



Original Article

Differences in maximal strength and endurance of the tongue according to region in healthy adults

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Abstract. [Purpose] The purpose of this study was to identify differences in maximal strength and endurance of the tongue among healthy adults. [Subjects and Methods] A total of 60 healthy volunteers (30 men; 30 women; age range, 20–26 years) were recruited and evaluated for maximal strength and endurance of the anterior and posterior regions of the tongue using the Iowa Oral Performance Instrument. [Results] Tongue strength in the anterior region was greater than that in the posterior region. In contrast, tongue endurance in the posterior region was greater than that in the anterior region. [Conclusion] In conclusion, these results confirm that the anterior region of the tongue exhibits greater strength, whereas the posterior region exhibits greater endurance.

Key words: Tongue, Strength, Endurance

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INTRODUCTION

The tongue plays an important role in swallowing and is essential for normal swallowing functions such as mastication and bolus formation and manipulation¹⁾. During the swallowing process, the tongue pushes against the hard palate to transport food to the tongue base. Therefore, maintaining proper tongue strength and endurance is important for normal swallowing. The tongue is a skeletal muscle characterized by a mixture of type 1 and 2 fibers²⁾. Several studies have measured the strength and endurance of the anterior and posterior regions of the tongue^{3, 4)}. These data can be used as the basis for treatment of dysphagia. However, since most of these data have been acquired in the United States or European countries, there is a lack of data derived from different countries or ethnic groups. Therefore, this study was designed to measure the tongue strength and endurance at different regions of the tongue in young Korean adults.

SUBJECTS AND METHODS

This study conducted between February and June 2016, included 60 participants (30 men; 30 women; age range, 20–26 years) recruited from universities. The subjects were all healthy volunteers with no reported neurologic or structural damage affecting speech or swallowing function. Ethical approval was obtained from the Inje University Institutional Review Board before conducting the experiment (2-1041024-AB-N-01-20141209-HR-125). Tongue strength and endurance were assessed using the Iowa Oral Performance Instrument (IOPI; IOPI Medical LLC, Carnation, WA, USA). Tongue strength was determined by measuring maximal isometric tongue elevation pressure. For measurement of anterior tongue pressure (ATP), the bulb was positioned on the hard palate immediately behind the upper gums, touching the front 10 mm of the tongue

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dorsum. Participants were instructed to press the bulb toward the hard palate with the tongue, as hard as possible, for 2 to 3 s. For measurement of posterior tongue pressure (PTP), the bulb was placed anteriorly, on the posterior border of the hard palate⁴, and the subjects were instructed to press the bulb in the same manner as described above.

Tongue endurance measurements were gathered after a 5-min rest following strength assessment. For measurement of anterior/posterior tongue endurance (ATE/PTE), the IOPI was set to 50% of the ATP of each participant. Participants were required to press the bulb against the hard palate with the tongue as hard as necessary to sustain the target force for as long as possible. Measurement was started when the pressure reached or exceeded the target force and stopped when the pressure dropped steeply to remain either between 40% and 50% of the ATP or PTP for ≥ 2 s or below 40% of the ATP or PTP for at least 0.5 s⁴).

Descriptive statistics are presented as mean values \pm standard deviation. Tongue strength and endurance according to region were assessed by the independent samples t-test. Participant characteristics were analyzed using SPSS version 20 (SPSS Inc., Chicago, IL, USA), with the level of significance set at $p < 0.05$.

RESULTS

The results of comparison of tongue strength revealed a significant difference between ATP and PTP (57.6 ± 16.3 vs. 46.5 ± 10.3 ; $p < 0.05$). Upon comparison of tongue endurance, a significant difference was also observed between ATE and PTE (25.3 ± 10.8 vs. 34.7 ± 9.2 ; $p < 0.05$).

DISCUSSION

Tongue strength in the anterior region was greater than that in the posterior region. In contrast, tongue endurance was greater in the posterior region than in the anterior region. In many previous studies, tongue strength was reported to be higher in the anterior region than in the posterior region^{4, 5}). All areas of the tongue contain muscle fiber types 1 and 2, of which type 2A is predominant³). However, with regard to intra- and inter muscular differences in the tongue, the anterior and middle regions predominantly contain type 2 muscle fibers³). Type 2 muscle fibers also called white muscle fibers—favor rapid contraction and generation of a large force. However, in a study by Todd et al.⁶), PTP was higher than the ATP, which was explained by the larger volume of tissue present at the posterior of the tongue than at the anterior. These findings differ from the present results. In the present study, tongue endurance in the posterior region was longer than that in the anterior region. While the anterior region contains mainly type 2 muscle fibers, type 1 muscle fibers are relatively predominant in the posterior region²). Type 1 muscle fibers do not favor rapid contraction or instant generation of a large force; they are, however, resistant to fatigue and, thereby, better suited than type 2 fibers for maintaining pressure for longer durations. Therefore, type 1 muscle fibers are considered to confer longer endurance to the posterior tongue region. The present findings confirmed that, in young adults, ATP is higher than PTP, while PTE is longer than ATE.

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