagia Severity Scale based on FEES (1, saliva aspiration; 2, food aspiration; 3, water aspiration; 4, occasional aspiration; 5, oral problems; 6, minimum problems; and 7, within normal limits),<sup>12</sup> and the EMG activity measured at baseline and follow-up were recorded.

## Results

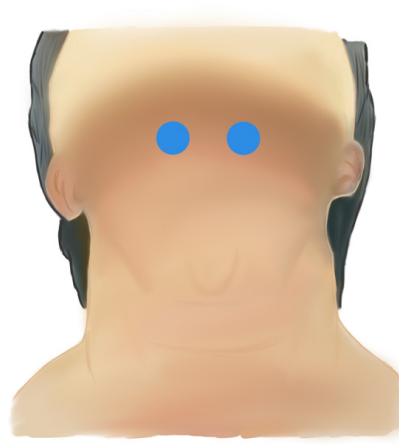
A total of 5 participants (Table 1) were followed weekly for two weeks after TPRE; there were no dropouts during the study. The majority were male (60%), with a mean age of 60.4 years (SD 6.69). All participants demonstrated increased EMG activity after the first and second weeks of TPRE (Table 2). The mean suprahyoid muscle strength was 8.56 (SD 3.456)  $\mu\text{V}$  at baseline, 15.26 (SD 3.19)  $\mu\text{V}$  after the first week, and 17.44 (SD 3.922)  $\mu\text{V}$  after the second week.

## Discussion

This was the first study of a 2-week home TPRE program for dysphagia patients during the COVID-19 pandemic in Indonesia. Each of the 5 patients had a different level of severity, duration, and cause of dysphagia. Increased EMG activity of the suprahyoid muscle was seen at the end of the first week, increasing further by the end of the second week of TPRE in all patients. The amount of the increase varied, but was greater in the patients with more severe dysphagia at baseline, including those with chronic dysphagia, than those with a less severe condition.

These results suggest that, even without EMG biofeedback, the home exercise TPRE program produces positive effects. Those effects might potentially be increased still further with proper TPRE training using an EMG biofeedback device.

Tongue movement against resistance while performing



**Figure 2.** Surface electrode placement over the suprahyoid area for recording electromyographic (EMG) activity of suprahyoid muscles

**Table 1.** Baseline characteristics of participants

Subject	Gender	Age	Underlying Disease	Tracheostomy	Dysphagia Severity Scale	Onset of dysphagia
I	Female	57	Presbyphagia	No	2	< 6 months
II	Female	52	Nasopharyngeal carcinoma	No	2	< 6 months
III	Male	65	Ischemic stroke	No	5	< 6 months
IV	Male	69	Ischemic stroke	Yes	4	6 - 12 months
V	Male	59	Nasopharyngeal carcinoma	Yes	1	> 12 months

**Table 2.** Change in electromyographic (EMG) activity over the suprahyoid area while performing tongue palate resistance exercise

Subject	Baseline DSS	EMG activity ( $\mu$ V)		
		T0	T1	T2
I	2	5.0	18.00	22.80
II	2	8.3	11.80	12.00
III	5	13.0	18.60	18.90
IV	4	11.0	12.10	16.50
V	1	5.5	15.80	17.00

DSS, Dysphagia Severity Scale

T0, pre-exercise; T1, at the end of 1<sup>st</sup> week; T2, at the end of 2<sup>nd</sup> week

TPRE increases suprahyoid muscle function, thereby increasing the elevation of the hyoid both anteriorly and superiorly during swallowing, thus indirectly improving the pharyngeal phase.<sup>3,9</sup> In addition, a stronger tongue push against the palate results in moving the boluses in the oral cavity more quickly and safely toward the pharynx, and reducing pharyngeal residues and aspiration of boluses during the pharyngeal phase of swallowing.<sup>3,9</sup>

Because this study was conducted during the COVID-19 pandemic, there were some limitations: (1) there was only one small group with diverse causes of dysphagia and no control group, (2) the period of study was short and there was no long-term follow-up, (3) a proper device for assessing tongue muscle strength was not available in Indonesia, and (4) there was no re-assessment of dysphagia severity after completing the program. Based on the results of this study, a randomized controlled trial using appropriate outcome measurements including the comparison between exercise and non-exercise, hospital- and home-based exercise programs, as well as short and long duration exercise programs and including both subacute and chronic cases should be conducted before further clinical implementation.

## Conclusions

A 2-week home program of tongue palate resistance exercises demonstrated improvement in suprahyoid muscle strength. Further studies are needed to confirm the effectiveness of those exercises in improving swallowing function.

## Disclosure

The authors declare no conflicts of interest.

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