Morphology of the pharynx in the elderly

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In order to collect morphological data on the mesopharynx, we measured the distances between the skull and epiglottic vallecula and between the external naris and epiglottic vallecula, and investigated the influences of gender and age on the major axis of the mesopharynx. The subjects were 186 patients (100 males and 86 females) who underwent computed tomography (CT) to diagnose suspected head and neck cancers or to evaluate the patient for third molar extraction, at the Department of Dental Radiology, Osaka Dental University Hospital, between January 2011 and April 2014. We used a multi-detector/multi-slice-type CT scanner.

The reference point of the skull was set to the lowest point of the inner contour of the sella turcica (Si), and the facial measurement point was set to the opening of the external naris (En). Reference points were also set to the lowest point of the palatine uvula (Pu) and the deepest point of the epiglottis (Ev), and the region between these was defined as the mesopharynx.¹ The Si-Pu, Si-Ev, Pu-Ev, and En-Ev distances (4 regions) were measured and analyzed. We found that all distances were significantly greater in males than females. On analysis of the relationships between age and distances, we found correlations among Si-Ev, Pu-Ev and En-Ev in males. The results of this experiment showed that gender differences in the mesopharynx should be taken into consideration when positioning the head for swallowing pressure measurements. (J Osaka Dent Univ 2015; 49: 219–223)

Key words: Morphology; pharynx; elderly

INTRODUCTION

The mesopharynx plays an important role in the swallowing processes, such as accumulation of the food bolus, generation of swallowing pressure, and transportation of food to the esophagus.¹ It also has diverse functions, such as changing the duration of accumulation depending on the properties and amount of food, and epiglottic inversion to prevent aspiration.²-⁴ Swallowing pressure measurements are used to evaluate mesophageal function.⁵-⁹ It is a safe test method that involves inserting a sensor into the pharynx and is capable of quantitatively and objectively evaluating the impaired region and mode of transmission of swallowing pressure.⁷ Attention should be paid to positioning the sensor for measurement because there are gender and age—related differences in the pharyngeal morphology. However, only a few studies have closely investigated the pharyngeal morphology.

Therefore, investigation of the morphological characteristics of the mesopharynx is essential for adequately measuring swallowing pressure, and may be useful in diagnosing and evaluating dysphagia.⁸,¹⁰ In order to collect morphological data on the mesopharynx, we measured the distances between the skull and epiglottic vallecula, and between the external naris and epiglottic vallecular, and investigated the influence of gender and age on the major axis of the mesopharynx.
MATERIALS AND METHODS

Subjects
The subjects were 186 patients (100 males and 86 females) who underwent CT to diagnose suspected head and neck cancers or evaluate their condition for third molar extraction at the Department of Dental Radiology, Osaka Dental University Hospital, between January 2011 and April 2014. The mean age was 64 ± 12 years in the males and 64 ± 14 years in the females. This study was performed after approval by the Ethics Committee of Osaka Dental University (Approval no.110771)

Measurement method
Measurement device and conditions
We used a multi-detector/multi-slice-type CT scanner (BrightSpeed Elite, GE Healthcare Japan, Tokyo, Japan). The acquisition conditions were: tube voltage, 120 kV; tube current, adjustable to the object thickness up to a maximum of 220 mA; slice thickness, 2.5 mm; table speed, 12.5 mm/sec; and pitch, 0.625:1. The inferior border of the mandible was positioned parallel to the axial section, and the patient was placed in a horizontal position. Measurements were done on a three-dimensional image constructed from the collected data (Fig. 1). Dentures were removed during acquisition.

Reference points and measurement sites
The reference point of the skull was set at the lowest point on the inner contour of the sella turcica (Si), and the facial measurement point was set at the opening of the external naris (En). Reference points were also set at the lowest point of the palatine uvula (Pu) and the deepest point of the epiglottis (Ev), and the region between these was defined as the mesopharynx (Fig. 2). Distances were measured in four regions, Si-Pu, Si-Ev, Pu-Ev and En-Ev.

Analytical method
The Mann-Whitney U test was used to compare distances between genders. Correlations between the age and distances were analyzed in each gender using Spearman rank correlation.

RESULTS
Gender differences in the measured distances
Si-Pu was 69.8 (65.6–74.4) mm in males and 61.0 (57.0–64.1) mm in females, Si-Ev was 107.1 (99.9–110.8) mm and 89.0 (84.1–93.8) mm, respectively, Pu-Ev was 37.3 (33.1–41.3) mm and 28.5 (24.3–32.4) mm, respectively, and En-Ev was 155.4 (149.5–161.2) mm and 137.6 (127.9–144.6) mm, respectively (Table 1), showing that all distances were significantly greater in males.
Table 1  Gender differences in the measured distances

<table>
<thead>
<tr>
<th>Gender</th>
<th>Si-Pu</th>
<th>Si-Ev</th>
<th>Pu-Ev</th>
<th>En-Ev</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>69.8 (65.6–74.4)</td>
<td>107.1 (99.9–110.8)</td>
<td>37.3 (33.1–41.3)</td>
<td>155.4 (149.5–161.2)</td>
</tr>
<tr>
<td>F</td>
<td>61.0 (57.0–64.1)</td>
<td>89.0 (84.1–93.8)</td>
<td>28.5 (24.3–32.4)</td>
<td>137.6 (127.9–144.6)</td>
</tr>
</tbody>
</table>

Median (25–75 percentile), **p<0.01 (mm).

**Fig. 3** Relationship between age and distances in males.

**Relationships between the age and distances in each sex**

The relationships between the age and distances are presented as scatter plots. Analysis using Spearman’s correlation showed that correlations for Si-Ev, Pu-Ev and En-Ev were noted in males, with r=0.23 (p<0.05), r=0.33 (p<0.01), and in females with r=0.38 (p<0.01) (Figs. 3 and 4).

**DISCUSSION**

The swallowing pressure test quantitatively and objectively evaluates swallowing dynamics based on the pressure value and time, allowing the examiner to determine the region where the swallowing disorder arises, and to investigate severity. However, there is not widespread clinical use of this test method. To collect basic data in order to accurately evaluate swallowing function using swallowing pressure measurement, we measured the distances between the four measurement points set between the skull and epiglottic vallecula, and between the external naris and epiglottic vallecula. This information was used to investigate the morphological characteristics of the mesopharynx. Investigations have been done on setting the measurement points at various locations, such as referencing to the palatine bone and oropha-
rygental isthmus.\textsuperscript{13-16}

We selected four measurement points, Si, Pu, Ev and En, because it is necessary to identify and compare the positional relationships between the head and epiglottic vallecula and between the external naris and epiglottic vallecula. In this way changes in the mesopharyngeal morphology can be used to investigate the appropriate positioning of the pharyngeal pressure measurement sensor. On comparing the sexes, we found all distances were significantly greater in males. This may have been due to gender differences in physique, indicating that such differences should be considered when positioning the sensor.

When the correlations between the age and distances were analyzed in each sex, no correlation was found with the Si-Pu (lowest point of the palatine uvula) distance. This suggests that the location of the uvula muscle, including the palatine uvula, which determines the position of Pu, is unlikely to be influenced by aging. However, three distances associated with Ev, Si-Ev, Pu-Ev and En-Ev, correlated with age in the male subjects, suggesting that Ev is influenced by aging. The position of the deepest point of the epiglottis, Ev, varies depending on the laryngeal position. Concerning the larynx, laryngoptosis, morphological changes in the mesopharyngeal space and significant extension of the distance have been reported.\textsuperscript{17}

This may happen because, the rate of decrease in skeletal muscle with aging is greater in males. Testosterone, which has an anabolic action and promotes muscle growth, readily decreases with age in males.\textsuperscript{21,22} In addition, laryngeal volume and weight are greater in males,\textsuperscript{16,18} and elevation of the larynx by the geniohyoid muscle, one of the main suprathyroid muscles elevating the larynx, decreases with age.\textsuperscript{20} Furthermore, the rate of visceral fat-type obesity increases more in males after 70 years of age. Adipocytokines and inflammatory cytokines produced by visceral fat and hyperinsulinemia decrease testosterone production.\textsuperscript{23} This may subsequently promote age-related changes in the body composition of males.

**Fig. 4** Relationship between age and distances in females.
When the Pu-Ev region is regarded as the mesopharynx, there is a gender difference of about 8 mm. The extension of the major axis of the mesopharynx results in an increase in the amount of laryngeal elevation necessary to swallow, which might induce aspiration. Our findings suggest that gender differences in the mesopharynx should be taken into consideration in positioning the test apparatus during swallowing pressure measurements.

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