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Evaluation of palatal rugae pattern in different sagittal skeletal relationships in orthodontic patients

Faezeh Heydari[1], Hemmat Gholinia[2], Reza Ghorbanipour[3*]

1. Dental Student, Student Research Committee, Babol University of Medical Sciences, Babol, Iran.
2. MSc in Statistics, Health Research Institute, Babol University of Medical Sciences, Babol, Iran.
3. Assistant Professor, Dental Materials Research Center, Health Research Institute, Babol University of Medical Sciences, Babol, Iran.

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ABSTRACT

Introduction: Palatal rugae is a collection of mucosal folds in front of the palatal and is unique to each individual. Rugae have been studied for various purposes. This research investigates the pattern of palatal rugae with different skeletal relationships in the sagittal dimension in a group of the Iranian population.

Materials & Methods: A cross-sectional study was examined on 135 pre-orthodontic dental casts. The patients were grouped as Class I, Class II, and Class III according to the Nasion -A to Nasion -B angle (ANB) 45 patients in each group. Palatal rugae were recorded based on length, orientation, and pattern in each group, then compared. Data were analyzed by Chi-square, ANOVA, and Tukey post hoc test. In this study $p < 0.05$ was considered significant.

Results: The mean number of total rugae was significantly different among groups (p=0.02). Cl III malocclusion had less number of rugae in comparison to other groups (p=0.03). The number of straight pattern was significantly different between groups, (p=0.04) and Cl I malocclusion had more straight pattern than other groups.

Conclusion: This study showed some differences in the palatal rugae pattern between different classes of malocclusion according to Angle's classificatin. In addition, orientation of some rugae were also found to be significantly different between malocclusion groups.

Keywords: Malocclusion, Palate, Orthodontics

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* **Corresponding Author:** Reza Ghorbanipour, Department of Orthodontics, Faculty of Dentistry, Babol University of Medical Sciences, Babol, Iran.
Tel: +981132291408
E-mail: dr_ghorbanipour@yahoo.com

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Introduction

The palatal rugae are mucosal folds in front of the palatal mucosa, behind the incisive papilla. Palatal rugae are widely found in mammals, but their biological significance is little known. In the human fetus, rugae are relatively prominent, and at the end of intrauterine life, its pattern becomes more regular, so that the posterior patterns disappear and the anterior patterns become significantly more prominent and compact. [1-5]

Developmentally, the palatal rugae are made up of hard connective tissue covering the bone in the third month of embryonic life. The first rugae in human embryos are 32 mm long and stand out from the incisive papilla. Some habits, such as finger sucking, constant pressure from orthodontics or dentures, may cause localized changes in the palatal rugae. However, their quality, such as shape and direction, is stable during life. Rugae have been studied for various purposes such as orthodontics, forensics, anthropology, anatomy, genetics, and prosthetics. They are compared to fingerprints because of their stability. [6-8]

According to Sassouni, no two palates are the same. They are also considered to remain stable throughout life, though there is some controversy. [9-11] Their stability is related to the anatomical position of the oral cavity. Rugae can withstand fire and damage due to the protection prepared by lips, cheeks, tongue, buccal fat pad, and teeth. The study of different types of palatal rugae is called palatal rogoscopy. The rugae palatal pattern is unique to each human, however, they are relatively similar in tribes and genders. So it is suggested to use this similarity in the population and identify gender in forensic medicine. [12-18] Studies on the twins have shown that rugae patterns have a genetic basis. [7] Early detection of malocclusion can lead to an acceptable prognosis with minimal orthodontic and surgical interventions. This reduces the severity of skeletal problems and the cost of treatment. [12, 19-22] Malocclusion causes cosmetic problems and functional disorders. It may have a negative effect on a person's mental health in the long term. [2] Several factors influence Ruga's development, inheritance, and environment. [23] Since teeth and anatomy palatal rugae are created in intrauterine life. [16] It can be said that the rugae palatal patterns develop very early in life and their development and pattern are strongly influenced by genetic factors. It can also be said that the correlation between palatal rugae patterns and skeletal relationships in the sagittal dimension may be helpful and predictive for dentofacial anomalies. Since there is no study to determine this pattern in the Iranian race with different skeletal relationships, we aimed to investigate the pattern of palatal rugae with different skeletal relationships in the sagittal dimension in a group of the Iranian population.

Materials & Methods

This study was approved by the Ethics Committee of Babol University of Medical Sciences, Babol, Iran (with the code of IR.MUBABOL.REC.1399.167). In this cross-sectional study was performed on the pre-orthodontic dental casts. According to the previous study, the sample size of the study was considered as 135. [2] Patients aged 18-25 years. They were divided into three groups of skeletal classes I, II, and III. Samples were collected from the orthodontic department of Babol Dental School. Data were collected from the files and casts. Patients with high-quality dental casts that had a well-recorded rugae pattern and molar-incisor relationships. Individuals with complete dentition and normal vertical growth pattern (FMA = 25±5 °) were included in the study. Patients with a history of orthodontic treatment, cleft lip and palate, dental and craniofacial abnormalities, head and neck trauma, tooth extraction, palate surgery, bone and soft tissue prominence, fetal problems, active lesions, deformity, scar, and oral habits such as finger sucking, asymmetry as well as non-recognizable rugae pattern were excluded. The determination of malocclusion classification was done using ANB angle. ANB angle between 0-4 degrees was classified in skeletal class I, more than 4 degrees was classified in skeletal class II, and the angle less than 0 degrees was categorized in skeletal class III. Each malocclusion group was equal in number. The palatal pattern was determined using a sharp graphite pencil in sufficient light (Figure 1).

The number of palatal rugae was recorded based on the orientation, shape, pattern on both sides, and total in each group. First, Based on the length of the rugae, it was divided into three categories: 1- Primary rugae: Equal or more than 5mm,2- Secondary rugae: between 3 to 5 mm, 3- Fragmented rugae: less than 3mm. [9] A digital caliper with an

accuracy of 0.1 mm was used to measure the length. Then, It was divided into three categories based on orientation according to Hauser et al method: 1-Posterior orientation 2- Anterior orientation 3-Horizontal orientation. [3]

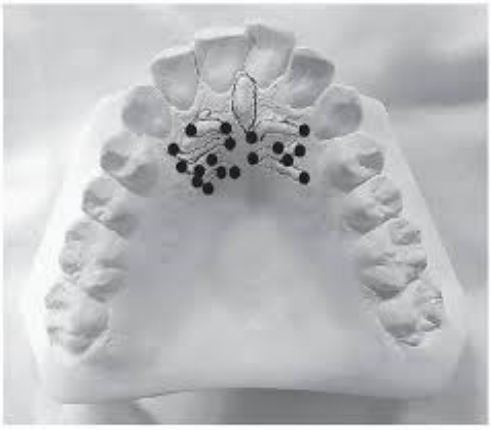

Figure 1. Tracing the rugae on dental plaster casts

The number of rugae patterns was recorded according to the Hauser et al 's category. [3]

1-Cyclic: Specific continuous loop straight: They appear directly from their origin to the end of the rugae

2- Wavy: Slight curvature

3- Curve: Crescent with a slight curve

4- Irregular: Rugae's broken and irregular pattern.

5-Island: A circular rugae showing the formation of a distinct continuous ring at the end.

6- Unification: Two rugae connected at the origin or end which is divided to two category according to Kapoor et al method. [6]

1. Divergent: with the same origin that diverges quickly
2. Convergence: Rugae with different origins that join together

All data were analyzed using SPSS software version 20. ANOVA and Tukey's post hoc test was used to compare the groups. Mean and standard deviation was calculated for the length of the palatal rugae. The orientation and number of the palatal pattern in the three groups were compared using the Chi-square test.

25 dental casts were re-evaluated 4 months later by the lead researcher. The results showed that no error was made by the researcher (correlation coefficient> 0.99). In this study, $p<0.05$ was considered significant.

Results

In the current study, the average number of primary, secondary and fragmentary palatal rugae on the right and left sides and the total number were compared (Table1). The mean number of primary rugae on the right side was significant between the groups (P=0.006). Post hoc test also showed that this significant difference was due to the difference between Classes I and III (P=0.005).

The mean number of total rugae was significantly different between groups (P=0.02). Cl III malocclusion had less number of rugae in comparison to other groups (p=0.03).

Wavy and straight types were the most common form of rugae in all skeletal groups. The straight pattern was significantly different between groups, (P=0.04) and Class I had more straight pattern than other groups (P=0.04) (Table2).

The most common type of orientation was anterior. There was more anterior direction of rugae in Cl II malocclusion (P=0.005). Horizontal direction in Cl III was significantly more than other groups (p=0.005) (Table3).

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Table1. The average of palatal rugae (based on length in mm) between skeletal classifications

		Class I Mean±(SD)	Class II Mean ±(SD)	Class III Mean ±(SD)	P- value
Primary	Right	3.60± 0.78	3.42± 0.94	3.02± 0.86	**0.006***
	Left	3.31± 0.87	3.53± 0.84	3.33± 0.70	0.36
	Total	6.91±1.36	6.96±1.41	6.36± 1.13	0.05
Secondary	Right	0.44±0.75	0.60±1.05	0.64±0.80	0.52
	Left	0.60± 0.88	0.47± 0.62	0.38± 0.61	0.34
	Total	1.04± 1.22	1.07± 1.19	1.02± 1.09	0.98
Fragmentary	Right	0.13± 0.45	0.09± 0.46	0.02± 0.14	0.39
	Left	0.07± 0.25	0.11± 0.38	0.04± 0.29	0.59
	Total	0.20± 0.58	0.20± 0.78	0.07± 0.33	0.47

* P<0.05

Table2. The number of palatal rugae (based on shape) in different skeletal classes

	rugae pattern	Class I	Class II	Class III	P- value
Right	Circular	1	4	3	0.33
	Straight	54	36	31	
	Wavy	72	82	74	
	Curve	23	23	23	
	Convergent	3	3	8	
	Divergent	21	19	27	
	Irregular	3	6	2	
	Island	1	1	1	
Left	Circular	2	5	4	0.21
	Straight	40	39	45	
	Wavy	86	87	48	
	Curve	19	24	19	
	Convergent	3	1	17	
	Divergent	22	16	21	
	Irregular	1	6	2	
	Island	13	0	0	
Total	Circular	3	9	7	**0.04***
	Straight	94	75	76	
	Wavy	158	169	142	
	Curve	42	47	42	
	Convergent	6	7	15	
	Divergent	43	35	48	
	Irregular	4	12	4	
	Island	2	1	1	

* P<0.05

Table3. Rugae orientation between skeletal groups (percentage in each class)

	rugae orientation	CLASSI	CLASSII	CLASSIII	P- value
Right	Anterior	42.2	33.3	37.8	0.06
	Horizontal	26.7	8.9	13.3	
	Posterior	31.1	57.8	48.9	
Left	Anterior	64.4	66.7	75.6	0.13
	Horizontal	22.2	8.9	6.7	
	Posterior	13.3	24.4	17.8	
Total	Anterior	33.3	56.4	23	**0.005***
	Horizontal	31.3	20.5	42.5	
	Posterior	35.4	23.1	34.5	

* P< 0 .05

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In this study, the pattern of palatal rugae in different skeletal relationships in 135 dental casts was investigated. The highest mean number of primary palatal rugae on the right side was in skeletal class I (p-value =0.006). Simultaneously, there was no statistically significant difference in the average number of primary palatal rugae on the left of the studied groups and secondary palatal rugae and fragmentary on both sides of the groups. Our study was new in examining skeletal relationships, so few similar studies have been performed.

A similar study was conducted by Lalitya et al. to investigate the relationship between skeletal malocclusion and rugae palatal patterns and its validity in determining gender in adolescents between 13 to 18 years. A total of 90 children who were equal in each skeletal group (class I, II, III) were included in the study. In this study, there was no clear pattern between rugae and skeletal relations in the sagittal dimension. The female population in class II skeletal malocclusion showed a significant difference in the number of rugae on the right and left sides of the middle raphe. Comparison of the number of rugae in men and women for gender determination did not show any significant difference. According to this study, in rugoscopy, no conclusive evidence was obtained in identifying a specific jaw relationship and gender determination. [20] This study's similarity with our research was the research method while the number of samples in their study was less. In our study, wavy and straight types were the most common form of rugae in all skeletal groups. The straight pattern on the right is significantly different between groups. (P-value = 0.04)

Oral et al. studied the Palatal rugae pattern in individuals with different sagittal skeletal relationships. 105 patients with an age range of 10 -22 years were classified based on ANB into three groups (Class I, Class II, and Class III). They concluded that there was no statistically significant difference in number between primary and secondary rugae as well as on the left side and right side between individuals with different malocclusions. Wavy and curved types were the most in all groups. While in our study the wavy and straight types were the most. Most palatal rugae based on orientation were horizontal. However, in our study, most of the palatal rugae were located in the anterior direction. This difference was due to the different number of participants and race differences in the two studies. According to this study, All rugae patterns were unique to each individual. The authors stated that rugae could be used to identify suspects in forensic investigations by reconstructing the face through skeletal malocclusion. [8]

Azab et al. studied the Rugae palatal pattern in Egyptian adults and its relationship to gender. A total of 108 pre-orthodontic dental casts were examined in this study (54 men, 54 women), who were in the age group of 18-35 years The palatal rugae pattern was determined based on classification. [12] The similarity of this study with our research is that the type of primary rugae showed the highest frequency, also wavy types were the most common rugae patterns and the most common direction was the anterior direction in both studies. In this study, the convergence form of the alliance was more common than the divergent form, while in our study the divergence form of the alliance was more common, Probably due to differences in the race of the participants.

In the present study, the morphology of rugae patterns showed different results because genetic factors, growth, and environment affect them. Variation in rugae patterns among different populations was the result of this study. There were some limitations such as the accuracy of determination of rugae pattern using graphite pencil, so the researchers suggest using 3D scanners instead of pencil in future studies.

Conclusion

This study showed some differences in the palatal rugae pattern between different classes of malocclusion according to Angle's classificatin. In addition, the orientation of some rugae were also found to be significantly different between malocclusion groups.

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Conflicts of Interest

There is no conflict of interest.

Authors' Contribution

The study was designed by Reza Ghorbanipour. The study data were collected by Faezeh Heydari. Analysis and interpretation of data were performed by Hemmat Gholinia.

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