Differences in maximal isometric tongue strength and endurance of healthy young vs. older adults

Dong-Hwan Oh1), Jī-Su Park2), Young-Moon Jo3), Moonyoung Chang4)*

1) Department of Occupational Therapy, Kyung-dong University, Republic of Korea
2) Department of Rehabilitation Science, Graduate School of Inje University, Republic of Korea
3) Department of Occupational Therapy, Asan Medical Center, Republic of Korea
4) Department of Occupational Therapy, College of Biomedical Science and Engineering, Inje University: 197 Inje-ro, Gimhae, Gyeongsangnam-do 621-749, Republic of Korea

Abstract. [Purpose] The aim of this study was to measure and compare the maximal tongue strength and endurance of young and older adults. [Subjects and Methods] This study recruited 60 healthy young (aged 20 to 39 years) and older adults (aged 67 to 75 years) at a university and in public places. The Iowa Oral Performance Instrument was used to measure maximal tongue strength and endurance. [Results] Maximal tongue strength was significantly higher in the young adult group than the older adult group. Maximal tongue endurance was longer in the young adult group than in the older adult group, but the difference between the groups was not significant. [Conclusion] This study confirmed that older adults have a lower maximal tongue strength and endurance than young adults. Key words: Endurance, Strength, Tongue

INTRODUCTION

The role of the tongue in oropharyngeal swallowing is extensive, and is essential for a normal swallowing function1). The tongue is a structure in the stomatognathic system, and serves in primary functions such as mastication, formation, manipulation, and transport of food into the pharynx2). During the swallowing process, at the oral stage, the front of the tongue squeezes food against the hard palate to transport it to the base of the tongue3). However, aging may decrease the strength and endurance of the tongue, resulting in reduced mastication, poor bolus formation, disturbed food transport into the pharynx, leaving residue in the oral cavity, leakage from the lips, and aspiration. Declines in tongue strength are related to aging, and are known to be related to sarcopenia, and older adults are vulnerable to sarcopenia4). Therefore, maintaining the tongue strength and endurance of older adults are vital for safe swallowing.

Several studies have reported tongue strength values according to age with respect to race or a population of a specific country5, 6). However, most previous studies were conducted using an American or European population; research involving Asian populations, such as Korean, is rare. In addition, studies of tongue endurance are relatively lacking compared to those of tongue strength. The present study aimed to compare the maximal tongue strength and endurance of young adults and older adults.

SUBJECTS AND METHODS

This study enrolled 60 participants. They were divided based on age into the young adult group (male, n = 15; female,
The tongue strength and endurance assessed in this study were measured using an IOPI (IOPI Medical LLC, Carnation, WA, USA). Maximal tongue strength and endurance were measured with reference to a previous study\(^5\). When measuring tongue strength, the bulb was positioned on the hard palate immediately behind the upper gums, touching the front 10 mm of the tongue dorsum. Participants were instructed to press the bulb toward the hard palate with the tongue as hard as possible for 2 to 3 s. Maximal tongue strength was measured three consecutive times, and the peak value was recorded. For the endurance assessment, the IOPI was set to 50% of the participant’s maximal tongue strength. Participants were required to press the bulb against the hard palate with the tongue as hard as required to sustain the target force for as long as possible. Endurance was measured in the same posture as the strength assessment, and was measured only once. Timing was started when the pressure reached or exceeded the target force and stopped when the pressure dropped steeply, or was maintained between 40% and 50% of maximal tongue elevation pressure for 2 s or more. The timing was recorded using a stopwatch.

The outcomes were analyzed using a statistical software program (SPSS Statistics 20). Descriptive statistics are presented as the mean ± standard deviation. The independent t-test was used to compare the differences in outcome measures of the two groups. Significance was accepted for values of p< 0.05.

**RESULTS**

All subject demographics are summarized in Table 1. The young adult group had significantly higher maximal tongue strength than the older adult group (55.46±5.0 kPa vs. 35.93±6.32 kPa, p < 0.05). Maximal tongue endurance was longer in the young adult group than in the older adult group, but there was no statistically significant difference between the two groups (27.40 ± 5.86 s vs. 24.43 ± 6.23 s, p > 0.05) (Table 2).

**DISCUSSION**

This study aimed to compare the tongue strength and endurance of young and older adults. In this study, we found that maximal tongue strength was significantly higher in young adults than in older adults. It is known that with aging, the muscles related to swallowing become weak, as muscle strength declines rapidly, particularly after 60 years of age\(^7\). This is because of a reduction in muscle size and motor units due to aging, which may have direct effects on muscle weakness\(^8\). A previous study of Belgian adults reported that tongue strength and endurance decreased with age\(^5\), which is consistent with the results of this study. However, interestingly, the present study revealed that the difference in tongue endurance was relatively small compared with the difference in maximal tongue strength. Although the exact reason for this is unknown, it is our hypothesis that it is associated with fiber type transformation due to aging. The tongue contains muscle fiber types 1, 2A, 1M, and 2 M in all areas, of which type 2A is dominant. However, with regard to tongue intra- and intermuscular differences, the anterior regions contain predominantly type 2 muscle fibers\(^9\). As aging progresses, skeletal muscle fibers may be subject

### Table 1. Characteristics of the participants

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Young adults (n=30)</th>
<th>Older adults (n=30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>26.2±3.5</td>
<td>63.1±5.6</td>
</tr>
<tr>
<td>Gender, male/female</td>
<td>15/15</td>
<td>15/15</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>163.1±10.2</td>
<td>159.2±7.4</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>62.5±9.3</td>
<td>64.4±10.3</td>
</tr>
<tr>
<td>BMI (kg/m(^2))</td>
<td>23.3±3.5</td>
<td>25.3±4.3</td>
</tr>
</tbody>
</table>

The values are mean ± SD

### Table 2. Comparison of the two groups

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Young adults</th>
<th>Older adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTS (kPa)</td>
<td>55.46 ± 5.10</td>
<td>35.93 ± 6.32*</td>
</tr>
<tr>
<td>MTE (second)</td>
<td>27.40 ± 5.86</td>
<td>24.43 ± 6.23</td>
</tr>
</tbody>
</table>

The values are mean ± SD.

MTS: maximal tongue strength, MTE: maximal tongue endurance

* p < 0.05

n = 15; age range, 20 to 39 years) and the older adult group (male, n = 15; female, n = 15; age range, 67 to 75 years). All subjects were healthy volunteers with no reported neurologic or structural damage affecting their speech or swallowing function. Before the start of the study, the participants were given detailed information about the study and consented to active participation.
to a transformation, involving type 2 fibers shifting to type 1 fibers\(^\text{10}\). Hence, skeletal muscles, including the tongue, may contain an increasing proportion of type 1 fibers. Type 1 fibers (slow twitch fibers) are also known as red muscle fibers, and they are more suitable than type 2 fibers for maintaining contraction for a longer duration with relatively less force\(^2\). The results of this study would be explained by such changes in muscle physiology.

This study had several limitations. First, the sample size was small. Second, because the subjects’ ages were not divided into 10 year intervals, a close analysis based on age was not possible. Finally, the measurements of muscle strength and endurance may have had errors because of unskilled operation of the instruments.

REFERENCES

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