Original Article

Correlation of soft palate morphology to growth pattern: A retrospective cephalometric study

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Abstract

Aim: The aim of the present study was to evaluate the radiographic length of velum (LV), width of velum (WV), velum angle (AV), depth of pharynx (PD), Need's ratio (NR), inclination angle (AI) in different morphological types of soft palate according to growth patterns in skeletal class I individuals. **Methodology:** 80 pretreatment lateral cephalograms of patients with skeletal class I malocclusion (ANB 2--4º) were divided on basis of six types of soft palate and further into three subgroups according to growth pattern and evaluation of LV, WV, angle with the palatal plane, and NR was done. Kruskal--Wallis test was used for the comparison between the groups. **Results:** Statistically significant difference was verified among all groups for measurement of NR. The highest NR was seen in Crook type of soft palate (mean 0.9). Similarly, the vertical growth pattern in all the six types of soft palate exhibited a higher NR than the average and horizontal growth pattern group; the highest being exhibited by vertical group in type VI (crook shaped). Velopharyngeal insufficiency is directly related to NR. **Conclusion:** Vertical growth pattern has the highest susceptibility to velopharyngeal insuffiency and speech and sleep apnea disorders.

Keywords: Lateral cephalogram, malocclusion, soft palate

Introduction

Nasal breathing, deglutition, and phonation are governed by a normal upper respiratory pattern. Besides respiratory or airway pattern, the velopharyngeal closure mechanism including the dimensions, shape, and dynamics of the soft palate is a reliable predetermining factor in carrying out these functions [Figure 1]. Soft palate is the posterior fibrovascular part of palate attached to posterior edge of hard palate.[1]

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The velopharyngeal mechanism consists of a muscular valve that extends from the posterior surface of the hard palate (roof of mouth) to the posterior pharyngeal wall and includes the velum (soft palate), lateral pharyngeal walls (sides of the throat), and the posterior pharyngeal wall (back wall of the throat). The function of the velopharyngeal mechanism is to create a tight seal between the velum and pharyngeal walls to separate the oral and nasal cavities for various purposes, including speech. Velopharyngeal closure is accomplished through the contraction of several velopharyngeal muscles including the levator veli palatini, musculus uvulae, superior pharyngeal constrictor, palatopharyngeus, palatoglossus, and salpingopharyngeus. The tensor veli palatini is thought to be responsible for eustachian tube function.

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Abnormal soft palate functionality is usually associated with craniofacial abnormalities like the cleft lip and palate patients exhibit frequent soft palate abnormalities and dysfunctions. This perpetuates in misarticulation, phonation errors, and hypernasality. Thus, the usefulness of the study. The relationship of length of velum (LV) and pharyngeal depth (PD) can be used to assess the velopharyngeal function.[2] The ratio of (PD) to (LV) is termed as Need's ratio (NR). Subtelny *et al.* reported that NR in normal individual ranged from 0.6 to 0.7 in normal subjects. However, a greater ratio demonstrated velopharyngeal incompetency. There have been studies demonstrating changes in upper airway resulting from orthodontic treatment, orthognathic surgery, or in individuals diagnosed with sleep apnea.[3-6] Studies have also been done on airspace related to facial types and angles class I individuals.[7] However, studies taking into consideration both the growth pattern and types of soft palate has not been considered. The aim of the present study is to evaluate the radiographic LV, width of velum (WV), velum angle (AV), depth of Pharynx (PD), NR, inclination angle (AI) in different morphological types of soft palate in different growth patterns in skeletal class I individuals.

Material and Methods

This was a retrospective study carried out in the Department of Orthodontics and Dentofacial Orthopaedics. A total of 80 pretreatment digital lateral cephalograms were randomly selected from the records of department of orthodontics were included.

Inclusion criteria

1. 80 pretreatment digital lateral cephalograms of orthodontic patients
2. Age group 18--30 years irrespective of gender
3. Permanent dentition
4. Skeletal class I determined by Steiner's variable ANB 2--4°.[8]

Exclusion criteria

1. Lateral cephalograms that was unclear
2. Previous history of palatine tonsils or pharyngeal tonsillar surgeries
3. History of extraction or previous orthodontic treatment
4. Previous history of orthodontic treatment
5. Craniofacial abnormalities like cleft lip and palate.

Methodology

The radiographs were traced manually on an acetate sheet (0.003 inch thickness) with 0.35 mm HB lead in a dark room by a single observer on a laminator [Figure 2]. The Tweed FMA[9] and Y Axis measurements were used to select growth pattern. The FMA measurement reference value was 25°. Values above 30° were considered as vertical growth pattern while below 20° were considered as horizontal growth pattern. Y axis mean value was considered 59°. All 80 subjects were morphologically classified according to You *et al.* classification [Table 1 and Figure 2].

Following parameters were noted on digital lateral cephalogram [Table 2].

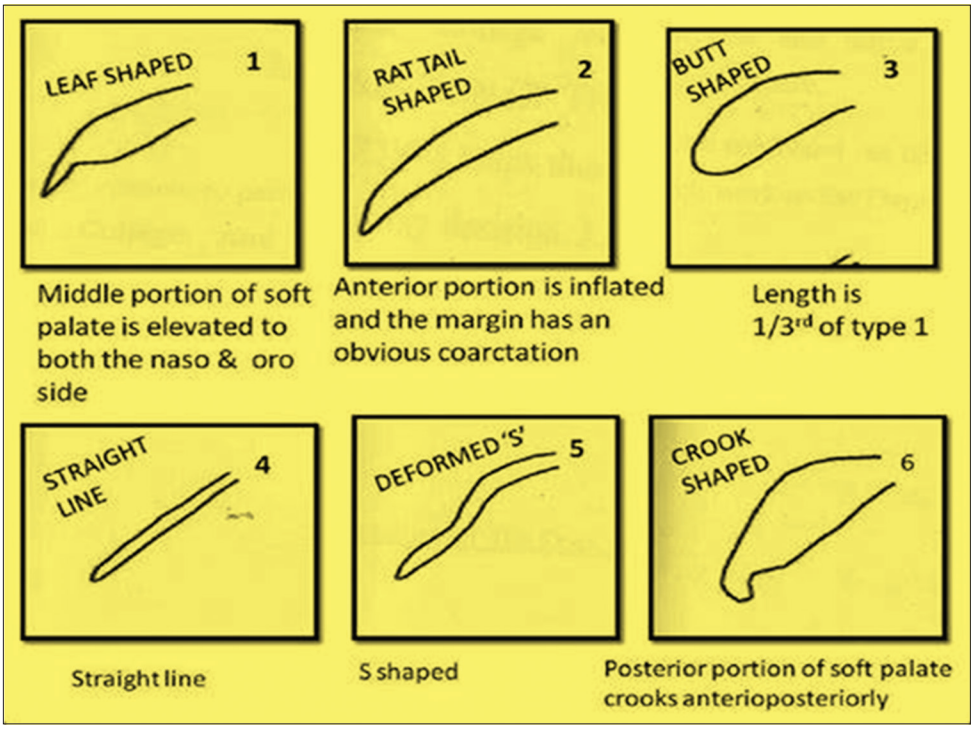

Figure 1: Types of soft palate on the basis of shape

Statistical analysis

A comparison was made between mean LV, WV, ration, and AV according to different growth patterns by Kruskal--Wallis test.

Result

A total of 80 lateral cephalograms were evaluated with mean age of subjects as 22.5 years. All samples were classified into six types of soft palate as per the You *et al.* classification. However, only one subject presented with s type of soft palate while straight type of soft palate was seen in two subjects. Type I soft palate was seen in around 60% of subjects while S-shaped palate was lowest in incidence [Figure 3]. In type I cases, values were significant for all the parameters except the AV, while group II showed significant different in only the NR. The highest NR was seen in Crook type of soft palate (mean 0.92) [Table 3]. Similarly, the vertical growth pattern in all the six types of soft palate exhibited a higher NR than the average and horizontal growth pattern group; the highest being exhibited by vertical group in type VI (crook shaped) [Table 4].

Table 3 shows comparison of length, width, AV, and NR in various types of soft palate. It was observed that crook-shaped palate (type VI) showed highest NR. Butt-shaped soft palate (type III) had all the parameters significant while in leaf shaped soft palate (type I), all parameters except AV were significant.

Table 4 shows comparison of NR in different types of soft palate according to growth pattern. The NR was highest in all types of soft palates followed by average and vertical growth pattern. NR is highest in crook-shaped (type VI) soft palate in vertical growth pattern.

Of all the types of soft palates in the sample, leaf shaped soft palate [Table 5] constituted around 63.1% followed by rat tail shaped (18.4%). Only 1% had S-shaped soft palate while butt-shaped, straight and crook shaped were around 8.5%, 3.5%, and 5.5%, respectively.

Discussion

Nasopharyngeal fiberscope and magnetic resonance imaging method are used for recording the pattern of growth and development of soft palate.[10,11] Lateral cephalogram being an affordable, readily available, and feasible diagnostic aid that can give quantitative

Table 1: Types of soft palate according to shape

TYPE	SHAPE	
I	leaf shaped	lanceolate shaped in which the middle portion of soft palate elevated to both naso and oro side
II	Rat tail shaped	when soft palate anterior portion is bulged and free margin has coarction
III	Butt like	shows shorter and flatter appearance and width has no distinct demarcation from anterior portion to free margin
IV	Straight line shaped	soft palate shows straight line
V	S-shaped	distortion of soft palate showing S shape
VI	Crook shaped	crook appearance revealed crook appearance in which posterior portion crook shaped anterosuperiorly

Table 2: Parameters considered for the lateral cephalograms

1	Velum length (LV)	linear distance from anterior nasal spine to posterior nasal spine along palatal plane
2	Velum width (VW)	linear measurement of thickest portion perpendicular to length
3	Pharyngeal depth (PD)	linear measurement from posterior nasal spine to Posterior pharyngeal wall
4	Velum angle (AV)	angle formed by palatal plane and posterior nasal spine to tip of uvula
5	Need's ratio (NR)	ratio of PD to LV in resting position

Table 3: Comparison of length, width, velum angle and Need's ratio in various types of soft palate

	Type I	Type II	Type III	Type IV	Type V	Type VI
VL	30.86*	30.39	22.16*	30	29	25.66
VW	9.35*	7.91	8.16*	4.5	5	6
AV	127.9	127.6	128.16*	121.5	129	128
NR	0.7*	0.76*	0.79*	0.85	0.9	0.92*

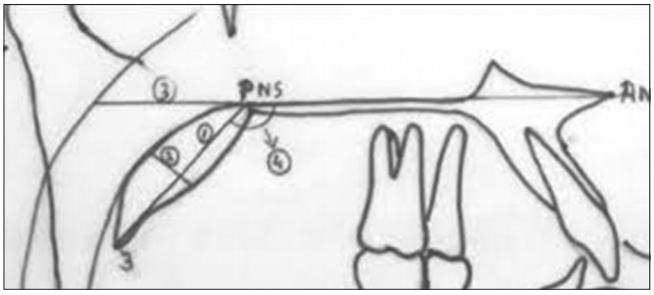

Figure 2: (1) PNS- S –velum length; (2) velum width (VW); (3) Pharyngeal depth (PD); (4) Velum angle (AV)

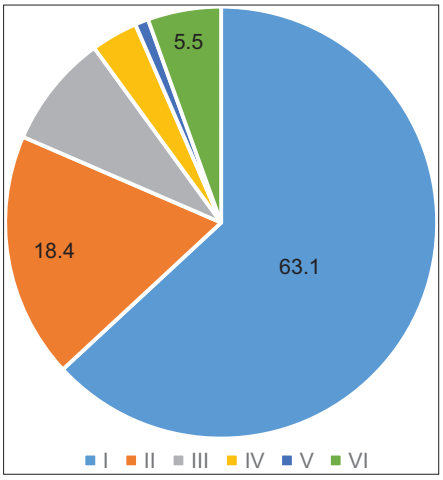

Figure 3: Shows the distribution of different types of soft palate in the sample

Table 4: Comparison of Need's ratio in different types of soft palate according to Growth pattern

	Horizontal	Average	Vertical
Type I	0.68	0.67	0.77
Type II	0.71	0.74	0.84
Type III	0.82	0.74	0.85
Type IV	-	0.85	-
Type V	0.89	-	-
Type VI	-	0.84	0.92

Table 5: Shows % distribution of various types of soft palate

Types	Distribution in %
Type I leaf shaped	63.1
Type IIrat tail shaped	18.4
Type IIIbutt shaped	8.5
Type IV straight line shaped	3.5
Type V S shaped	1
Type VI crooked	5.5

assessment of the PD and palatal inclination in the form of AV, PD, and NR. Thus, it can act as a prediagnostic aid for velopharyngeal insufficiency problems like misarticulation and sleep apnea. In the present study, the highest NR was seen in vertical growth pattern subjects having a crook-shaped morphology which coincides with the study by Elkunchwar *et al.*[12] The shape of soft palate may differ. Six major types of soft palate have been recognized. In the present study, leaf-shaped soft palate was found in majority of the subjects. It has been shown that the pharyngeal morphology changes throughout adulthood. Therefore, the subjects of mean age 22.5 years were taken. The clinician could follow the stability of this NR for early diagnosis of sleep apnea and misarticulations. Stellzig–Eisenheuer pointed out the ratio between soft palate and sagittal depth of nasopharyngeal airway was of prime importance in resonance. Pepin *et al.* found that S-shaped morphology of velum indicated the highest risk for obstructive sleep apnea. He hypothesized that hook-shaped soft palate contributes an abrupt and major reduction in the oropharyngeal dimension. This causes increase in the upper airway resistance culminating into pharyngeal collapse. In the present study, only one subject were seen to possess S-shaped morphology and showed a high NR (0.9), highest being crook-shaped soft palate (0.92) Studies have been conducted on various facial types. Sprenger *et al.* in a cephalometric study concluded that there is a significant difference in linear space measurement posterior to palate in the region of oropharynx. This was found to be predominant in individuals who had dolicofacial growth pattern.[7] The present study combines both the growth patterns as well as different types of soft palates. Taking into consideration the types of soft palate, the type most predisposed to velopharyngeal insufficiency and sleep apnea can be recognized. In present study, vertical growth pattern was seen to be most predisposed to obstructive sleep apnea especially with crook-shaped soft palate. This study was performed using two-dimensional digital lateral cephalogram that is a limitation. Therefore, it is important to recognize that three-dimensional evaluation of the airways by means of cone-beam computed tomography, respecting legal and ethical aspects, due a higher dose of radiation, could be useful for improved assessment in further studies to minimize this limitation. The limitation of the study was unequal distribution of samples. Equitable distribution of samples would prove to be more validating.

Conclusion

Type I Leaf-shaped soft palate is the most common shape of soft palate. Crook-shaped type of soft pate showed overall larger values in all parameters. Vertical growth pattern showed an increased NR in all groups, the highest being crook-shaped group. Crook shape soft palate in vertical growth pattern is more likely predisposed to velopharyngeal insufficiency resulting into misarticulation and sleep apnea.

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Conflicts of interest

There are no conflicts of interest.

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