Diverse Morphologies of Soft Palate in Normal Individuals: A Cephalometric Perspective

Kruthika S Guttal, Rohit Breh, Ramaprakasha Bhat, Krishna N Burde, Venkatesh G Naikmasur

ABSTRACT

Purpose: Soft palate plays a significant role in various important functions in the head and neck region. Its varied morphology is implicated in variety of diseases. Therefore, it is essential to establish the morphology of soft palate in normal patients to establish the variations in its morphology in various diseases. The present study aims to investigate the variation of the soft palate morphology in Indian subpopulation and possibly classify types of soft palate, to evaluate the dimensional differences of the soft palate between each types and to investigate the proportional differences in different age and gender groups.

Materials and methods: Two hundred digital lateral cephalograms were analyzed for the velar morphology and categorized into different types. In addition length and thickness of the soft palate was also measured.

Results: In addition to original seven types of soft palate two more morphological variants of soft palate were observed. The velar length was significantly higher in males and the velar width was significantly less in females. Also a significant increase in velar length was observed with increase in age.

Conclusion: Type 1 was the most common of all the variants. Moreover, additional morphological variants which did not fit into the classical categories were also observed. There was no significant correlation between the different age groups and the types of soft palate. The velar length and width was significantly greater in males than in females. A significant increase in velar length was noted with increase in age.

Keywords: Velar morphology, Length of soft palate, Types of soft palate, Velopharyngeal competence.

INTRODUCTION

Soft palate as part of nasopharyngeal and oropharyngeal apparatus has an important role in phonation, deglutition and respiration. More so soft palate being a part of velopharyngeal apparatus has a major role in maintaining velopharyngeal competence.1

Literature review reveals that little attention has been paid to the variety of soft palate morphology and configuration.

You M et al2 in their study on morphological types of soft palate observed that the configuration of the soft palate presented variously in normal individuals and they put forward that it is irrational to describe the morphology of the soft palate as only one kind as believed previously. They also have noted that types observed in their study were not described by other investigators.

Various authors have studied the dimensional changes of soft palate with increasing age, changes in cleft lip and palate and in patients with sleep apnea.3-7 These continued efforts toward the dimensional analysis of the soft palate and its surrounding structures have emphasized the importance of soft palate in various functions.

The present study aims to investigate the variation of soft palate morphology as described by You M et al2 and to find any additional variants existing in our population, the dimensional differences of the soft palate between each type and the proportional differences in different age and gender groups were studied as well.

MATERIALS AND METHODS

Two hundred digital lateral cephalograms of normal subjects were derived from the department of oral radiology. All subjects had normal speech function.

Exclusion criteria: Radiographs of patients with any history of cleft palate or systemic diseases, or any diseases or fracture of the head and neck were excluded from the study.

All lateral cephalograms were taken using Kodak 9000C (Carestream Health Inc, Rochester, NY). The tube potential was adjusted to optimize the contrast of both hard and soft tissues (80 kV). Digital radiographs were processed by Kodak software 6.1.2.0.

The sample involved digital cephalograms of 79 males and 121 females, with age ranging from 15 to 30 years (mean age of 19.37 years).

All of the radiographs were observed and categorized into six types and additional variants by a single observer.

The length of the soft palate was evaluated by measuring the linear distance from the posterior nasal spine (PNS) to the tip of the uvula of the resting soft palate.

STATISTICAL ANALYSIS

All statistical procedures were performed using SPSS software v10.0. A cross-tab was composed by dividing subjects into age groups 15 to 20 years, 21 to 25 years, 26 to 30 years, 30 and above year. χ² tests were performed
to evaluate for significant relationships among variables. Data of the velar length in each type are reported as mean ± standard error (SE). One-way ANOVA (and Student Newman–Keuls test) was carried out to perform the multiple comparison of the means between different types and also for comparing velar length and width. Significance levels were based on two-tailed tests with a level <0.05.

RESULTS

Six types of velar morphologies were traced by observing the image of the velum on lateral cephalograms.

- **Type 1**: ‘Leaf shape’ lanceolate, indicated that the middle portion of the soft palate elevated to both the naso- and the oro-side, 76 patients (38%) (Fig. 1).
- **Type 2**: ‘Rat-tail shape’ soft palate showed that the anterior portion was inflated and the free margin had an obvious coarctation, 55 cases (27%) (Fig. 2).
- **Type 3**: A ‘butt-like’ soft palate with a shorter and fatter velum appearance, and the width had almost no distinct difference from the anterior portion to the free margin, 30 cases (15%) (Fig. 3).
- **Type 4**: ‘Straight line shape’, five cases (2.5%) (Fig. 4).
- **Type 5**: The distorted soft palate, presented the S-shape, three cases (1.5%) (Fig. 5).
- **Type 6**: ‘Crook’ appearance of the soft palate, in which the posterior portion of the soft palate crooks anterio-superiorly, 13 cases (6.5%) (Fig. 6).

In addition to the above mentioned types, types 7 and 8 were noted in the present study.

- **Type 7**: U-shaped soft palate-possible variant of the rat tail shape, with blunt end-nine cases (4.5%) (Fig. 7).
- **Type 8**: Variants which did not fit into either of the aforementioned categories nine cases (4.5%) (Fig. 8).

Graph 1 depicts the distribution of various types of soft palate.

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**Fig. 1**: Type 1 or lanceolate pattern indicated that the middle portion of the soft palate elevated to both the oral and nasal side

**Fig. 2**: Rat-tail shaped soft palate

**Fig. 3**: Butt-like soft palate with a shorter and fatter velum

**Fig. 4**: Straight-line shaped soft palate

**Fig. 5**: S-shaped soft palate

**Fig. 6**: Crooked appearance of the soft palate
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All 200 subjects were categorized according to the radiographic features in the above-mentioned figures. Distribution and proportion of these types among males and females are presented in Table 1. A significant increase in velar length was noted with increase in age Table 2. Also, velar length and width was significantly greater in males than in females Table 3.

Type comparison among males and females—type 1 was highest among both males and females, followed by type 2, 3 and 8, 7, 5 among males whereas in females it was type 2, 3, 6, 7, 4, 5, 8 (Table 1). There was no significant correlation between the different age groups and the types of soft palate.

DISCUSSION

Cephalometric analysis is one of the most commonly accepted techniques for evaluating the soft palate in both normal individuals and those with cleft palate. Cephalometry is a relatively inexpensive method and permits a good assessment of the soft tissue elements that define the soft palate and its surrounding structures.

The convenience of using lateral cephalogram lies in morphometric assessment of the nasopharynx or the configuration of adjacent structures which can be defined in terms of depth and height in the median sagittal plane. The variety of velar morphology, such as velar length and width was first analyzed by You M et al. Similar study was done by Niu YM et al to study the morphology of the soft palate in normal humans to provide the references for therapy of the cleft. The morphology of the soft palate was observed in 106 normal people with the use of digital cephalometry. The findings of their study suggested that all static images of soft palate could be divided into six types: Shuttle-shaped, crescent-shaped, strip-shaped, S-shaped, hamulus-shaped and anomalous shaped. The dynamic image was knee-shaped. Similarly the present study was designed to assess the velar morphology in Indian population.

In the present study, type 1, leaf-shaped palate being present in 76 patients (38%) was the most frequent type as observed by You M et al. This type was previously described as a classic velar morphology in the literature and is considered to be the most frequent type of presentation.

<table>
<thead>
<tr>
<th>Types of soft palate</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32</td>
<td>44</td>
<td>76</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
<td>38</td>
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<tr>
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<td>7</td>
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</tr>
<tr>
<td>8</td>
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<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>79</td>
<td>121</td>
<td>200</td>
</tr>
</tbody>
</table>
Table 2: Age-wise comparison of length and width of soft palate

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Length Means</th>
<th>Width Means</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-20 years</td>
<td>29.3622</td>
<td>7.4990</td>
<td>0.0162*</td>
</tr>
<tr>
<td>21-25 years</td>
<td>30.4093</td>
<td>7.9037</td>
<td>0.4574</td>
</tr>
<tr>
<td>26-30 years</td>
<td>31.0611</td>
<td>8.1667</td>
<td></td>
</tr>
<tr>
<td>&gt;30 years</td>
<td>32.6375</td>
<td>7.6438</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>30.0599</td>
<td>7.6800</td>
<td></td>
</tr>
</tbody>
</table>

*p-value (<0.05)

Table 3: Comparison of velar length and width among males and females

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sex</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>Males</td>
<td>30.8161</td>
<td>4.3013</td>
<td>2.0379</td>
<td>0.0429*</td>
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<tr>
<td></td>
<td>Females</td>
<td>29.5661</td>
<td>4.2003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width</td>
<td>Males</td>
<td>8.3986</td>
<td>2.1574</td>
<td>4.2388</td>
<td>0.0000*</td>
</tr>
<tr>
<td></td>
<td>Females</td>
<td>7.2107</td>
<td>1.7798</td>
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<td></td>
</tr>
</tbody>
</table>

*p-value (<0.05)

The dimensional analysis of the soft palate and its surrounding structures, especially the velar length and width, have been studied by many investigators. In addition, authors have also described the importance of soft palate’s growth in maintaining velopharyngeal closure and other functions. 3-7

Satoh K et al3 compared the cephalometric growth characteristics of nasopharyngeal structures between unilateral cleft lip and palate and in noncleft individuals. They observed that the soft palate length was significantly less in cleft patients.

Satoh K et al4 in their study stressed the importance of velar length in maintaining velopharyngeal closure and harmonious growth of nasopharyngeal structures.

In the present study, it was noted that significant increase in velar length was noted with increase in age. This is in correlation with the findings of Taylor M et al5 wherein the dimensional changes in bony and soft tissues of oropharyngeal structures were assessed. It was observed in their study that there was 1 mm increase in length of soft palate and 0.5 mm increase in thickness of soft palate every 3 years after the age of 9 years.

Similar observations were made by Johnston CD et al6 wherein nasopharyngeal skeletal dimensions remained unchanged but the depth of airway in oropharyngeal region decreased and the soft palate became longer and thicker with the advancement of age.

Kollias I et al7 in their study compared similar dimensional changes in between male and female young adults. From their study, they inferred that increase in length and thickness and sagittal area of soft palate was equal among males and females. But in the present study, it was noted that velar length and width was significantly greater in males than in females.

Akcam MO et al9 in their follow-up evaluation investigated the relationship between the soft palate and the nasopharyngeal airway in different mandibular growth rotation models. They observed that a linear increase in the soft palate length was seen in all groups, with the posterior mandibular rotation group showing the largest increase within the observation period. They inferred that the soft palate dimensions and its functional relations with the surrounding structures has to be examined in detail for appropriate treatment planning of various skeletal problems to avoid posttreatment speech problems.

In view of the above-mentioned findings, the role of soft palate in maintaining harmony cannot be over-emphasized. Johnston CD et al6 from the observations of their study on changing morphology of velar dimensions proposed that small bony pharyngeal skeleton and small oropharyngeal airway (owing to decreased airway depth and increase in length and thickness of soft palate) paves way for development of obstructive sleep apnea in adults.

The morphological variants and changes in angulation of soft palate have been implicated in obstructive sleep apnea syndromes. According to Pe`pin JLD et al10 hooking of the soft palate, which they defined as an angulation of 30º or greater between the distal part of the uvula and the longitudinal axis of the soft palate was seen in most of obstructive sleep apnea patients. They concluded that hooking of the soft palate is a key factor in upper airway obstruction.

They postulated that the soft palate may play a crucial role in the development of apnea in some cases of obstructive sleep apnea.

In this regard, the present study may be considered as a preliminary attempt to describe the soft palate morphology. Future studies are required to assess the morphology in sleep.
CONCLUSION

The present study aimed to investigate the variation of soft palate morphology as described by You M et al. Type 1 was the most common of all the variants. Moreover, additional morphological variants which did not fit into the classical categories were also observed. There was no significant correlation between the different age groups and the types of soft palate. The velar length and width was significantly greater in males than in females. A significant increase in velar length was noted with increase in age.

REFERENCES


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