Research Article

Morphological Variants of Soft Palate in Patients with Malocclusion – A Digital Cephalometric Research Study

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ABSTRACT:

Background- Patients with cleft lip and palate, swollen adenoids, snoring, poorly retained maxillary dentures, obstructive sleep apnea syndrome (OSAS), and skeletal craniofacial malocclusion are commonly associated with soft palate dysfunctions. We carried out a study in our institute to assess various shapes of soft palate in different malocclusions by Lateral cephalometry.

Materials & Methods- 100 OPD patients who came to the department of Oral Medicine and Radiology in our institute formed the study group. The patients were subjected for LC radiograph using Planmeca Proline XC LC along with software Planmeca Romexis 2.9.2.R with Exposure time – 17 sec, mA- 5, kVp- depending on physical status of patient. Radiographs were observed by two experienced oral radiologists at different time period to avoid bias. The soft palate morphology was observed and categorized into six types as suggested by You et al.

Results- Out of a total of 100 participants, 57 were classified as Class I, 39 as Class II, and 4 as Class III when malocclusion was examined. 48% had leaf-shaped palates, whereas 35% had rat-tail-shaped palates. Leaf shaped soft palate was most prevalent in males & females. Leaf shaped palate was evident in Class I and Class II, and Butt shaped soft palate was evident in Class III.

Conclusion- The comparison of the age, VL, VW and PD of soft plate among different genders, was done. It was found that VL, VW differed significantly. Malocclusion and malocclusion shape, have a strong positive association, based on Pearson correlation test.

KEYWORDS: LC, soft palate shape, malocclusion, velar width, velar length.

INTRODUCTION:

The soft palate is a fibrovascular portion, and is joined to the back border of the hard palate. It keeps the nasal and oral cavities seperate during deglutition and speaking. It takes part in the majority of oral cavity activities, including speech, breathing, and deglutition etc. The soft palate is a moveable flap that rests from the hard palate's posterior edge and slopes back and down between the pharynx's nasal and oral regions. Soft palate is a thick fold of mucosa enclosing an aponeurosis, muscle tissue, arteries, nerves, lymphoid tissue, and mucus glands.[1] Patients with cleft lip and palate, swollen adenoids, snoring, poorly retained maxillary dentures, obstructive sleep apnea syndrome (OSAS), and skeletal craniofacial malocclusion are commonly associated with soft palate dysfunctions.[2-4] By analyzing the image of the soft palate on lateral cephalograms (LC), You et al. classified the soft palate into six morphological types (Type 1: Leaf shaped/ lanceolate shaped; Type 2: Rat tail shaped; Type 3: Butt-like shaped; Type 4: Straight line shaped;

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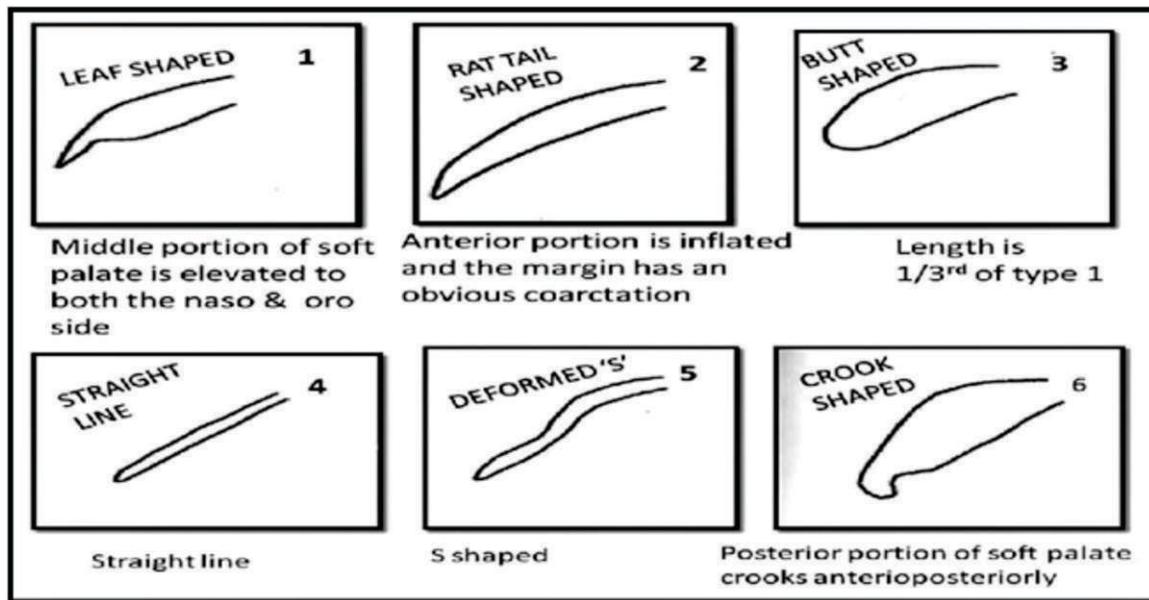| **Quick Response Code:**	**Website:**
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Figure1: Diagrammatic representation of various shapes of soft palate.

Type 5: S-shaped/distorted soft palate; and Type 6: Crooked shaped)[2,5,6] as depicted in Figure 1.

One of the most widely used methods for assessing the six distinct kinds of soft palate that can occur in both healthy persons and in various pathologies is cephalometric examination. LC is economical, more beneficial, simple to do, requires less radiation, and correlates well with other studies like computed tomography. Therefore, it may be used for morphometric assessment of the soft palate and the tissues that surround it.[7] We carried out a study in our institute to assess various shapes of soft palate in different malocclusions by LC.

MATERIALS & METHODS:

100 OPD patients who came to the department of Oral Medicine and Radiology in our institute, for LC were included in this study. The patients were explained briefly about the study and their consent was taken. Institutional ethical clearance was obtained. They were grouped based on malocclusion. The following inclusion & exclusion criteria was used-

A) Inclusion criteria:

1. Patients with class I, class II, and class III molar relations.
2. Patient without any syndromes or diseases.
3. Patients within age range of 18-40 years.

B) Exclusion criteria:

1. Participants with history of trauma, fractures, or surgery.
2. Images with positioning error, magnification, and distortion.

3. Patients who refused to be a part of the study.

The patients were made to sit on a dental chair for clinical examination. The type of malocclusion was evaluated based on Angle's Classification. Thorough intraoral examination was carried out and observations were recorded in a proforma.

The participants were positioned in cephalostat with Frankfort plane parallel to the floor, and were asked to swallow once to clear any saliva in the oral cavity and pharynx. The participants were then asked to close their mouth tightly to place their upper and lower teeth in centric occlusion with tongue in resting position and relaxed oropharyngeal musculature. The radiographic exposure was obtained by machine using horizontal scanning of the patient.

The patients were subjected for LC radiograph using Planmeca Proline XC LC along with software Planmeca Romexis 2.9.2.R with Exposure time – 17 sec, mA- 5, kVp- depending on physical status of patient. Radiographs were observed by two experienced oral radiologists at different time period to avoid bias. The soft palate morphology was observed and categorized into six types as suggested by You et al (Figure 2).

Linear measurements were carried out, and the length of soft palate was evaluated by measuring the linear distance from the posterior nasal spine to the tip of the uvula of resting soft palate. The width of soft palate along with Pharyngeal depth were recorded from posterior pharyngeal wall to posterior nasal spine.

The velar length (VL) was measured as a linear distance from the posterior nasal spine (PNS) to the tip
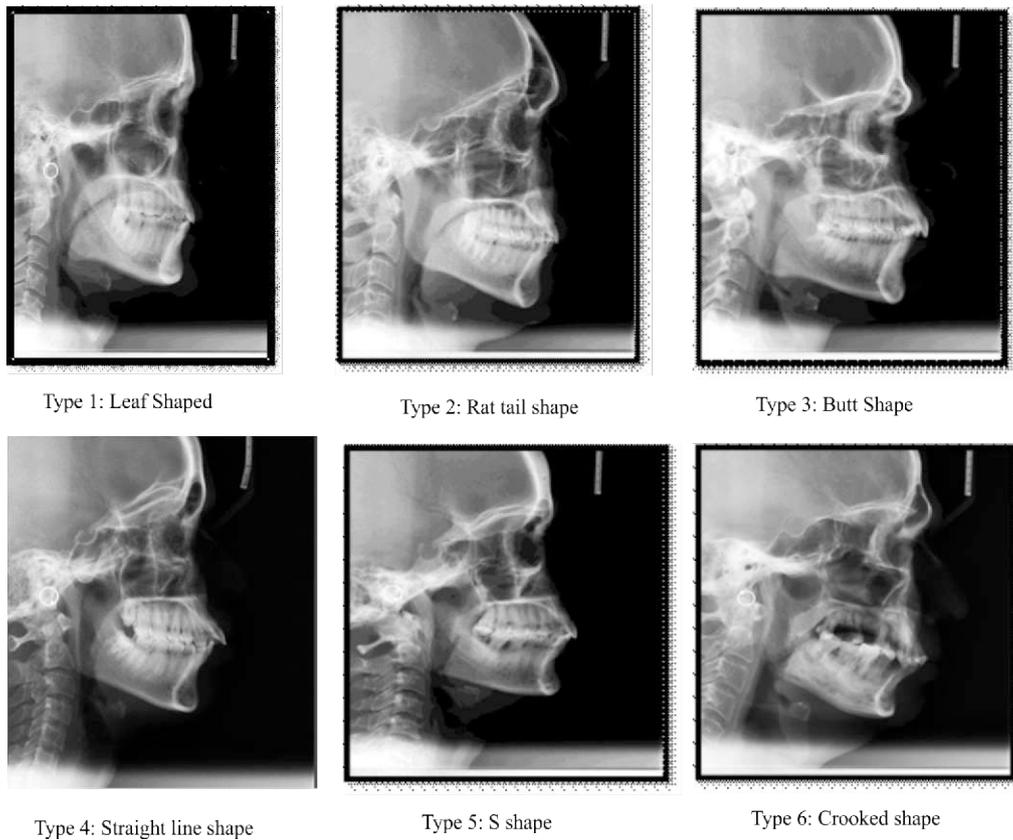
Type 1: Leaf Shaped

Type 2: Rat tail shape

Type 3: Butt Shape

Type 4: Straight line shape

Type 5: S shape

Type 6: Crooked shape

Figure 2: Types of soft palate observed in the present study.

of the uvula of the resting soft palate [Figure-3 (a)]. The velar width (VW) was taken at thickest section of velum [Figure-3(b)]. The pharyngeal depth (PD) was taken as a linear measurement from the PNS to the anterior pharyngeal wall along the palatal plane [Figure-3(c)]. All these findings were tabulated in an excel sheet. The data was subjected to statistical analysis.

RESULTS:

The 100 participants in the current study showed that 34 were men and 66 were women. 57 were classified as Class I, 39 as Class II, and 4 as Class III when the malocclusion was examined.

An analysis of the individuals' palate shapes revealed that 48% had leaf-shaped palates, whereas 35% had rat-tail-shaped palates. The palates with the S and straight shapes were least prevalent [Tables 1; Graph 1].

Leaf shaped soft palate was most prevalent in males (n=14) & females (n=34). This was followed by rat tail shape. The results were non-significant [Table 2; Graph 2].

The distribution of various shapes of soft palate among different malocclusions were analyzed and summarized. It was found that leaf shaped palate

Table 1: Descriptive Statistics of shape of soft palate among study participants.

Shape Of Soft Palate	Frequency	Percentage
Leaf Shape	48	48.0
Croocked Shape	7	7.0
Rat Tail Shape	35	35.0
Butt Shape	6	6.0
Straight Shape	3	3.0
S Shape	1	1.0
Total	100	100.0
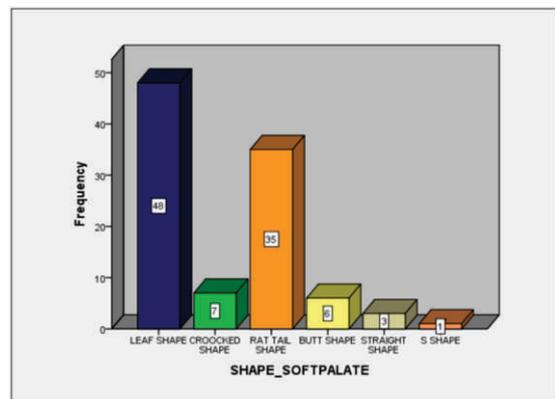
Graph 1: Graphical representation of shape of soft palate among study participants

a. Velar width

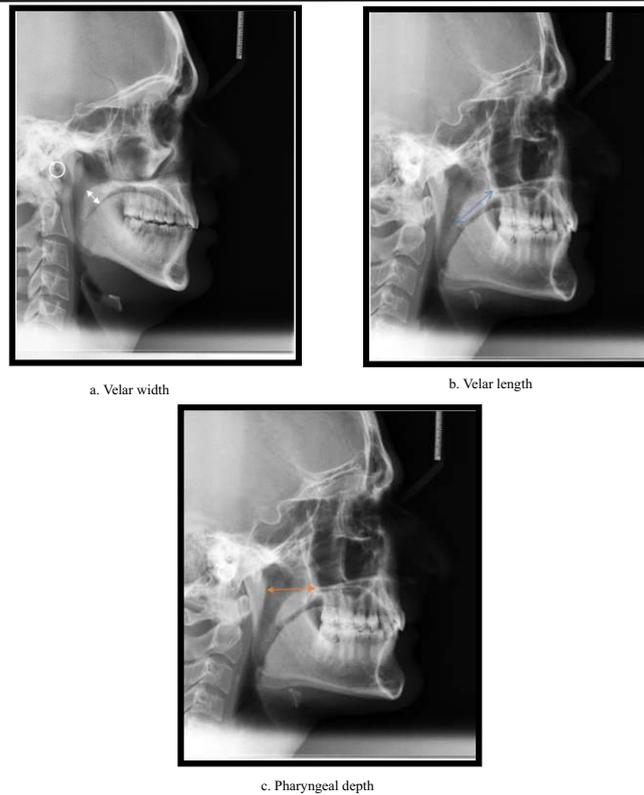b. Velar length

c. Pharyngeal depth

Figure 3: 3(a) (VL) Blue line: velar length (Antero-posterior distance); 3(b) (VW) White line: velar width (supero inferior width) and 3© (PD) Orange line: Pharyngeal depth.

Table 2: Comparison of the types of soft palate shapes among different genders.

Shape Of Soft Palate	Gender						p-value
	Male		Female		Total		
	Count	Column N %	Count	Column N %	Count	Column N %	
Leaf Shape	14	41.2%	34	51.5%	48	48.0%	
Croocked Shape	4	11.8%	3	4.5%	7	7.0%	
Rat Tail Shape	11	32.4%	24	36.4%	35	35.0%	0.825
Butt Shape	4	11.8%	2	3.0%	6	6.0%	
Straight Shape	1	2.9%	2	3.0%	3	3.0%	
S Shape	0	0.0%	1	1.5%	1	1.0%	
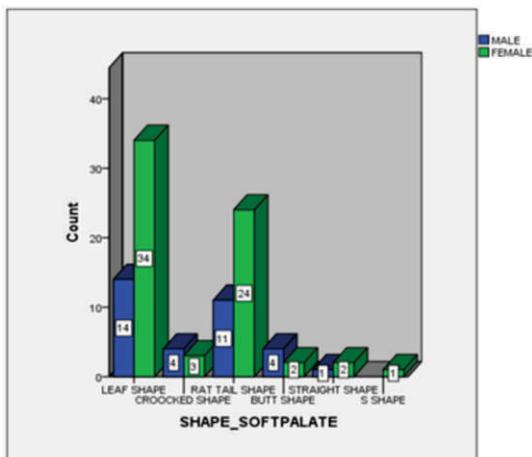
Graph 2: Graphical representation of types of soft palate shapes among different genders

was evident in Class I and Class II, and Butt shaped was evident in Class III [Table 3].

The correlation was analyzed between types of malocclusion and soft palate shapes using pearson correlation. It was found that they were significantly correlated with p-value less than 0.05 [Table 4; Graph 3].

DISCUSSION:

The dimensional analysis of the soft palate and its surrounding structures, especially the VL and VW, has been studied by many investigators. Acquiring careful understanding concerned to the changes noticed in soft palate in different pathologies such as oral submucous fibrosis will be helpful to halt the progression of the disease at that particular stage to

Table 3: Distribution of the types of soft palate shapes among various malocclusions

Malocclusion			Count	Percentage
Class I	Shape of Soft palate	Leaf Shape	27	47.4%
		Crooked Shape	2	3.5%
		Rat Tail Shape	21	36.8%
		Butt Shape	4	7.0%
		Straight Shape	2	3.5%
		S Shape	1	1.8%
Class II	Shape of Soft palate	Leaf Shape	21	53.8%
		Crooked Shape	4	10.3%
		Rat Tail Shape	13	33.3%
		Butt Shape	0	0.0%
		Straight Shape	1	2.6%
		S Shape	0	0.0%
Class III	Shape of Soft palate	Leaf Shape	0	0.0%
		Crooked Shape	1	25.0%
		Rat Tail Shape	1	25.0%
		Butt Shape	2	50.0%
		Straight Shape	0	0.0%
		S Shape	0	0.0%

Table 4: Correlation of the types of malocclusion and soft palate shapes

Malocclusion	SHAPE_SOFTPALATE						Total	p-value
	Leaf Shape	Crooked Shape	Rat Tail Shape	Butt Shape	Straight Shape	S Shape		
CLASS I	27	2	21	4	2	1	57	
CLASS II	21	4	13	0	1	0	39	
CLASS III	0	1	1	2	0	0	4	0.014 *
	48	7	35	6	3	1	100	
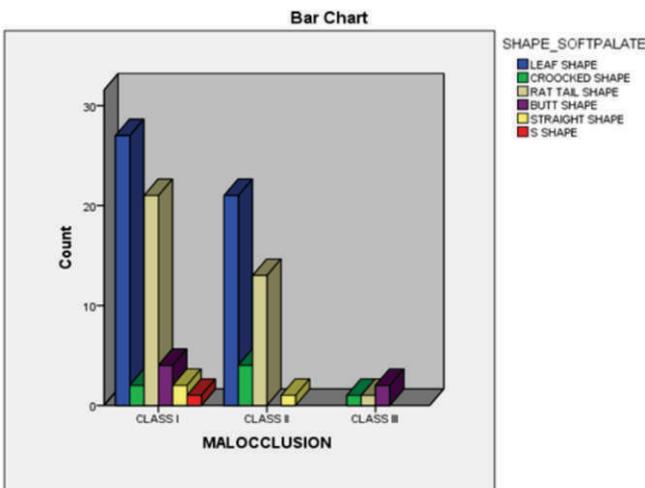
Graph 3 : Correlation of the types of malocclusion and soft palate shapes

prevent further complication and restore structural and functional outcomes.[8] The study of soft palate patterns like shape, length, width and pharyngeal depth helps for the evaluation of any risk factors for velopharyngeal incompetence. The clinical observation of soft palate is difficult. LC can be used to get an accurate diagnostic. It is relatively inexpensive and aids in the assessment of soft palate morphology and its surrounding structures.[9] Advanced diagnostic imaging techniques such as magnetic resonance imaging and fluoroscopy are now available worldwide for imaging of soft palate, but still, LC is preferred imaging technique for the analysis of soft palate for its indispensable advantages. LC is preferred due to its easy accessibility, economical, and relatively good assessment of soft tissue.

In the present study, out of 100 participants, 34 were male and 66 were female. When the malocclusion was checked among all the participants 57 were Class I, 39 were Class II, and 4 were class III. When the shape of palate was analyzed, it was found that most of the participants showed leaf shaped palate (48%), followed by Rat tail shaped palate (35%). The least common was S shaped and the Straight shaped palate.

The comparison of the age, VL, VW and PD of soft plate among different genders, was done. It was found that VL, VW differed significantly, [$p<0.001$].

On comparing different malocclusions among genders, it was found that they varied significantly [$p<0.001$]. Different shapes of soft palates were compared among different genders, and it was found that there was no significant difference [$p>0.05$].

The distribution of various shapes of soft palate among different malocclusions were analyzed and summarized. It was found that leaf shaped palate was evident in Class I and Class II, and Butt shaped soft palate was evident in Class III.

The correlation was analyzed between types of malocclusion and soft palate shapes using pearson correlation. It was found that they were significantly correlated with p-value less than 0.05.

The majority of the participants showed leaf shaped palate, followed by Rat tail shaped palate. The prevalence of the remaining shapes are as follows Croocked shape (7%), Butt shape (6%), Straight shape (3%), and S shape (1%). The least common was S shaped and the Straight shaped palate.

The results of the current study were in accordance with the study conducted by Ravi prakash et al (2014)[10], where leaf shaped palate followed by Rat tail shaped were most commonly seen. In contrast, the study conducted by Raja Lakshmi et al in 2016 [11], the most common shape was found to be butt and crook shape. The least common shape in this study was S shaped and absence of straight line shape (0%) soft palate. This was contrary to Raja Lakshmi et al(2016) study, which showed least common as type 4 and absence of type 5 soft palate.[11] These variations could be attributed to smaller sample size in each of the stages of OSMF, whereas in other studies there was no such equal distribution. Another reason could be geographical variations.

The S-shape, which was described as a hooked appearance of the soft palate by Pepin et al in 1999[12] was found in 8.3% cases in our study group. Hooking of the soft palate was defined in their study as an angulation of about 30° between the distal part of the uvula and the longitudinal axis of the soft palate. They hypothesized that soft palate hooking plays a key role in pharyngeal collapse, since hooking results in a sudden and major reduction in the oropharyngeal dimensions, which therefore dramatically increases the upper airway resistance and the transpharyngeal pressure gradient.

In the present study, it was found that most common shape of soft palate among the class I and class II participants was leaf shaped and among class III it was Butt shaped. The correlation was analyzed using pearson correlation test and it was found that the malocclusion was significantly correlated with malocclusion. Subramaniam found that leaf shape was most common in Class I malocclusions, rat tail type in Class II malocclusions, and leaf type and crooked type in Class III malocclusions in the sample of skeletal malocclusions[13]. Our study's discrepancy in results could be the result of ethnic variance.

By the 12th week of intrauterine life[14], the soft palate has finished developing, and by the 16th–17th week, the muscles have developed.[15] Thus, the development of a soft palate occurs during the intrauterine period. Nonetheless, during the pubertal growth surge, the maxilla and mandible's bone development continues. Furthermore, the definitive malocclusion is determined between the ages 16 and 18. Our research revealed a strong relationship between the different forms of soft palate and skeletal malocclusion. Thus, by looking at the form of the soft palate, we may predict the skeletal malocclusion in children at a very young age.

Therefore, in order to prevent speech issues after treatment, the soft palate dimension and its functional link to the surrounding structure should be considered in the diagnostic and treatment planning of various skeletal diseases. As a result, treatment planning that involves expanding the pharynx ought to be taken into account. When employing orthopedic or surgical techniques, that may require maxillary advancement, the clinician should exercise caution.

CONCLUSION:

Because of its accessibility, affordability, and somewhat accurate assessment of soft tissue, cephalometric analysis is a widely used method for evaluating soft palates. Numerous studies have addressed the dimensional study of the soft palate and the surrounding structures, particularly the velar length and width; nonetheless, the most logical reason for the variations in soft palate dimensions is the variance in velar morphology.

Malocclusion and malocclusion shape, have a strong positive association, based on Pearson correlation test.

Understanding the wide range of velar morphology may be useful in future studies to determine the etiology of OSA and associated illnesses as well as in the effective functional and structural restoration of the soft palate. However, there is no connection between the soft palate pattern and the treatment of various malocclusions.

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Conflicts of interest
There are no conflicts of interest.

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