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Variation in Morphology of Soft Palate Using Cone-Beam Computed Tomography in Sakaka Population

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ABSTRACT

Objective: The aim of the present study was to investigate the variation in morphology of soft palate in age groups and gender using CBCT in Sakaka population.

Study design: The study sample consisted of 240 CBCT scans aged between 15 and 45 years. The velar morphology on CBCT was examined and grouped into six types. The results obtained were subjected to statistical analysis to find out the association between variants of the soft palate with gender and different age groups.

Results: The most frequent type of soft palate was Rat tail shaped. (46.25%) followed by Leaf shape, 18.75% Butt shape, 13.33% and Handle shape, 10%. S-shape7.5% and Crook shape, was 4.1%. There was no significant difference between Males and Females.

Conclusions: The knowledge of a varied spectrum of velar morphology and the variants of the soft palate assist in the better understanding of the velopharyngeal closure and craniofacial anomalies.

Keywords: Soft Palate, Morphology, cone -beam computed tomography.

INTRODUCTION

The posterior fibro-muscular part of the palate which is attached to the hard palate is called soft palate [(1).] The palate is formed by the fusion of three components, namely two palatal processes and the primitive palate, which is formed by the front nasal process. At a later stage, the mesoderm in the palate undergoes intra-membranous ossification to form the hard palate [(2)]. However, the ossification does not extend into the most posterior portion, which remains as the soft palate.

Soft palate isolates the mouth from oropharynx during swallowing so that breathing is unaffected, the quality of voice can be modified and consonant can be correctly pronounced by the closure of the pharyngeal isthmus [(2).]

There have been various studies carried out showing variation in morphological patterns of soft palate. All the studies were carried out using lateral cephalogram. You et al. observed the image of the velum on lateral cephalograms and classified them into six morphological types (Type 1: leaf shaped; Type 2: rat tail; Type 3: butt like; Type 4: straight line; Type 5: S-shaped and Type 6: crook shaped) [(3)].

Pepin etal. found that the "hooked or S-shaped" appearance of the soft palate in awake patients indicated a high risk of the obstructive sleep apnoea syndrome [(4).]

Recent advances in radio diagnostic technique like CBCT (Cone Beam Computed Tomography) have allowed its commercial production and practical application in today's patient care and dental education environment [(5).] It has added advantages over other radio diagnostic techniques as it gives three-dimensional view of an object, correct identification of landmarks as compared to lateral cephalogram which gives two-dimensional view of an object [(6).] The linear measurements that were made from CBCT images were not significantly different from the actual direct measurements of anatomic structures in the dento-maxillofacial area [(7).]

According to our knowledge, no studies have been done to determine the varied soft palate morphology and configuration using CBCT.

Objective

The aim of the present study was to investigate the variation in morphology of soft palate in different age and gender groups, and to examine its association with, age groups and gender using CBCT in Sakaka population.

MATERIALS AND METHODS

A retrospective study was conducted at department of Oral Radiology of our institute. Two hundred and Forty CBCT scans of healthy individuals within the age range of 15-45 years were retrospectively selected from the daily outpatients visited the department from January 2017 to March 2018. Patients below 15 years and above 45 years of age and scans of patients showing cleft palate, soft palate syndromes and fractures of the head and neck were excluded.

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240 scanned full volume CBCT images recorded by digital radiographic machine (SCANORA 3DX,) S9300, with a tube potential of 90 kV, a tube current of 5 mA, Voxel size of 300µm and an exposure time of 11.30 meter/second were included. All the scans were taken with the patients seating upright in a natural head position and were instructed to contact their molars and breathe through their nose, so as to allow the same observation of the mobile sites of the soft palate and the upper airway.

All the scans were analysed and categorized into six types according to the soft palate morphology by an oral and maxillofacial radiologist.

The measurements were carried out for each digital scan using On Demand software, twice by the same examiner, and the obtained mean values were considered.

RESULTS

Statistical analyses included both descriptive and inferential methods. The data was analyzed by using statistical software SPSS version 20(chingo.inc) Continuous variables were expressed as mean ± standard deviation while the results on categorical measurements were presented in numbers (%). The Pearson's Chi-Square test was used to observe the association of sex with types of soft palate. One-way analysis of variance (ANOVA) was carried out to identify the significance of mean differences; in morphological variants among different age groups, types of the soft palate, and in different types of morphological soft palate among various age groups. The probability value $p \leq 0.05$ was considered as significant while $p \leq 0.001$ was considered as highly significant.

In this cross-sectional study, 240 subjects that included, 144 males (96.4%) and 96 females (94.4%) were studied for evaluation of the morphological variants and types of soft palate observed in CBCT images.

Table I showed that the sex was negatively associated significantly with morphological types of soft palate.

The rat tail shape was most common (111, 46.25%) in subjects, was recognized in 54 (37.5%) females and in 57 (59.37%) males. The second common type of soft palate was Leaf shape (45, 18.75%) was reported in 35 (24.30%) males and in 10 (10.41%) females and followed by Butt shape (32, 13.33%) which was noted in 22 (9.16%) males and in 10 (4.16%) females.

A new dimension was added to morphological types of soft palate in Sakaka population was the handle shape (24, 10.0%) which was observed in 16 (11.11%) males and in 8 (8.33%) females. The least common type of soft palate was crook shape (10, 4.1%) which was obtained in each 7 (4.86%) males and in 3 (3.12%) females. These differences in the morphological types of soft palate between sexes were statistically insignificant ($p>0.05$). Moreover, it was inference statistically that sex wasn't the significant factor that impacted the shapes of soft palate. Thereby, concluding that sex determination cannot be considered with respect to variation in shapes of soft palate.

Leaf shape and butt shape identified in all age groups, are presented in Table II. Crook shape wasn't recognized in age groups 6 (41-45) The new dimension to types of soft palate was handle shape was absent in group 6 (41-45 year).

Rat tail shape (type 2) was the most prevalent type in all the age groups and followed by butt shape. The statistical agreement by using one-way analysis of variance (ANOVA) showed that the mean differences among all the six age groups for morphological types were highly significant, which justify that types of soft palate, can be determined according to the age.

Table 1: Distribution and association of types of soft palate with sex

Sex	Shape of soft palate						Total
	Leaf shape	***Rat tail shape***	***S-shape***	***Butt shape***	***Crook shape***	***Handle shape***	
Male	35 24.30%	54 37.5%	10 6.9%	22 15.27%	7 4.86%	16 11.11%	**144** **99.94%**
Female	10 10.41%	57 59.3%	8 8.3%	10 10.41%	3 3.12%	8 8.3%	**96** **99.84%**
Total	**45** **18.75%**	**111** **46.25%**	**18** **7.5%**	**32** **13.33%**	**10** **4.1%**	**24** **10%**	**240** **99.02%**
p-value	$\chi^2_5 = 9.19^{\otimes}$; ***p>0.05 (Insignificant)***						

$^{\otimes}$ The association is not significant at 5 degrees of freedom at the 0.05 levels of significance

Table 2:Distribution and association of Types of Soft palate with age

Age groups	SOFT PALATE						Total	Chi square test	
	Leaf shaped	Rat shaped	S -shaped	Butt Shape	Crooke shape	Handle shape		Test value	P-value
15-20 years	8	20	3	3	1	5	40	11.946[a]	0.987
21-25 years	17	35	7	10	4	9	82		
26-30 years	7	17	2	5	3	4	38		
31-35 years	5	16	2	6	1	3	33		
36-40 years	3	9	3	4	1	3	23		
41-45 years	5	14	1	4	0	0	24		
Total	45	111	18	32	10	24	240		

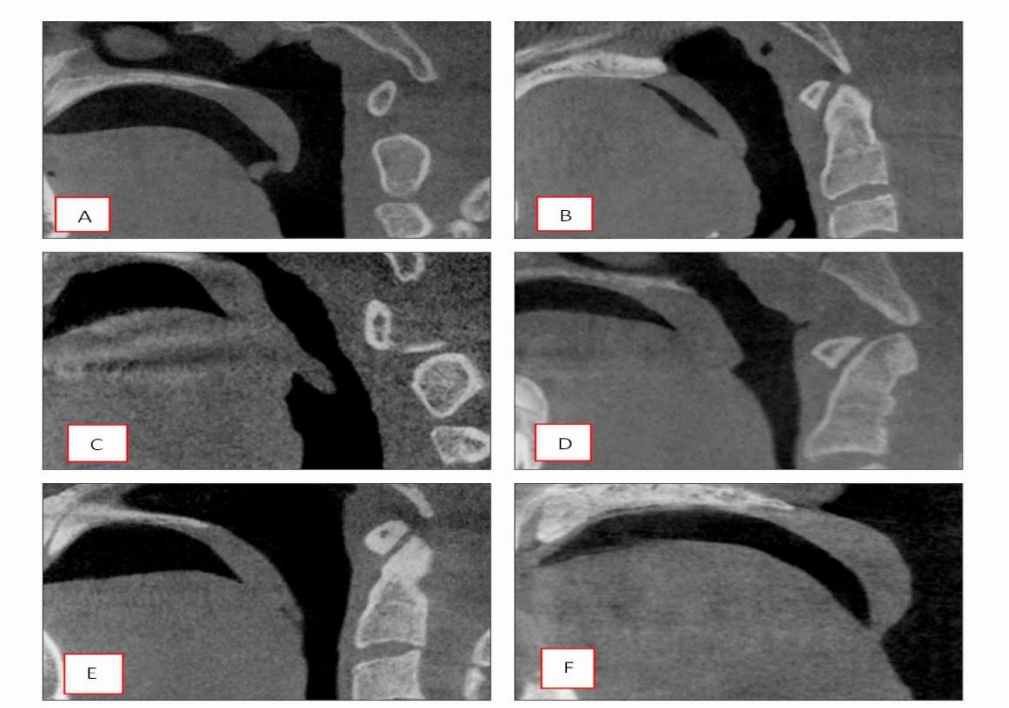

Figure1: Various velar morphologies:
Various velar morphologies were seen on Cone Bean Computed Tomography. A. Type 1 "leaf-shaped" soft palate, B. Type 2 "rat-tail-shaped" soft palate, C. Type 3 "S-shaped" soft palate, D. Type 4 "butt-like" soft palate, E. Type 5 "crook-shaped" soft palate, and F. Type 6 "handle-shaped" soft palate.

DISCUSSION

The recent Advanced technique for evaluating pharyngeal and velar morphology is cone Beam Computed Tomography analysis. It provides a good assessment of the soft-tissue elements that define the soft palate and its surrounding structures [(5)].

In the present study, Rat Tail shaped soft palate was the most frequent type (46.25% cases), noted in our studied samples of Sakaka population, while according to ***You et al.***[3] and **Verma *et al*.** the common type found was leaf shaped in north Indian sub population [(1).]

Handle shaped was a new velar morphology observed in 10.0% cases and was not found in groups 6 using CBCT in Sakaka population. However, according to **Verma *et al.*** linear shape was found in

North Indian subpopulation using lateral cephalogram which was not remarked in our study samples[1].

S-shaped soft palate was seen in 7.5% of the cases in the present study, while it was observed in 3.5% of the cases in the study of You et al[3] and in 1.5% of the cases in **Guttal *et al***. so chances of having velopharyngeal incompetency is more in Sakaka population [8].

Moreover, the present study highlighted the variable appearances of the soft palate on CBCT with rat tail shape as a commonest velar morphology.
The statistical findings of pharyngeal morphology in this study might help in a better understanding of velopharyngeal closure and etiology of the obstructive sleep apnoea syndrome.

CONCLUSION

The morphology of the soft palate can be divided into six types according to their features according to their Cone Beam Computed Tomography, in which Handle shape was the new type found. This classification can help us to better understand the diversity of the velar morphology in the median sagittal plane. We also concluded that age of the individual can be determined by measuring velar length and velar width.

In addition, these findings can be used for the research of velopharyngeal closure in cleft palate individuals and for aetiological research of obstructive sleep apnea syndrome (OSAS) and other conditions as references. Further studies should be carried out to justify the results taking more sample size.

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