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Original Article

Dentistry Section

Morphological Study of Soft Palate by Using Computed Tomography–A Prospective Study

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ABSTRACT

Background: Soft palate is an important part of oro-naso-pharyngeal apparatus. The morphometric assessment of soft palate is well-performed on computed tomography (CT).

Aim: To evaluate the morphology of soft palate in healthy individuals by using Computed tomography.

Materials and Methods: The study was conducted on 300 healthy voluntary participants who were subjected to CT scan (sagittal view) of head and neck region. The measurements of antero-posterior and supero-inferior length of soft palate were performed by using Syngo CT 2009E software.

Statistical Analysis: The statistical analysis was performed by using SPSS software version 16 and test applied were one-way ANOVA, independent t-test, chi-square and Karl Pearson's co-relation coefficient.

Results: The participant's age ranged from 18-80 years with mean of 39.51±14.64. The study had equal number of males (n=150) and females (n=150). Out of six shapes of soft palate, Butt type (38.7%) was the commonest. The morphology of soft palate in different age groups was statistically not significant (p>0.05). The total mean of antero-posterior length (30.31±3.39 mm) of soft palate was more than supero-inferior length (10.72±1.71 mm). The mean of antero-posterior length in males (30.69±3.42 mm) was more than females (29.92±3.32 mm); which was statistically significant (p<0.05). The mean of supero-inferior length in males (10.67±1.78 mm) was less than females (10.78+1.64 mm), which was statistically not significant (p>0.05).

Conclusion: CT scan is an important diagnostic aid for studying the accurate morphology of soft palate.

Keywords: Lateral cephalogram, Oro-naso-pharyngeal, Sagittal view

INTRODUCTION

Soft palate is a mobile fibro-muscular part attached to the posterior border of hard palate, sloping down and back between the oral and nasal parts of the pharynx [1,2]. The palate is formed by the fusion of three components - two palatal processes and the fronto-nasal process. In the later stage, the mesoderm in the palate undergoes intra-membranous ossification to form the hard palate whereas the posterior part does not undergo ossification and remains as soft palate [2-4]. The hard and soft palate is easily palpable and identified by change in colour [1]. Soft palate plays an important role in phonation, deglutition, respiration and velo-pharyngeal competence [5]. This soft tissue structure has not been studied much. You M et al., [6] has laid down morphological types of soft palate.

The soft palate can be studied on lateral cephalogram and sagittal section of computed tomography (CT) scan. CT scan permits a good assessment of the soft tissue elements that define the soft palate and its surrounding structures [7,8]. Using CT scan, it is possible to analyse the boundary of soft palate and its position and accurate measurements are obtained easily. CT scan has minimal superimposition of structures and allows better visualization of minute differences of density than conventional radiographs. The morphometric assessment of soft palate on CT scan can be defined in terms of depth and height or antero-posterior and supero-inferior length in the median sagittal plane [7,9-12]. The soft palate has variable radiographic forms on lateral or sagittal imaging.

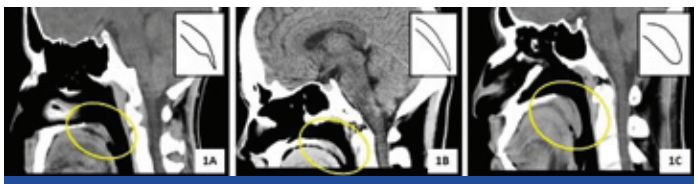
The existing literature reveals numerous studies on soft palate using lateral cephalogram but only one study till date using CT scan [13]. The present study was designed to evaluate the morphology and variation of soft palate through computed tomography in different age group and gender, as the statistical findings may help in understanding the velo-pharyngeal closure in cleft palate and in obstructive sleep apnoea syndrome.

MATERIALS AND METHODS

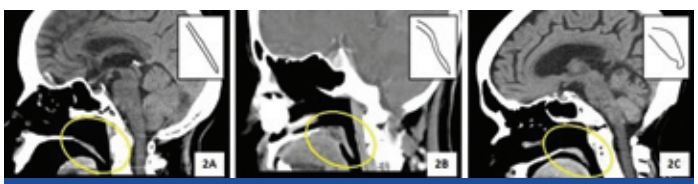
The present study was conducted with the permission of Institutional Ethics Committee of Sumandeep Vidyapeeth University with protocol number SVIEC/ON/DENT/RP/1526, dated 17/10/2014. The total of 300 voluntary healthy participants, above 18 years of age were included in the study whereas participants with head & neck anomalies, intra-osseous pathologies, history of trauma/surgery, images with positioning errors, magnification or distortion were excluded from the study. After obtaining informed consent form in local language, each participant was subjected to CT scan of head and neck region (sagittal view). The shapes of soft palate was classified according to You M et al., [6] - Type 1: Leaf shape [Table/Fig-1a], Type 2: Rat Tail shape [Table/Fig-1b], Type 3: Butt like shape [Table/Fig-1c], Type 4: Straight line shaped [Table/Fig-2a], Type 5: Distorted/S-shape [Table/Fig-2b] and Type 6: Crooked shape [Table/Fig-2c]. The morphometric analysis for antero-posterior and supero-inferior length of soft palate was performed using mouse driven method i.e. by moving the mouse and drawing lines between the selected points on the sagittal sections of CT scan by using Syngo CT 2009E software [Table/Fig-3a,b].

STATICTICAL ANALYSIS

The measurements were recorded in millimetres. The collected data was analysed using SPSS software version 16 and the test applied



[Table/Fig-1a-c]: Shows Sagittal section of computed tomography scan- (a) showing leaf shape, (b) rat-tail shape and (c) butt-like of soft palate (yellow circle)



[Table/Fig-2a-c]: Shows Sagittal section of computed tomography scan - (a) showing straight line shape, (2) S-shape and (c) crook shape of soft palate (yellow circle)

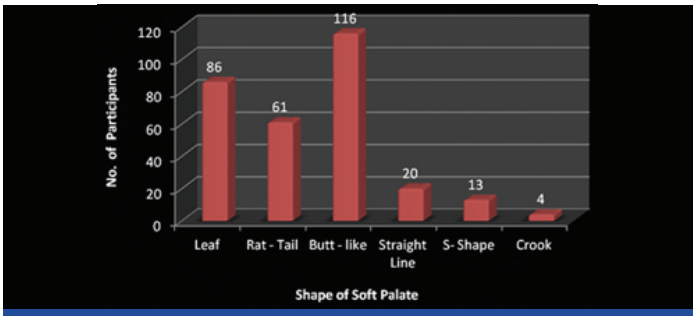
[Table/Fig-3a,b]: Shows Sagittal section of computed tomography scan - (a) showing measurements of soft palate antero-posteriorly and (b) supero-inferiorly

were one-way ANOVA, Independent t-test, Chi-square and Karl Pearson's co-relation coefficient.

RESULTS

In the present study, the age of participants ranged from 18-80 years with mean of 39.51+14.64. There were total 300 participants including equal number of male (n=150) and female (n=150) participants. The maximum numbers of participants were between the age group of 21-30 years.

Out of all the type of soft palate, the maximum number of participants had Butt type of soft palate (38.7%) [Table/Fig-4] and was seen more or less equal in male (19.7%) and female (19%) participants. Correlation of shape of soft palate with age group and gender



[Table/Fig-4]: Distribution of frequency of shape of soft palate

Shape	Age Group (in Years)														Obtained p-value
	<=20		21- 30		31-40		41-50		51-60		61-70		71-80		Total		
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Leaf	03	01.0	29	09.7	12	04.0	19	06.3	13	04.3	08	02.7	02	0.7	86	28.7	0.741 Not Significant (p>0.05)
Rat - Tail	04	01.3	18	06.0	13	04.3	14	04.7	08	02.7	02	0.7	02	0.7	61	20.3	
Butt - like	14	04.7	29	09.7	26	08.7	19	06.3	19	06.3	07	02.3	02	0.7	116	38.7	
Straight Line	04	01.3	05	01.7	03	01.0	03	01.0	04	01.3	01	0.3	00	0.0	20	06.7	
S- Shape	00	0.0	02	0.7	04	01.3	04	01.3	01	0.3	02	0.7	00	0.0	13	04.3	
Crook	01	0.3	01	0.3	00	0.0	01	0.3	01	0.3	00	0.0	00	0.0	04	01.3	
Total	26	08.7	84	28.0	58	19.3	60	20.0	46	15.3	20	06.7	06	02.0	300	100	

[Table/Fig-5]: Co-relation of shape of soft palate with age group
(n = number, %= percentage, p= Probability value)

Shape	Gender						Obtained p-value
	Male		Female		Total		
	n	%	n	%	n	%	
Leaf	35	11.7	51	17.0	86	28.7	0.229 Not Significant (p<0.05)
Rat - Tail	36	12.0	25	08.3	61	20.3	
Butt - like	59	19.7	57	19.0	116	38.7	
Straight Line	12	04.0	08	02.7	20	6.7	
S- Shape	07	2.3	06	02.0	13	4.3	
Crook	01	0.3	03	01.0	04	1.3	
Total	150	50	150	50	300	100	

[Table/Fig-6]: Co-relation of shape of soft palate with gender
(n = number, %= percentage, p= Probability value)

were analysed by using Chi-square test and were statistically not significant (p>0.05) [Table/Fig-5,6].

It was distinctly noted that the mean values for antero-posterior and supero-inferior length of various shapes of soft palate in both male and female when analysed by using one-way ANOVA test, the values were highly significant (p<0.05) [Table/Fig-7,8].

It was observed that the minimum and maximum mean of antero-posterior length of soft palate was 24.20 mm and 37.80 mm respectively whereas the minimum and maximum mean of supero-inferior length was 06.10 mm and 14.80 mm respectively [Table/Fig-9].

In the present study, when the dimensions were co-related with gender, it was observed that the mean antero-posterior length of soft palate in males (30.69±3.42 mm) was more than females (29.92±3.32 mm), which was statistically significant (p<0.05). But,

Shape	n	Gender	Mean (mm) ± Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum (mm)	Maximum (mm)	Obtained p-value
					Lower Bound	Upper Bound			
Leaf	35	Male	32.58 ± 1.20	0.203	32.17	32.1	30.10	35.90	<0.001 Highly Significant (p<0.05) For both Males & Females
	51	Female	32.29 ± 0.91	0.128	32.04	32.55	30.30	34.70	
Rat- Tail	36	Male	31.21 ± 1.17	0.195	30.81	31.60	30.10	34.70	
	25	Female	31.10 ± 1.36	0.272	30.53	31.66	28.20	35.80	
Butt like	59	Male	28.12 ± 3.38	0.440	27.24	29.00	25.40	37.10	
	57	Female	26.25 ± 0.62	0.082	26.08	26.41	24.20	27.90	
Straight Line	12	Male	36.80 ± 0.28	0.082	36.62	36.98	36.30	37.30	
	08	Female	37.25 ± 0.39	0.137	36.92	37.57	36.70	37.80	
S- Shape	07	Male	30.30 ± 0.14	0.053	30.17	30.43	30.10	30.50	
	06	Female	30.87 ± 0.58	0.239	30.25	31.48	30.40	31.80	
Crook	01	Male	27.50	.	.	.	27.50	27.50	
	03	Female	28.20 ± 0.17	0.100	27.77	28.63	28.10	28.40	
Total	150	Male	30.69 ± 3.42	0.279	30.14	31.25	25.40	37.30	
	150	Female	29.92 ± 3.32	0.271	29.38	30.46	24.20	37.80	

[Table/Fig-7]: Co-relation of antero-posterior length in different shapes of soft palate with gender
(n = number, mm = millimeter, Std= Standard, p= Probability value)

Shape	n	Gender	Mean (mm) ± Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum (mm)	Maximum (mm)	Obtained p-value
					Lower Bound	Upper Bound			
Leaf	35	Male	10.12 ± 0.37	0.063	09.1	10.25	08.80	11.20	<0.001 Highly Significant (p<0.05) For both Males & Females
	51	Female	10.18 ± 0.30	0.041	10.10	10.26	09.50	11.50	
Rat- Tail	36	Male	09.84 ± 0.30	0.049	09.74	09.94	08.90	10.40	
	25	Female	09.81 ± 0.54	0.108	09.58	10.03	08.30	10.60	
Butt like	59	Male	12.47 ± 0.79	0.103	12.26	12.67	10.10	14.80	
	57	Female	12.53 ± 0.54	0.072	12.39	12.68	11.10	14.10	
Straight Line	12	Male	06.71 ± 0.25	0.073	06.55	06.87	06.20	07.20	
	08	Female	06.76 ± 0.47	0.167	06.37	07.16	06.10	07.30	
S- Shape	07	Male	09.54 ± 0.17	0.065	09.38	09.70	09.30	09.70	
	06	Female	09.75 ± 0.10	0.043	09.64	09.86	09.60	09.90	
Crook	01	Male	08.20	.	.	.	08.20	08.20	
	03	Female	08.37 ± 0.15	0.088	07.99	08.75	08.20	08.50	
Total	150	Male	10.67 ± 1.78	0.146	10.38	10.95	06.20	14.80	
	150	Female	10.78 ± 1.64	0.134	10.51	11.04	06.10	14.10	

[Table/Fig-8]: Co-relation of supero-inferior length in different shapes of soft palate with gender
(n = number, mm = millimeter, Std= Standard, p= Probability value)

Length	n	Minimum (mm)	Maximum (mm)	Mean (mm) ± Std. Deviation
Antero-posterior	300	24.20	37.80	30.31 ± 3.39
Supero-inferior	300	06.10	14.80	10.72 ± 1.71

[Table/Fig-9]: Distribution according to the total length of soft palate
(n = number, mm = millimeter, Std= Standard)

the mean supero-inferior length of soft palate in males (10.67±1.78 mm) was less than females (10.78±1.64 mm), which was statistically not significant (p>0.05). These values were statistically analysed by using independent t-test [Table/Fig-10].

It was noted that Karl Pearson's Co-relation Coefficient value when applied between dimensions and different age groups, it was 0.016 and 0.011 respectively for antero-posterior and supero-inferior length. The p-values were statistically not significant (p>0.05) [Table/Fig-11].

Length	Gender	n	Minimum (mm)	Maximum (mm)	Mean (mm) ± Std. Deviation	Obtained p value
Antero-posterior	Male	150	25.40	37.30	30.69 ± 3.42	0.048 Significant (p<0.05)
	Female	150	24.20	37.80	29.92 ± 3.32	
Supero-inferior	Male	150	06.20	14.80	10.67 ± 1.78	0.574 Not Significant (p<0.05)
	Female	150	06.10	14.10	10.78 ± 1.64	

[Table/Fig-10]: Co-relation of total length with gender
(n = number, mm = millimeter, Std= Standard)

Length	n	KPCC (> 0.6)	p-value (p<0.05)	Significance
Antero-posterior	300	- 0.016	0.781	Not Significant
Supero-inferior	300	0.011	0.849	Not Significant

[Table/Fig-11]: Karl Pearson's Co-relation Coefficient (KPCC) with age and morphology of soft palate
(n = number, p= Probability value)

DISCUSSION

Soft palate is formed by interweaving of muscles: tensor veli palatini, levator veli palatini, palatoglossus and palate-pharyngeus [1,2,10]. It plays a significant role in important functions of head and neck region. Soft palate can be studied on lateral or sagittal sections of conventional radiographs and advanced imaging. CT scan is an important and reliable tool for morphometric analysis of soft palate [7,8].

In the present study, the 'Butt' like shape of soft palate was the most frequent type (38.7%) and 'Leaf' type (28.7%) was the second common type. Various studies on lateral cephalogram have put forward 'Leaf' type as the most commonest [3,5,6,13]. This may be due to population related trait and study sample size. With intersex difference in the soft palate, we observed that the percentage of butt-like shape was more or less equal in males (19.7%) and females (19%) which was statistically not significant (p>0.05). Our result did not simulate with the studies of Kumar D et al, Guttal K et al., You M et al., and Kaur S et al., wherein the Leaf type was equally common in males and females [3,5,6,13], but Rat type was the most common type in the study of Praveen B. et al., [11].

The growth of soft palate takes place in antero-posterior and supero-inferior directions. In the early years of life the growth is rapid. The growth curve takes place by the age of 1.5 to 2 years whereas by the age of 4 to 5 years the upward growth ceases [1]. In our study, the age and the morphology of soft palate co-relation was statistically not significant (p>0.05) which proves that there is no significant relationship between age and growth of soft palate. We noted that the overall mean of antero-posterior length (30.31±3.39 mm) was more than the supero-inferior length (10.72±1.71 mm) of soft palate.

In our study, the co-relation of gender with morphology of soft palate gave surprising results. The co-relation of gender with different shape of soft palate was statistically not significant (p>0.05). The co-relation of antero-posterior length and supero-inferior length in different shapes of soft palate was statistically highly significant (p<0.001). The overall mean of antero-posterior length was more in males (30.69±3.42 mm) than females (29.92±3.32 mm), which was statistically significant (p<0.05). But, the overall mean of supero-inferior length was less in males (10.67±1.78 mm) as compared with females (10.78±1.64 mm), which was statistically not significant (p>0.05). These type of observation did not match with the existing studies [3,5,6,11].

The results of our study indicates that soft palate is an important structure in velo-pharyngeal closure and provides information for diagnosis, prognosis and treatment in individuals with cleft palate and in obstructive sleep apnoea syndrome.

CONCLUSION

The morphometric analysis of soft palate on CT scan has helped us to understand the multiplicity of velar morphology. Our study may help as a reference for research pertaining to cleft palate/ velo-pharyngeal closure and in obstructive sleep apnoea syndrome.

The results may differ geographically and depending on the oro-pharyngeal structure.

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