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Evaluation of Airway in Different Types of Soft Palate According To Growth Pattern

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Abstract: *A normal upper airway is important for nasal breathing, swallowing and phonation. Along with airway the velopharyngeal closure mechanism including the dimensions, shape and dynamics of the soft palate proves to be an important factor in carrying out these functions. The aim of the present study is 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. 80 pre treatment lateral cephalograms of patients with skeletal class I malocclusion(ANB 2-4 deg) were divided on basis of six types of soft palate and further into three subgroups according to growth pattern and evaluation of velum length, width, angle with the palatal plane and Need's ratio was done. Kruskal Wallis test was used for the comparison between the groups. Statistically significant difference was verified among all groups for measurement of Need's ratio. The highest Need's ratio 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 Need's ratio 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 Need's ratio. Vertical growth pattern has the highest susceptibility to Velopharyngeal insuffiency and speech and sleep apnea disorders.*

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I. Introduction

A normal upper airway is important for nasal breathing, swallowing and phonation. Along with airway the velopharyngeal closure mechanism including the dimensions, shape and dynamics of the soft palate proves to be an important factor in carrying out these functions. Soft palate is the posterior fibro vascular part of palate attached to posterior edge of hard palate.[1] Usually the patients of craniofacial abnormalities like the cleft lip and palate patients exhibit frequent soft palate abnormalities and dysfunctions. This may result in misarticulation , phonation errors and hypernasality. 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. Subtelny et al reported that Need's ratio in normal individual ranged from 0.6-0.7 in normal subjects. However a greater ratio demonstrated velopharyngeal incompetencey. There have been studies demonstrating changes in upper airway resulting from orthodontic treatment, orthognathic surgery or in individuals diagnosed with sleep apnoea.[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 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 in different growth patterns in skeletal class I individuals.

II. Material And Methods

This retrospective study was carried out on digital Lateral cephalograms from Department of Orthodontics and Dentofacial Orthopaedics at MGV's KBH Dental College and Hospital, Nashik, Maharashtra

Study Design: Retrospective

Study Location: Department of Orthodontics and Dentofacial Orthopaedics at MGV's KBH Dental College and Hospital, Nashik, Maharashtra.

Sample size: 80

Subjects & selection method: The digital lateral cephalograms were randomly selected from the records of department of orthodontics at MGV's KBH Dental college and Hospital, Nashik, Maharashtra.

Inclusion criteria:

1. Pretreatment digital lateral cephalograms of 80 subjects
2. age group 18-30 years irrespective of gender
3. permanent dentition
4. skeletal class I determined by steiner's variable ANB 2-4 deg[8]

Exclusion criteria: .

1. Lateral cephalograms that were 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**.**

Procedure 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 (fig no 2). The Tweed FMA9 and Y Axis measurements were used to select growth pattern. The FMA measurement reference value was 25deg. Values above 30 deg were considered as vertical growth pattern while below 20 deg a horizontal growth pattern. Y axis mean value was considered 59 deg.

All 80 subjects were morphologically classified according to You et al classification (table1) (fig no 2)

Table no. 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

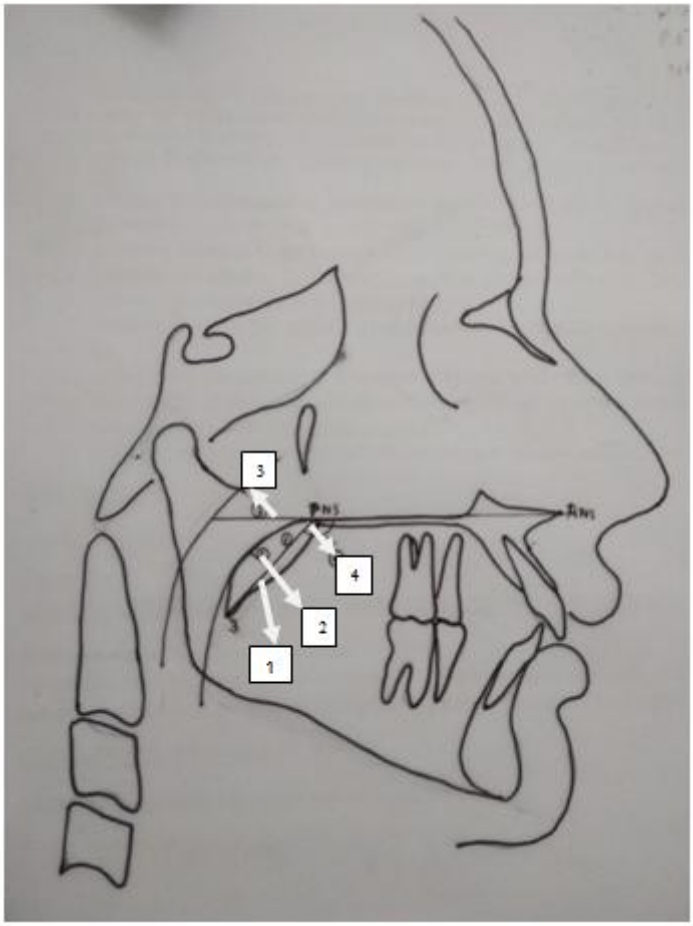
Following parameters were noted on digital lateral cephalogram (table 2)

Table no 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

Fig no 1. Types of soft palate

I)leaf II) rat tail III) butt shape IV) straight V) s shape VI) crook



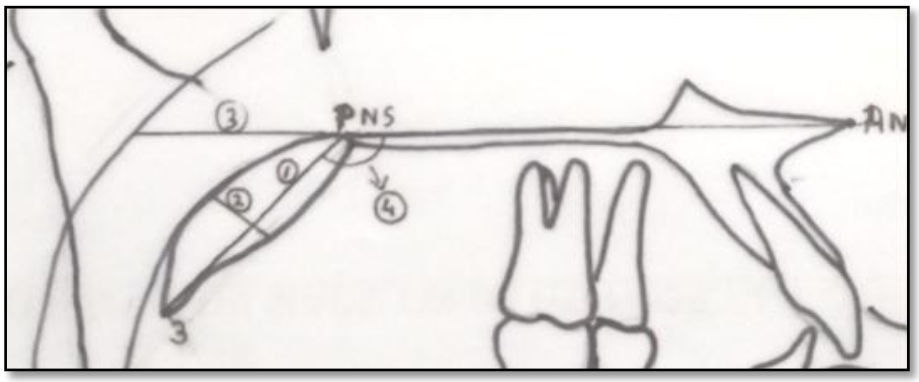


Fig no 2 : (1) PNS- S –velum length; (2) velum width(VW); (3) Pharyngeal depth(PD); (4) Velum angle(AV)

Statistical analysis

A comparison was made between mean velum length, velum width, Need's ratio and velum angle according to different growth patterns by Kruskal Wallis test. P value <0.05 was considered statistically significant.

III. 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(fig 3). In type I cases values were significant for all the parameters except the velum angle while group II showed significant different in only the Need's ratio. The highest Need's ratio was seen in Crook type of soft palate (mean 0.9)(table 3). Similarly The vertical growth pattern in all the six types of soft palate exhibited a higher Need's ratio 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, velum angle and Need's ratio in various types of soft palate. It was observed that crook shaped palate(type VI) showed highest Need's ratio. Butt shaped soft palate(type III) had all the parameters significant while in leaf shaped soft palate(type I) all parameters except angle of velum were significant.

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	31.88*	31.39	21.16*	31	30	27.66
VW	9.26*	7.91	8.16*	3.5	4	7
AV	127.9	127.6	128.16*	121.5	129	128
NR	0.7*	0.76*	0.79*	0.85	0.9	0.92*

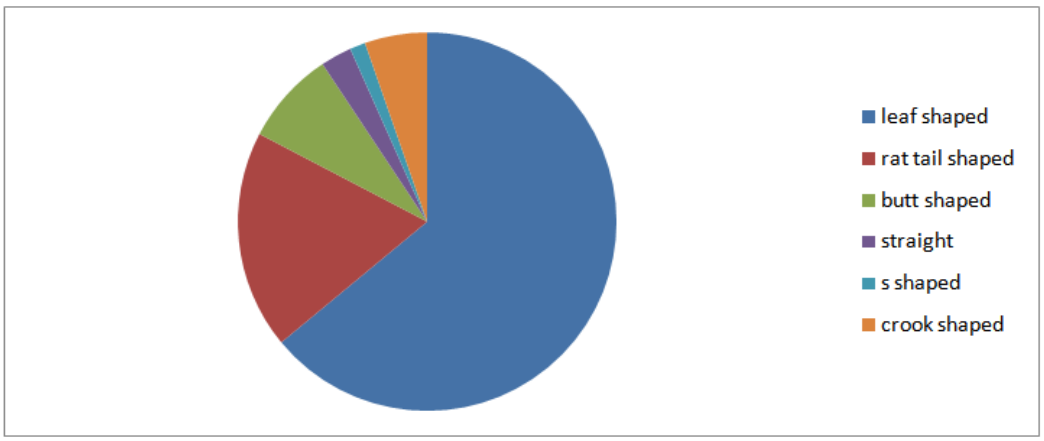
Table 4 shows comparison of Need's ratio in different types of soft palate according to Growth pattern. The Need's ratio was highest in all types of soft palates followed by average and vertical growth pattern. Need's ratio is highest in crook shaped (type VI) soft palate in vertical growth pattern.

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

	Horizontal	Average	Vertical
Type I	0.69	0.67	0.76
Type II	0.72	0.74	0.84
Type III	0.8	0.74	0.85
Type IV	-	0.85	-
Type V	0.9	-	-
Type VI	-	0.83	0.92

Of all the types of soft palates in the sample, leaf shaped soft palate constituted around 60% followed by rat tail shaped ,17.5%. Only one sample had S shaped soft palate while butt shaped ,straight and crook shaped were around 7.5%, 2.5% and 5% respectively. Fig 3 shows the distribution of different types of soft palate n the sample.

Fig 3 Distribution of soft palate according to shape.



IV. Discussion

Soft palate function and development can be monitored and recorded by a nasopharyngeal fiberscope and magnetic resonance imaging method [10-11]. Lateral cephalogram being an economical, readily available and easily used diagnostic aid can give quantitative assessment of the pharyngeal depth and palatal inclination in the form of velum angle, pharyngeal depth and Need's ratio. Thus it can act as a pre-diagnostic aid for velopharyngeal insufficiency problems like misarticulation and sleep apnoea. In the present study, the highest Need's ratio was seen in Vertical growth pattern subjects having a crook shaped morphology which coincides with the study by Nerkar et al[12]. The shape of soft palate may differ. Six major types of soft palate have been recognised. 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[13]. Therefore the subjects of mean age 22.5 years were taken. The clinician could follow the stability of this Need's ratio for early diagnosis of sleep apnoea and misarticulations. Stellzig –Eisenheuer [14]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 hypothesised 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[15]. In the present study, only one subject were seen to possess S shaped morphology and showed a high Need's ratio (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 indivuals 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 apnoea can be recognised. 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.

V. Conclusion

1. Leaf type of soft palate is the most common shape of soft palate
2. Crook shaped type of soft pate showed overall larger values in all parameters.
3. Vertical growth pattern showed an increased Need's ratio in all groups, the highest being crook shaped group
4. Crook shape soft palate in vertical growth pattern is more likely predisposed to Velopharyngeal insufficiency resulting into misarticulation and sleep apnoea.

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