https://doi.org/10.29309/TPMJ/2026.33.06.9859 www.theprofesional.com

ORIGINAL ARTICLE

Plica Palatine: A multicentric morphometric odonatological analysis for gender and age groups in Karachi, Pakistan.

Salik Rasool[1], Rabia Arshad[2], Sara Gardezi[3], Hasan Mehdi[4], Nimra Qaiser[5], Bushra Jabeen[6]

ABSTRACT… Objective: To analyze age groups and gender-related rugoscopic morphometric analysis in our population and compare it with other nations. **Study Design:** Cross-Sectional Study. **Setting:** FJDC, DIDC and AIDM. **Period:** March 2024 to Aug 2024. **Methods:** 456 participants with defined criteria were enrolled with convenience sampling. After written informed consent, jaw imprints of the subjects were engaged using Alginate and cast to measure the length and analyze the shape with Thomas classification and pattern of palatine rugae as documented by Kapali. Data was collected on a predesigned form and was further analyzed by SPSS 24 for descriptive and inferential statistics. **Results:** The most common pattern of rugae observed in our study was wavy. Significantly longer primary rugae were seen on the right side in the 41–60-year age group (p=0.02). Fragmentary rugae were significantly longer in females on the both, right (p=0.002) and on the left side (p=0.001) of the palate. When the mean results were compared to the other nations, our population has significantly longer rugae compared to statistics from Saudia, Iran, Lebanon and Sudan in contrast, similar rugae lengths were observed in the Indian Population. **Conclusion:** The palatine rugae are longer with mostly wavy patterns in our population. Furthermore, the 41–60-year-old age group has the longest primary rugae and the female gender has longer fragmentary rugae.

Key words: Forensic Dentistry, Oral Analysis, Palatine Rugae, Rugoscopy.

Article Citation: Rasool S, Arshad R, Gardezi S, Mehdi H, Qaiser N, Jabeen B. Plica Palatine: A multicentric morphometric odonatological analysis for gender and age groups in Karachi, Pakistan. Professional Med J 2026; 33(06):987-992. https://doi.org/10.29309/TPMJ/2026.33.06.9859

INTRODUCTION

Forensic odontology is associated with ameloglyphics assessments, radiographs, rugoscopy, cheiloscopy, and tongue prints as a fundamental biometric tool to aid in the human identification process of deceased individuals in disasters, crimes, or any other mass tragedies. Dental morphological studies help to determine the type of specimen, population affinity, gender, age, stature, race etc. through a comparative biometric recognition system.[1]

Rugoscopy or palato-rugoscopy is the study of palatal rugae for evaluating human specification and identification. Moreover, it relates to the crisscrossing or stitching of the parts of two biological structures during fetal differentiation.[2] The design and placement of palatal rugae patterns are organized between the 12th and 14th weeks of the intrauterine phase, and this alignment lasts for the whole life unless the soft tissue decays afterwards.[3]

Palatoscopy refers to the study of the palate as a whole, whereas rugoscopy focuses on examining the specific patterns of the palate's ridges and grooves, or rugae.[4] The asymmetrical and uneven mucous membrane ridges known as rugae extend laterally from the anterior region of the median palatal raphe and the incisive papilla. In addition to facilitating chewing, these rugae help move food through the oral cavity. Food characteristics and tongue positions in oral cavity as a result of tactile and gustatory receptors.[5] These rugae emerge in humans during the third month of pregnancy, but once produced, they only alter in length as a result of normal growth, staying in the same place for the duration of a person's life. In reality, no illness, chemical reaction, or mechanical injury appears to alter the shape of the palatal rugae, making it a crucial instrument in Odontology for forensics.[6]

Epithelial–mesenchymal interchange is the factor which controls and expands the dimensions of rugae patterns, and with this, some molecules are also identified during growth.[7,8]

1. BDS, MDSc, M.Phil, Cert OPOM, CHPE, Associate Professor Oral Pathology, DIDC, DUHS, Karachi.
2. M.Phil, PhD, Professor Pharmacology, DIDC, DUHS, Karachi.
3. BDS, M.Phil, Assistant Professor Oral Biology, Altamash Institute of Dental Medicine, Karachi.
4. BDS, FCPS, Professor Oral Surgery, Fatima Jinnah Dental College Hospital, Karachi.
5. BDS, Lecturer Pharmacology, Altamash Institute of Dental Medicine, Karachi.
6. BDS, MCPS, MDS, Associate Professor and HOD Prosthodontics, DIDC.

Correspondence Address:
Dr. Salik Rasool
Department of Oral Pathology, DIDC, DUHS, Karachi.
salik.rasool@duhs.edu.pk

Article received on:
22/05/2025
Date of revision:
04/02/2026
Accepted for publication:
07/02/2026

Rugae are useful in recognition methods due to their simplicity, accuracy and cost-effectiveness.[9] Hence, with these features, palatal rugae patterns are one of the specific postmortem proofs. The stability of palatal rugae, similar to fingerprints, makes it a relevant source of human identification. Palatal rugae are unique to each individual and no two patterns are identical in terms of characteristics, including orientation, length, shape, and position. Rugae can withstand decomposition changes for seven days after death and rarely change in shape with age. They reappear after trauma or surgery and are protected by the lips, cheeks, tongue, buccal pad of fat, and teeth in case of fire or forceful trauma. Few factors that can alter the pattern of palatal rugae could be finger sucking in childhood, orthodontic treatment, extraction of adjacent teeth, and surgical palatal repair.[10]

Very little data is available for palate-rugae in the Pakistani population and furthermore, no documented research has been conducted for the rugae length analysis. These factors lead to the design of this study with the objective, of analyzing the age groups and gender-related rugoscopic morphometric analysis in our population and further comparing the results from other populations.

METHODS

For this Cross-Sectional study, IRB approval was taken (letter no: MAR-2024-SUR01 from FJDC scientific and ethical review board, dated 17th March 2024), before starting the study. For sample size, the WHO sample size estimation calculator was used for evaluating the pattern of palatal rugae in a sample of the Pakistani population with the formula, $n = p\ q\ z^2 / d^2$ and a sample size of 456 gave the power of > 80%. With the convenience sampling, samples were collected from Dental patients at FJDC, DIDC and AIDM from March 2024- Aug 2024.

Inclusion criteria comprise of all healthy individuals of both the genders (males and females), between the age of 9-60 years (divided in to three groups; group 1: 9-20 years; group 2: 21-40 years and group 3: 41-60 years) and those who gave consent to the procedure. The individuals with dental and skeletal abnormalities, with a history of infant finger sucking, any palatal surgery or major trauma, individuals with any ongoing orthodontic treatment or with the complains of bruxism and individuals who were not comfortable with the procedure or had a complain of severe gagging or dryness of mouth were excluded from the study.

Finally, after written informed consent, jaw imprints of the subjects were engaged using impression material (alginate) in a pierced tray. After sterilizing the impression, high-power plaster was poured into the impression to obtain the cast (working model) after trimming the cast a number was assigned to it. Rugae pattern and size were documented using a graphite pencil and evaluated under adequate light. The following classification was used for rugae pattern and size. Thomas classification was used for palatal rugae and were divided into 3 groups according to their size.[11] Primary rugae were 5-15mm, Secondary rugae were 3-5mm and Fragmentary rugae were 1-3mm. Shapes of rugae on the palate were logged according to the classification by Kapali.[12] Palatal rugae were divided into 5 groups, including curved (crescent-shaped and curved gently), wavy (slight curve at the origin and cessation of the rugae), straight (they run directly from their origin to closure), circular (rugae forming a ring), unification (rugae with two arms) may be departing or congregating. Diverging means when two arms of rugae begin from the same origin and bifurcate transversely. On the other hand, converging means when two arms of rugae arise from different origins and converge transversely. Data was collected on a predesigned form and was further analyzed by SPSS 24 with mean ± SD for numerical values and percentages for categorical details. Further, using a required statistical test such as chi-square, Independent T-test and one-way ANOVA, significance was calculated and a P-value less than 0.05 was considered significant statistically.

RESULTS

When results were tabulated for 456 samples it was observed that 55.3% were males and 41.7% were females in our study. 60.5% of samples were in the age group of 21-40 years whereas 19.7 % were both from the age group 9-20 years and 41-60 years. The wavy pattern is the most prevalent type

followed by curved and straight on both the sides of palate.

TABLE-I

Demographic details (n=456)

S.no	N	%
Gender		
Male	252	55.3
female	204	44.7
Age		
9-20	90	19.7
21-40	276	60.5
41-60	90	19.7
Shape Rugae Right side		
Curve	108	23.7
Wavy	176	38.6
Straight	87	19.1
Circular	10	2.2
Divergent	43	9.4
Convergent	32	7
Shape Rugae Left side		
Curve	99	21.7
Wavy	188	41.2
Straight	94	20.6
Circular	14	3.1
Divergent	32	7
Convergent	29	6.4
	Mean ±SD	
Size Rugae Right side (mm)		
Primary	11.64±1.80	
Fragmentary	1.53±0.98	
Secondary	4.34±0.91	
Size Rugae left side (mm)		
Primary	11.33±1.65	
Fragmentary	1.54±0.97	
Secondary	4.38±0.97	

On the right side mean primary rugae was 11.64 mm ±1.80, fragmentary1.53mm ±0.98 and secondary 4.34mm ±0.91. On the left side, the primary rugae were 11.33mm ±1.65 long whereas fragmentary and secondary were 1.54mm ±0.97 and 4.38mm ±0.97 respectively. For the shape of the rugae, it was observed that the wavy pattern was most prevalent on the left and right sides of the palate of the males and females and all the age groups with no statistical differences. Significantly longer primary rugae were seen in the 41-60 years group (p=0.02) on the right side of the palate. Furthermore, it was seen that fragmentary rugae were statistically longer in females on the right (p=0.002) as well as on the left (p=0.001) sides of the palate. When the mean results were compared to the other nations where similar data was available, we concluded that our population has significantly longer rugae compared to statistics available from Saudia, Iran, Lebanon and Sudan whereas similar rugae lengths were observed in literature from the Indian Population. Straight patterns were mostly present in samples from Iran and Lebanon. On the other hand, wavy and curved patterns were present more in Saudi, India and Sudan followed by wavy patterns mostly prevalent in our population.

DISCUSSION

Every person has a unique pattern of palatal rugae which makes this feature distinct and highly specific for an individual. Numerous efforts have been undertaken to develop safe methods of human identification that can prevent errors and enable accurate identification.[13] In certain forensic scenarios, identification by DNA, dental records, and fingerprints can have limitations, and in such cases, the palatal rugae pattern of a person could be regarded as a helpful auxiliary tool for identification.[14]

Today, palatal rugae patterns and their configurations are examined using non-invasive techniques like palatal rugoscopy, as well as more intricate, costly, and technique-sensitive methods such as calcorrugoscopy, stereoscopy, and stereophotogrammetry. Among these, using maxillary cast models remains the most cost-effective and straightforward method for studying palatal rugae. Palatal rugae are categorized according to their shape, length, and pattern.[15]

Since Trobo was the first to propose studying palatal rugae in terms of their form and to propose the idea of "Palatal Rugoscopy," in 1932 his classification of Palatal rugae was employed in this investigation for its comprehensiveness, ease of use, and distinctiveness. Like the majority of previous research, we also employed the widely accepted Thomas and Kotze's classification approach to distinguish between the palatal rugae's patterns.

TABLE-II

Age group and Gender-based dimorphism for shape and size of Rugae (n=456)

S. No		9-20 Year n(%)	21-40 Year n(%)	41-60 Year n(%)	P-Value	Male	Female	P-Value
1	**Shape:**							
	Right Side							
	Curve	22(4.8)	63(13.8)	23(5.0)		53(11.6)	55(12.0)	
	Wavy	37(8.1)	112(24.5)	27(5.9)		106(23.2)	70(15.3)	
	Straight	13(2.8)	48(10.5)	26(5.7)		51(11.1)	36(7.8)	NA
	Circular	2(0.4)	7(1.5)	1(0.2)	NA	3(0.6)	7(1.5)	
	Divergent	7(1.5)	29(6.3)	7(1.5)		20(4.3)	23(5.0)	
	Convergent	9(1.9)	17(3.7)	6(1.3)		19(4.1)	13(2.8)	
	Left side							
	Curve	20(4.3)	57(12.5)	22(4.8)		45(9.8)	53(11.6)	
	Wavy	37(8.1)	123(26.9)	28(6.1)		110(24.1)	78(17.1)	
	Straight	15(3.2)	50(10.9)	29(6.3)		57(12.5)	37(8.1)	0.28
	Circular	3(0.6)	7(1.5)	4(0.8)	NA	7(1.5)	7(1.5)	
	Divergent	7(1.5)	21(4.6)	4(0.8)		15(3.2)	17(3.7)	
	Convergent	8(1.7)	18(3.9)	3(0.6)		17(3.7)	12(2.6)	
2	Size (mm):							
	Right side							
	Primary							
	Fragmentary	11.26±1.6	11.64±1.8	12.01±1.8	0.02*	11.42±1.7	11.22±1.58	0.09
	Secondary	1.5±0.99	1.51±0.97	1.62±0.96	0.64	1.4±1.03	1.69±0.89	0.002*
		4.1±1.03	4.4±0.85	4.1±1.03	0.11	4.35±0.85	4.33±0.85	0.81
	Left side							
	Primary	11.11±1.43	11.36±1.66	11.47±1.81	0.2	11.42±1.7	11.22±1.58	0.1
	Fragmentary	1.50±0.97	1.53±0.96	1.62±0.97	0.71	1.42±1.03	1.7±0.85	0.001*
	Secondary	4.31±1.05	4.45±0.87	4.26±1.15	0.28	4.4±1.09	4.36±0.91	0.68

One-way ANOVA, chi-square and independent T-test applied; p value less 0.05 considered significant*, NA: chi-square not applicable due to less cell count

TABLE-III

Length of primary rugae in Pakistani population compared to other nations

Sr No	Nations	Year	Nations	Primary Rugae Size (Mean ±SD)	P-Value	The Most Prevalent Shape of Rugae
1	Pakistan			11.49± 1.4		Wavy
2	Sheikh et al, (24)	2017	Iran	7.84±1.89	0.00*	Straight
3	Malikzedah et al, (21)	2016	Iran	8.97±1.74	0.00*	Straight and wavy
4	Alshammai et al, (10)	2022	Saudia	9.2±2.2	0.00*	Wavy and curved
5	Hardin et al, (25)	2022	India	11.62±2.55	0.34	Wavy and curved
6	Ahmed et al, (26)	2015	Sudan	5.02±1.33	0.00*	Wavy and curved
7	Saddeh et al, (27)	2017	Lebanon	10.37 ± 2.91	0.00*	Linear/straight

This approach is thought to be the most useful. And simpler to use than alternative techniques and is free from the problems associated with intricate patterns that could result in further observer bias.[11]

In the present study, the wavy pattern was found to be the most prevalent shape of palatal rugae followed by curved and straight patterns, indicating a potential pattern consistency across gender and age groups, with no statistically significant differences in rugae shape between the genders. The wavy rugae's high prevalence aligns with the findings of a study by Siraj in Kerala and Bajracharya, who also found no significant differences in the

number and pattern of palatal rugae between males and females.[16,17] However, our results differ from Chatterjee and Khanna, who reported the left-sided- wavy rugae to be more common in males. The convergent type rugae observed predominantly on the right side in our study, contrast with the findings of Chatterjee and Khanna and Saraf, who reported a higher prevalence of convergent rugae in women.[18,19] Additionally, the circular rugae pattern was noted more frequently in males in their studies, which was not observed in our data.

When rugae lengths were analyzed, our study found a statistically significant observation (p=0.02), age 41-60 years age group exhibited longer primary rugae on the right side. The overall rugae length did not differ considerably between gender, which corroborates findings by Yildirim and Malekzadeh.[20,21] However, Dohke and Osato reported longer rugae in females, a discrepancy that suggests potential regional or methodological differences in the study population.[22]

Our findings on Fragmentary rugae revealed significantly longer fragmentary rugae in females, with p-values of 0.002 (right side) and 0.001 (left side) suggesting a potential gender-based dimorphism in fragmentary rugae length. However, the lack of statistically significant differences in other shape and size parameters across genders aligns with findings reported by Chatterjee and Khanna, and Malekzadeh who noted a higher prevalence of fragmentary rugae among females.[18,21] while results from Abdulmajid contradict this observation by suggesting that the gender-based dimorphism in fragmentary rugae length might vary across population or be influenced by sample size and methodology.[23]

Additionally, as statistics have been extensively available in published research, enabled us to equate of our findings with those present on different demographics. Comparing our findings internationally, the mean primary rugae lengths in our population were significantly longer than the population studied in Saudia Arabia, Iran, India, Sudan and Lebanon, but comparable to those reported in Indian samples. The predominance of the wavy pattern in our study mirrors findings from Saudia Arabia, India, and Sudan while the straight pattern dominated in the Iranian and Lebanese populations. The curved pattern though less prevalent in our population, was frequently reported in studies from Saudia Arabia, India and Sudan.[10,21,24,25,26,27]

The large number of our population samples is one of the unique characteristics that sets our study apart from others. We used more than 400 rugae samples for our investigation and that improves the accuracy and dependability of our outcomes. Racial and geographic differences among the populations under study, sample size, and methodological variations among earlier studies may all contribute to the contentious findings of earlier research on the validity of palatal rugoscopy in sex and racial subset differentiation.

While our findings align with several existing studies on palatine rugae morphology and length, notable discrepancies highlight the importance of regional and demographic factors in palatal rugae research. The lack of a standard universally accepted system for the classification of palatal rugae patterns may cause different results. Therefore, further race-specific research using a large sample size and standard classification system is recommended. Further studies with standardized methodologies and larger, diverse samples are needed to explore these variations more comprehensively.

CONCLUSION

The palatine rugae are longer with mostly wavy patterns in our population. Furthermore, the age group of 41-60 years have longer primary rugae and the female gender has longer fragmentary rugae.

Summary independent sample T-test applied, p-value less than 0.05 was considered significant when compared with Pakistani Population.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

SOURCE OF FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

REFERENCES

1. Faheem S, Hirani S, Maqsood S, Shaikh F, Soomro MA, Zaidi SJA. **Palatal Rugoscopy: Individuality and gender differences in a subset of the population of Karachi.** Professional Med J 2021; 28(6):842-47.
2. Bhattacharjee R, Kar AK. **Cheiloscopy: A crucial technique in forensics for personal identification and its admissibility in the Court of Justice.** Morphologie. 2024; 108(360):100701.
3. Jaber M, Varma SR, Hassan M, Hadi K, Khamis A. **Assessment of a lip print (cheiloscopy) patterns and its use for personal identification and crime investigation: A systematic review and Meta-Analysis.** J. Int. Dent. Med Res. 2023; 16(1):331-9.
4. Jindal V, Mahajan A, Mahajan N, Goel A, Kaur R, Puri C. **Rugae pattern determination in periodontitis patients: A descriptive study.** JICDRO. 2016; 8(2):115-9.
5. Pramod JB, Marya A, Sharma V. **Role of forensic odontologist in post mortem person identification.** Dent. res. J. 2012; 9(5):522.
6. Buchtova M. **The development of palatal rugae in the European pine vole, Microtus subterraneus (Arvicolidae, Rodentia).** Folia Zoo. 2003; 52:127-36.
7. Sabarigirinathan C, Vinayagavel K, Meenakshi A, Selvamani C, Sriramaprabu G, Sivasakthikumar S, et al. **Palatal rugae in forensic odontology–a review.** IOSR J Dent Med Sci. 2015; 14(10):83-7.
8. Patil MS, Patil SB, Acharya AB. **Palatine rugae and their significance in clinical dentistry: A review of the literature.** J Am Dent Assoc. 2008; 139:1471-8.
9. Raj Y, Munisekhar MS, Shylaja S, Bhavani SN, Ramanand OV, Reddy S. **Role and Reliability of cheiloscopy, rugoscopy and dactyloscopy in gender identification.** Oral Maxillofac Pathol J. 2024; 15(2); 210-15.
10. Alshammari A, Farook FF, Alyahya L, Alharbi M, Alazaz NN, AlKadi L, et al. **A morphometric analysis of palatal rugae patterns in a Saudi Arabian population.** Cureus. 2022; 14(12):e33058.
11. Thomas C, Kotze T. **The palatal ruga pattern: A new classification.** The Journal of the Dental Association of South Africa. SADJ. 1983; 38(3):153-7.
12. Kapali S, Townsend G, Richards L, Parish T. **Palatal rugae patterns in Australian aborigines and caucasians.** Aust. Dent. J. 1997; 42(2):129-33.
13. Setiadi D, Syukriani YF, Supian S, Oscandar F, Malinda Y, Nugraha A. **Association between direction patterns of palatal rugae and thumbprints: Implications for forensic identification.** J. Dent. Indones. 2019; 26(1):19-25.
14. Huzefa N. **Palatal rugae is a reliable source in forensic dentistry.** IJER. 2024; 1(1):31-3.
15. Nagalaxmi V, Ugrappa S, Ch L, Maloth KN, Kodangal S. **Cheiloscopy, palatoscopy and odontometrics in sex prediction and dis-crimination-a comparative study.** The Open Dentistry Journal. 2015 Jan 6; 8:269.
16. Premakumar P, Azeez M, Sivakumar R, Deepa MS, Siraj SE. **Gender determination using morphological analysis of palatal rugae patterns – A retrospective study.** Online J Health Allied Scs. 2022; 21(1):9.
17. Bajracharya D, Vaidya A, Thapa S, Shrestha S. **Palatal rugae pattern in Nepalese subjects.** OJN. 2013; 3(2):36-9.
18. Chatterjee S, Khanna M. **Dimensional analysis of various rugae patterns in north Indian population subset.** J. Forensic Dent. Sci. 2011; 3(2):86.
19. Saraf A, Bedia S, Indurkar A, Degwekar S, Bhowate R. **Rugae patterns as an adjunct to sex differentiation in forensic identification.** J. Forensic Odonto-stomatol. 2011; 29(1):14.
20. Yıldırım AZ, Ünver S, Kardiyen F, Peker i. **Evaluation of the palatal ruga morphologies of young adult individuals attending a dental school in Turkey.** GUHES. 2024; 6(2):63-72.
21. Malekzadeh AR, Pakshir HR, Ajami S, Pakshir F. **The application of palatal rugae for sex discrimination in forensic medicine in a selected Iranian population.** Iran. J. Med. Sci. 2018; 43(6):612.
22. Dohke M, Osato S. **Morphological study of the palatal rugae in Japanese I. Bilateral differences in the regressive evolution of the palatal rugae.** Japanese Journal of Oral Biology. 1994; 36(2):126-40.
23. Abdulmajid Z, Bugaighis I. **Evaluation of the morphology of palatal rugae in Libyan school children.** J. Dent Res. 2015; 2(3):1-6.
24. Sheikhi M, Zandi M, Ghazizadeh M. **Assessment of palatal rugae pattern for sex and ethnicity identification in an Iranian population.** Dent Res J. 2018; 15:50-6.
25. Hardiya S, Kumar GJ, Vimala Sai M, Rana K, Desai D, Kaur G. **Evaluation of the denture impact on the palatal rugae: Original research.** J Pharm Bioall Sci. 2023; 15: S224-9.
26. Ahmed AA, Hamid A. **Morphological study of palatal RUGAE in a Sudanese population.** Int. J Dent. 2015; Article ID 650648.
27. Saadeh M, Ghafari JG, Haddad RV, Fouad Ayoub F. **Sex prediction from morphometric palatal RUGAE measures.** JFOS. July 2017; 35(1):9-20.

AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Salik Rasool:** Literature search, sample analysis.
2	**Rabia Arshad:** Statistical analysis, write-up.
3	**Sara Gardezi:** Presented idea.
4	**Hasan Mehdi:** Proof read.
5	**Nimra Qaiser:** Technical aspects of data.
6	**Bushra Jabeen:** Literature search.