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Palatal Rugae Pattern in Adolescents of Southeastern Kosovo with Class I, II, III Malocclusions According to Angle's Classification

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Abstract

Background: Palatal rugae, or plicae palatinae, are uniquely designed structures, well-formed, asymmetric, irregular mucosal folds suited in the anterior part of the hard palate. Palatoscopy, or the analysis of the palatal rugae pattern, is a simple, low-cost, non-invasive, innovative, and highly sensitive technique that can be successfully used in stomatology. This study aimed to analyze the palatal rugae pattern among an adolescent sample of the Albanian population in Kosovo, to determine the most prevalent palatal rugae pattern in both genders in association with Class I, II, and III malocclusions according to Angle's classification.

Materials and Methods: In this cross-sectional study, a total of 100 adolescents (50 males and 50 females) aged from 12 to 18 were randomly selected from schools in southeastern Kosovo. All subjects were divided into classes of malocclusion according to Angle's classification (Class I, Class II, and Class III). The rugae patterns were classified based on shape, unification, and length according to the Thomas and Kotze classification. In the present study, the palatal rugae pattern in Class I, II and III malocclusions show no significant difference between female and male subjects. In Class I malocclusion, the straight pattern was dominant in female subjects, and the wavy pattern was dominant in male subjects. The straight pattern was dominant in males and females with Class II malocclusion. In Class III malocclusion, the wavy pattern was dominant in female subjects, and the curved pattern was dominant in male subjects. The study showed that male subjects were at slightly higher risk for having Class I malocclusion and slightly lower risk for having Class II and Class III malocclusions than female subjects.

Conclusion: This study provides essential information regarding the dominant palatal rugae pattern among Albanian adolescents of southeastern Kosovo with Class I, II, and III malocclusions according to Angle's classification.**(International Journal of Biomedicine. 2024;14(1):141-147.)**

Keywords: palatoscopy • palatal rugae • malocclusions • Albanian population

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Introduction

Palatal rugae (PR) are unique mucosal elevations seen on the anterior part of the hard palate and are the most stable characteristics in the oral cavity. PR develop in the third month in utero from connective tissue. They are genetically determined, well-formed, asymmetrical, irregular mucosal called "plicae palatinae." [(1)] Physiologically, the relief of the palate helps oral swallowing, speech, tasting food, and sucking of the finger in children.[(2)]

Palatoscopy, or the analysis of the PR pattern, is a simple, low-cost, non-invasive, innovative, and highly sensitive technique that can be successfully used in stomatology. The PR patterns of an individual may be considered to be a useful tool for sex determination and a person's identity.[(3)] Like fingerprints, the PR pattern does not change during life. The PR are protected from traumas, high temperatures, and injuries because of their internal position in the mouth. The Thomas and Kotze classification is used most in identifying palatal patterns, including shape, length, and number of rugae.[(4)]

During orthodontic treatment, some changes occur in the rugae, but the primary morphology of PR remains stable throughout life. Also, events such as finger sucking in childhood or constant pressure from dentures may affect the PR pattern. Due to their location, PR in the molar area are the most stable.[5] After maxillary expansion in orthodontic treatment, the separation distance of the palate could be measured using the distance between the left and right rugae.[6]

Malocclusions fundamentally impact a patient's psychological health; hence, early treatment and prevention of malocclusion may provide an advantage in the duration of treatment outcomes. Since PR are very stable and unique structures, they may serve as an excellent diagnostic appurtenance for predicting Angle's classes of malocclusion early in life to mitigate future dental–skeletal aberrations.[7,8]

Since both malocclusion and PR display hereditary predisposition, many studies have been done to approve the application of the PR pattern as an auxiliary diagnostic method of malocclusion.[9]

According to a study by Alshahrani et al.,[10] wavy and complex rugae are good predictors for class I and III malocclusions. Also, a significant number of wavy rugae in childhood could be a strong predictor for class I malocclusion according to Angle's classification; on the contrary, a study conducted by Ekrem et al.[11] found that there is no significant correlation between rugae pattern and malocclusions among classes I, II, and III. Sudhakar et al.[12] found a correlation between PR and forthcoming growth patterns. A wavy type of rugae was observed in both vertical and horizontal growth patterns. Curved and diverging PR patterns were mainly observed in vertical growth patterns. Thus, the PR pattern may be beneficial in determining the malocclusion early during the growing stage.

Palatoscopy is a simple, low-cost, non-invasive, innovative, and highly sensitive technique that can be successfully used in stomatology. The purpose of this study was to analyze the PR pattern among an adolescent sample of the Albanian population in Kosovo, to determine the most prevalent PR pattern in both genders in association with Class I, II, III malocclusions according to Angle's classification.

Materials and Methods

Study design

The participants for the study were recruited from January 2020 to May 2022 among schools in southeastern Kosovo. In this cross-sectional study, 180 adolescents aged from 12 to 18 were selected. Of 180 subjects, 69 did not fulfill the full inclusion criteria, and 11 plaster models were not poured well. The final group comprised 100 subjects, 50 males and 50 females.

All subjects were divided into classes of malocclusion according to Angle's classification (Class I, Class II, and Class III) without considering the etiology of malocclusion. Malocclusions were evaluated only clinically. Data distribution according to malocclusion group of 50 females: Class I -19, Class II - 24, Class III - 7. Data distribution according to malocclusion group of 50 males: Class I - 22, Class II - 22, and Class III - 6.

The study has compiled a study card with general data on the subjects with dental and medical anamnesis. Palatal impressions were taken with elastomers (C-silicone), and models of the upper jaw were poured into a dental cast of stone.

Selection criteria

Participants without previous orthognathic surgeries, without any congenital abnormalities, without previous orthodontic treatment, and inflammation, trauma, or malformation.

Materials for data collection

- C-silicone impression material (Zhermack)
- Graphite pencil (AIHAO 0.7mm)

Palatal impressions were taken with elastomers (C-silicone), and models of the upper jaw were poured into a dental cast of stone. The shape of the rugae is traced with a graphite pencil under adequate light (Image 1).

Image 1. *The pattern of palatal rugae.*

The rugae patterns were classified based on shape, unification, and length according to the Thomas and Kotze classification.[4]. The rugae were divided into 4 types based on their shape:

1.Wavy – The wavy rugae were serpentine (snake-like) in shape.

2. Straight - The rugae run directly from their origin to termination

3. Circular – Rugae that forms continuous ring

4. Curved - Crescent and curved gently

Unification was defined as when two rugae are joined at their origin or termination. Unification was classified into two categories:

Diverging: Rugae were considered to be diverging if two rugae had the same origin but immediately branched.

Converging: Rugae were considered to be converging if two rugae with different origins joined on their lateral portions.

The rugae were also classified based on their length as:

Primary rugae (>5 mm); Secondary (3-5 mm); Fragmentary (<3 mm).

Statistical analysis was performed using statistical software package SPSS version 23.0 (SPSS Inc, Armonk, NY: IBM Corp). Baseline characteristics were summarized as frequencies and percentages for categorical variables. Differences in attributive series between the patient groups

were tested using Pearson Chi-square / Monte Carlo Sig. (2-sided), Fisher's Exact Test / Monte Carlo Sig (2-sided). Binary logistic regression analysis was performed to predict malocclusion. In all cases, a probability value of $P<0.05$ was considered statistically significant.

Ethical approval for this study was obtained from the Ethical Committee of the University of Pristina (protocol N #02-150115) and the Ethical Committee of the Kosovo Dental Chamber (N #19). All participants provided written informed consent.

Results

Palatal Rugae Patterns in Malocclusions according to Angle's Classification

Class I malocclusion

The results presented in Graph 1 refer to the rugae patterns in the Class I malocclusion group concerning the gender of the subjects. The straight pattern was dominant in female subjects, and the wavy pattern was dominant in male subjects (Table 1). There was no significant difference in the rugae patterns between male and female subjects (Fisher's exact test = 20.223, P=0.215 / Monte Carlo Sig. (2-sided) / 0.204 – 0.225 /). The enter method was used to determine the gender predictive value for Class I malocclusion. The global accuracy of this model in predicting Class I malocclusion was 56.0%. The sensitivity was 0.0%, and the specificity was 100.0% (Table 2). Male subjects were at a slightly higher risk from Class I malocclusion than female subjects (Table 3).

Class II malocclusion

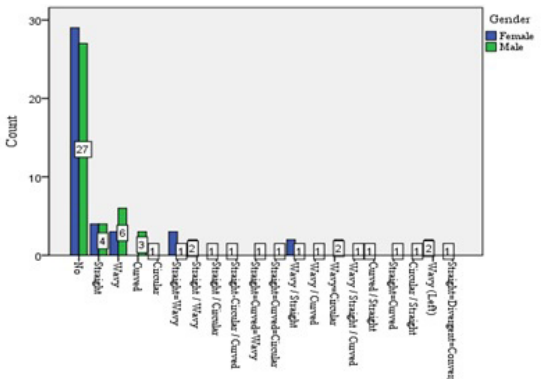
The results shown in Graph 2 refer to the rugae patterns in the Class II malocclusion group concerning the gender of the subjects. The straight pattern was dominant in males and females (Table 4). There was no significant difference in the rugae patterns between male and female subjects (Fisher's exact test = 24.973, P=0.236 / Monte Carlo Sig. (2-sided) / 0.225 - 0.247 /). The enter method was used to determine the gender predictive value for Class II malocclusion. The global accuracy of this model in predicting Class II malocclusion was 54.0%. The sensitivity was 54.0%, and the specificity was 54.0% (Table 5). Male subjects were at a slightly lower risk from Class II malocclusion than female subjects (Table 6).

Class III malocclusion

The results shown in Graph 3 refer to the rugae patterns in the Class III malocclusion group concerning the gender of the subjects. The wavy pattern was dominant in female subjects, and the curved pattern was dominant in male subjects (Table 7). There was no significant difference in the rugae patterns between male and female subjects (Fisher's exact test = 9.529, P=0.610 / Monte Carlo Sig. (2-sided) / 0.598 – 0.623 /). The enter method was used to determine the gender predictive value for Class III malocclusion. The global accuracy of this model in predicting Class III malocclusion was 87.0%. The sensitivity was 0.0%, and the specificity was 100.0% (Table 8). Male subjects were at a slightly lower risk from Class III malocclusion than female subjects (Table 9).

Table 1.
Rugae patterns in the Class I malocclusion group according to Angle's classification / Gender

		Gender		Total
		Female	Male	
No	Count	29	27	56
	%	58.0%	54.0%	56.0%
Straight	Count	4	4	8
	%	8.0%	8.0%	8.0%
Wavy	Count	3	6	9
	%	6.0%	12.0%	9.0%
Curved	Count	0	3	3
	%	0.0%	6.0%	3.0%
Circular	Count	1	0	1
	%	2.0%	0.0%	1.0%
Straight=Wavy	Count	3	1	4
	%	6.0%	2.0%	4.0%
Straight / Wavy	Count	2	0	2
	%	4.0%	0.0%	2.0%
Straight / Circular	Count	1	0	1
	%	2.0%	0.0%	1.0%
Straight-Circular / Curved	Count	1	0	1
	%	2.0%	0.0%	1.0%
Straight=Curved=Wavy	Count	0	1	1
	%	0.0%	2.0%	1.0%
Straight=Curved=Circular	Count	0	1	1
	%	0.0%	2.0%	1.0%
Wavy / Straight	Count	2	1	3
	%	4.0%	2.0%	3.0%
Wavy / Curved	Count	0	1	1
	%	0.0%	2.0%	1.0%
Wavy=Circular	Count	0	2	2
	%	0.0%	4.0%	2.0%
Wavy / Straight / Curved	Count	0	1	1
	%	0.0%	2.0%	1.0%
Curved / Straight	Count	1	0	1
	%	2.0%	0.0%	1.0%
Straight=Curved	Count	0	1	1
	%	0.0%	2.0%	1.0%
Circular / Straight	Count	0	1	1
	%	0.0%	2.0%	1.0%
Wavy (Left)	Count	2	0	2
	%	4.0%	0.0%	2.0%
Straight=Divergent= Convergent (Left)	Count	1	0	1
	%	2.0%	0.0%	1.0%
Total	Count	50	50	100
	%	100.0%	100.0%	100.0%



Graph 1. Class I malocclusion

Table 2.

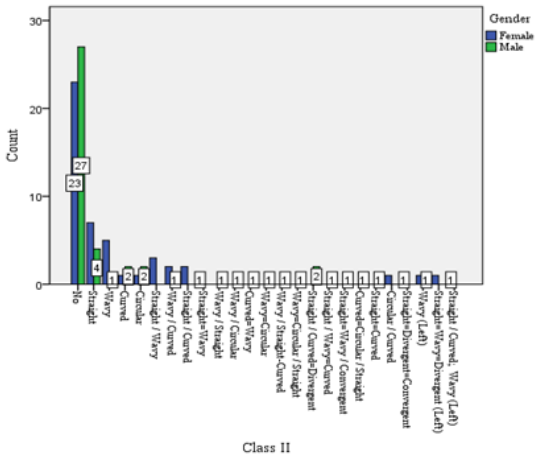
Gender predictive value for Class I malocclusion / Model discrimination

Observed			Predicted		
			Class I		Percentage Correct
			No	Yes	
Step 1	Class I	No	56	0	100.0
		Yes	44	0	.0
	Overall Percentage				56.0
The cut value is .500					

Table 3.

Binary logistic regression analysis for prediction of Class I malocclusion / Gender

		B	S.E.	Wald	df	Sig.	Exp(B)	95% CI for Exp(B)	
								Lower	Upper
Step 1[a]	Gender (1)	.162	.403	.162	1	.687	1.176	.534	2.593
	Constant	.323	.287	1.269	1	.260	.724		
a. Variable entered on step 1: Gender.									



Graph 2. Class II malocclusion

Table 4.

Rugae patterns in the Class II malocclusion group according to Angle's classification / Gender

		Gender		Total
		Female	Male	
No	Count	23	27	50
	%	46.0%	54.0%	50.0%
Straight	Count	7	4	11
	%	14.0%	8.0%	11.0%
Wavy	Count	5	1	6
	%	10.0%	2.0%	6.0%
Curved	Count	1	2	3
	%	2.0%	4.0%	3.0%
Circular	Count	1	2	3
	%	2.0%	4.0%	3.0%
Straight / Wavy	Count	3	0	3
	%	6.0%	0.0%	3.0%
Wavy / Curved	Count	2	1	3
	%	4.0%	2.0%	3.0%
Straight / Curved	Count	2	0	2
	%	4.0%	0.0%	2.0%
Straight=Wavy	Count	1	0	1
	%	2.0%	0.0%	1.0%
Wavy / Straight	Count	0	1	1
	%	0.0%	2.0%	1.0%
Wavy / Circular	Count	0	1	1
	%	0.0%	2.0%	1.0%
Curved=Wavy	Count	0	1	1
	%	0.0%	2.0%	1.0%
Wavy=Circular	Count	0	1	1
	%	0.0%	2.0%	1.0%
Wavy / Straight-Curved	Count	0	1	1
	%	0.0%	2.0%	1.0%
Wavy=Circular / Straight	Count	0	1	1
	%	0.0%	2.0%	1.0%
Straight / Curved=Divergent	Count	0	2	2
	%	0.0%	4.0%	2.0%
Straight / Wavy=Curved	Count	0	1	1
	%	0.0%	2.0%	1.0%
Straight=Wavy / Convergent	Count	0	1	1
	%	0.0%	2.0%	1.0%
Curved=Circular / Straight	Count	0	1	1
	%	0.0%	2.0%	1.0%
Straight=Curved	Count	0	1	1
	%	0.0%	2.0%	1.0%
Circular / Curved	Count	1	0	1
	%	2.0%	0.0%	1.0%
Straight=Divergent= Convergent	Count	1	0	1
	%	2.0%	0.0%	1.0%
Wavy (Left)	Count	1	1	2
	%	2.0%	2.0%	2.0%
Straight=Wavy= Divergent (Left)	Count	1	0	1
	%	2.0%	0.0%	1.0%
Straight / Curved; Wavy (Left)	Count	1	0	1
	%	2.0%	0.0%	1.0%
Total	Count	50	50	100
	%	100.0%	100.0%	100%

Table 5.

Gender predictive value for Class II malocclusion / Model discrimination

Observed			Predicted		
			Class II		Percentage Correct
			No	Yes	
Step 1	Class II	No	27	23	54.0
		Yes	23	27	54.0
	Overall Percentage				54.0

The cut value is .500

Table 6.

Binary logistic regression analysis for prediction of Class II malocclusion / Gender

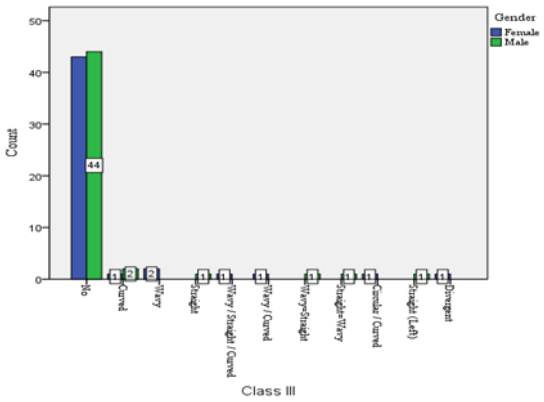
		B	S.E.	Wald	df	Sig.	Exp(B)	95% CI for Exp(B)	
								Lower	Upper
Step 1[a]	Gender (1)	.321	.401	.639	1	.424	.726	.330	1.593
	Constant	.160	.284	.319	1	.572	1.174		

a. Variable entered on step 1: Gender.

Table 7.

Rugae patterns in the Class III malocclusion group according to Angle's classification / Gender

		Gender		Total
		Female	Male	
No	Count	43	44	87
	%	86.0%	88.0%	87.0%
Curved	Count	1	2	3
	%	2.0%	4.0%	3.0%
Wavy	Count	2	0	2
	%	4.0%	0.0%	2.0%
Straight	Count	0	1	1
	%	0.0%	2.0%	1.0%
Wavy / Straight / Curved	Count	1	0	1
	%	2.0%	0.0%	1.0%
Wavy / Curved	Count	1	0	1
	%	2.0%	0.0%	1.0%
Wavy=Straight	Count	0	1	1
	%	0.0%	2.0%	1.0%
Straight=Wavy	Count	0	1	1
	%	0.0%	2.0%	1.0%
Circular / Curved	Count	1	0	1
	%	2.0%	0.0%	1.0%
Straight (Left)	Count	0	1	1
	%	0.0%	2.0%	1.0%
Divergent	Count	1	0	1
	%	2.0%	0.0%	1.0%
Total	Count	50	50	100
	%	100.0%	100.0%	100%



Graph 3. Class III malocclusion

Table 8.

Gender predictive value for Class III malocclusion / Model discrimination

Observed			Predicted		
			Class III		Percentage Correct
			No	Yes	
Step 1	Class III	No	87	0	100.0
		Yes	13	0	.0
	Overall Percentage				87.0

The cut value is .500

Table 9.

Binary logistic regression analysis for prediction of Class III malocclusion / Gender

		B	S.E.	Wald	df	Sig.	Exp(B)	95% CI for Exp(B)	
								Lower	Upper
Step 1[a]	Gender (1)	.177	.596	.088	1	.766	.838	.260	2.695
	Constant	1.815	.408	19.838	1	.000	.163		

a. Variable entered on step 1: Gender.

Discussion

Palatal rugae are considered as the most stable anatomic landmark in the oral cavity. Palatal rugae have unique phenotype characteristics for each person, including their number, shape, and size.[13,14] The palatine rugae have clinical importance as a reference landmark for certain types of dental treatment,[15,16] identification of submucous cleft palate,[17, 18] for forensic identification.[19,20] Studies have demonstrated that no two individual's rugae patterns are alike in their arrangement, and the characteristic rugae pattern of the palate does not change as a result of growth.[20] Differences between genders using the rugae pattern have been studied without any conclusions till now.[21]

A study by Shrestha et al.[22] aimed to find the association between gender and palatal rugae patterns. The study included 100 maxillary plaster casts. The authors concluded that females had more rugae than males, but it was not statistically significant. The prevalent rugae among the young adults of Nepal were wavy shapes followed by curved shapes.

Few studies have been performed to probe the relation of palatal rugae patterns with early diagnostic of malocclusions.[23] During orthodontic movements, Kulkarni and Gore[24] revealed that palatal rugae remain stable, but Deepak V et al.[25] found minimal changes in rugae length.

Shukla et al.[5] concluded that some changes occur during orthodontic treatment, but the morphology of palatal rugae does not change. In addition, the authors concluded that the most reliable points that remain stable over a person's life are the medial and lateral third rugae points. These could be used as reference points to evaluate dental movements.

Shailaja et al., in their study "Assessment of palatal rugae pattern and its significance in orthodontics and forensic odontology,"[6] aimed to compare the shape of rugae and its positional changes before and after rapid maxillary expansion. During the study, the shape of the rugae and the distance between the median points and lateral points of the first and the last two rugae on either side of the mid-palatal raphe were noted and marked. It was found a statistically significant difference in the distance between the medial and lateral points of the first two and last two rugae. The authors concluded that during maxillary expansion, there is stability of palatal rugae with respect to its shape and number but not with respect to its position. Barbieri et al.[19] also found that in the presence of intra-oral changes owing to the use of palatal expanders, the palatine rugae retained the biological and technical requirements for the human identification process.

Juvva et al.,[26] studying 105 subjects, concluded that the most common pattern in three classes of malocclusion was a wavy shape followed by a straight pattern. They found no statistical significance between the palatal rugae patterns and malocclusions.

A study by Qadeer et al.[27] aimed to find the association between malocclusions and palatal rugae patterns. They concluded that palatal rugae, including shape, number, and orientation of rugae, do not have any statistical significance in predicting malocclusions and do not show any significant correlation between palatal rugae and dental arch form. Similar results were obtained by Ekrem et al.,[11] who evaluated the morphological structure of palatal rugae in Turkish orthodontic subjects with different sagittal skeletal malocclusions. Wavy and curved types were the most common types of rugae pattern in all groups (Class I, Class II, Class III malocclusions According to Angle's classification). The number of primary and secondary rugae on the left and right sides was not statistically different among subjects with different skeletal malocclusions. All rugae patterns were unique for each individual.

The present study provides essential information regarding the dominant palatal rugae patterns among Albanian adolescents of southeastern Kosovo with Class I, II, and III malocclusions according to Angle's classification.

Conclusion

In our study, the palatal rugae patterns in Class I, II and III malocclusions show no significant difference between female and male subjects. In Class I malocclusion, the straight pattern was dominant in female subjects, and the wavy pattern was dominant in male subjects. The straight pattern was dominant in males and females with Class II malocclusion. In Class III malocclusion, the wavy pattern was dominant in female subjects, and the curved pattern was dominant in male subjects. The study showed that male subjects are at slightly higher risk for having Class I malocclusion and slightly lower risk for having Class II and Class III malocclusions than female subjects.

Competing Interests

The authors declare that they have no competing interests.

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