



3D Morphometric Analysis of Palatal Rugae Pattern and its Association with Gender

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ABSTRACT-

Aim: To determine whether there exists any gender difference in palatal rugae pattern among individuals from west Uttar Pradesh in relation to (a) rugae count (b) measurement (c) shape (d) angulation in both male and female samples of the rugae on either side of mid palatine raphe.

Materials and Method: The study was conducted on a total of 50 adult subjects belonging to western Uttar Pradesh. The samples were randomly selected comprising 25 males and 25 females. 3D scans were performed to record the palate using iTero intra-oral scanner. The data was screened based on the Thomas and Kotze classification (1983) and subjected to adequate statistical assessment.

Results: A total of 278 rugae were screened, with a mean count of 6.25 (SD=0.44) in females and 6.38 (SD=0.65) in males, indicating no significant gender differences. The total number of rugae ranged between 5-8. Among males, 4.2% had 8 rugae. Among females, 75% had 6 rugae, and 25% had a maximum of 7 rugae. The mean count on the right was 3.21 (SD=0.46), on the left was 3.11 (SD=0.32). No significant difference in rugae length or angle was found between genders or sides, except for specific instances noted in the study.

Conclusion: This research sample shows no gender bias in any of the metric or non-metric characteristics of the palatal rugae. The wavy pattern was most common in both the genders. Forwardly placed palatal rugae was most common in both the genders.

Introduction

Palatal rugae are non-identical mucosal elevations seen on the anterior third of the palate. They are placed on each side of the mid-palatine raphe¹ in a transverse orientation. Considering their remarkable durability inside the oral cavity, they are one of the most important identifying instruments in forensic odontology². No two individuals possess the same palate, and these structures are unique³. In forensic science, palatal rugae are highly useful in situations involving fire, natural catastrophes, and extreme disfigurement⁴. Although the two main techniques utilised for this purpose are often dental records and deoxyribonucleic acid (DNA), it is important to understand that they have major limitations. Palatal rugae, on the other hand, are situated in a way that makes them resistant against damage and ensures that they stay intact for the duration of an individual's life⁵. Given that they are keratinized⁶, the palatal rugae are robust and abrasion-

resistant. Our research makes use of the teeth and tongue's ability to shield the palatal rugae from harm.

Each rugae's orientation was evaluated in relation to the mid-palatine raphe (MPR). The direction of a rugae is determined by the angle established by the line between its starting and ending point [Fig.1]. Positive angles are

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Figure 1: Points for measurements of palatal rugae length

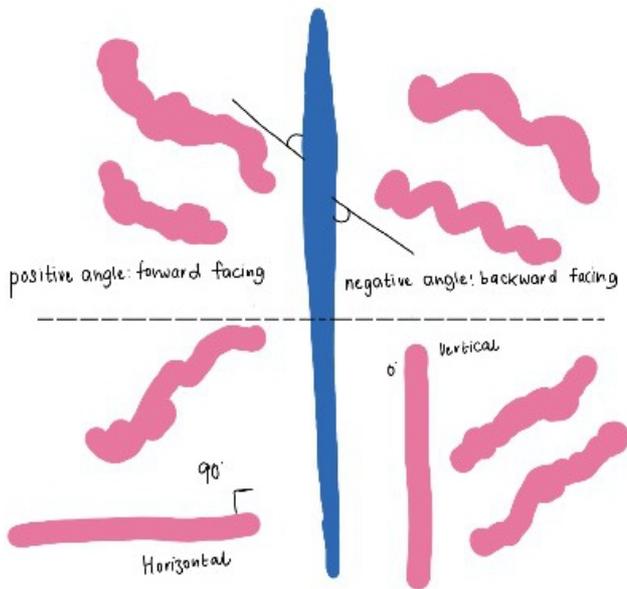


Figure 2: Classification based on the direction of palatal rugae

indicative of forward-running rugae (F), whereas negative angles indicate backward-directed rugae (B). Rugae parallel to the mid-palatal raphe are classified as perpendicular (P), while those having an angle of zero are designated as horizontal (H) [Fig.2]. Each rugae was noted as straight, curved, wavy, circular, divergent, and convergent [Fig.3].

Materials and Methods

Sample Size Calculation

The sample size was calculated using G power software version 3.2.9. In this study, a significance level of 0.05, a power of 95%, and an estimated sample size of 400 were used. The study was approved by the Institutional Ethics Committee (IEC) (reference number SDCRI/IEC/22/09) and followed the principles of the Declaration of Helsinki.

Methodology

The study was conducted on a total of 50 adults belonging to western Uttar Pradesh population. The participants in the research were chosen randomly. For this investigation, pre-orthodontic intraoral scans were used. The iTero intraoral scanner was used to record the palatal pattern. The GOM INSPECT software was utilised to measure the palatal rugae length.

The number of rugae on the right and left sides of the mid palatine raphe was recorded. From anterior to posterior, each rugae on the right was given a number and matching letter, R1, R2, R3, and similarly L1, L2, L3, on the left side. The metric [Fig.4] and non-metric properties of palatal rugae was assessed [Fig.5]. Thomas and Kotze method was used to classify the shape of the palatal rugae.⁷ [Fig.2]

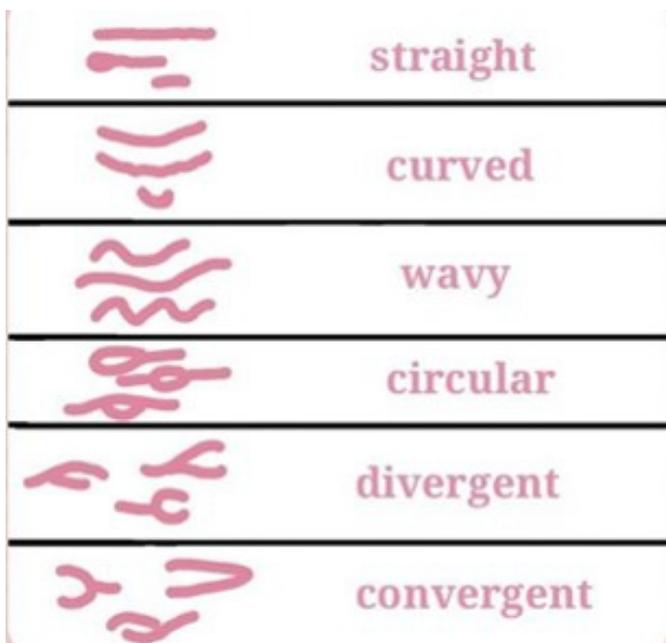


Figure 3: Shape of palatal rugae based on Thomas & Kotze Classification

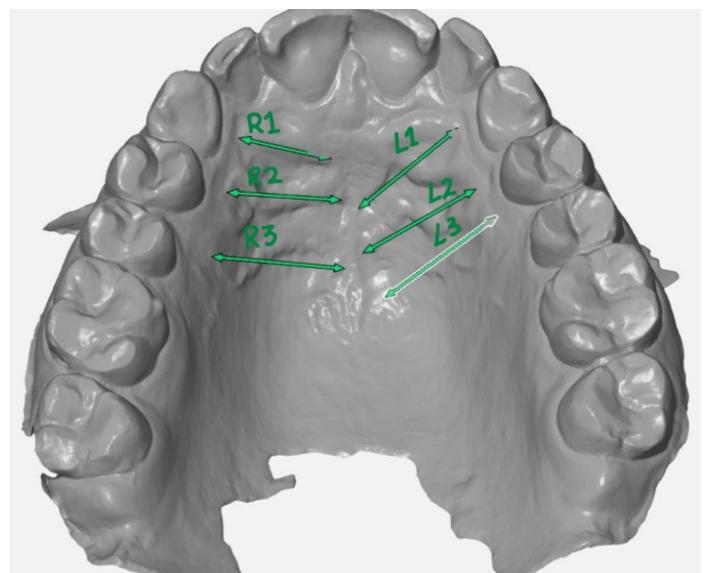


Figure 4

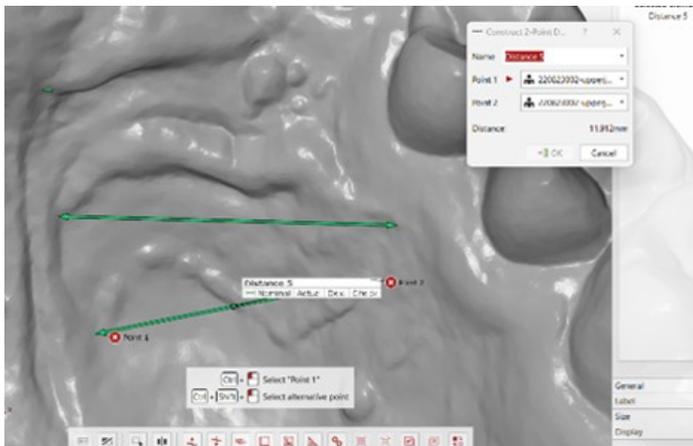


Figure 5

Statistical Analysis:

IBM Corp.'s SPSS Version 21.0 (Armonk, NY) was used to perform statistical analysis on the collected data. The mean values of two samples were compared using the student's t-test, and the significant difference between the two sets of data was examined using the Chi-square test.

Results

Overall Rugae Count

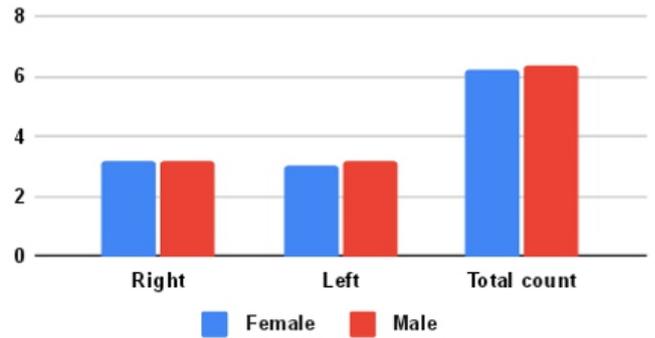
In this study sample, 278 rugae were found in total. In females, the mean rugae count was 6.25 (SD=0.44), whereas in men, it was 6.38 (SD=0.65). There was no gender difference that could be considered statistically significant [Graph 1]

Rugae Count on Right and Left Sides

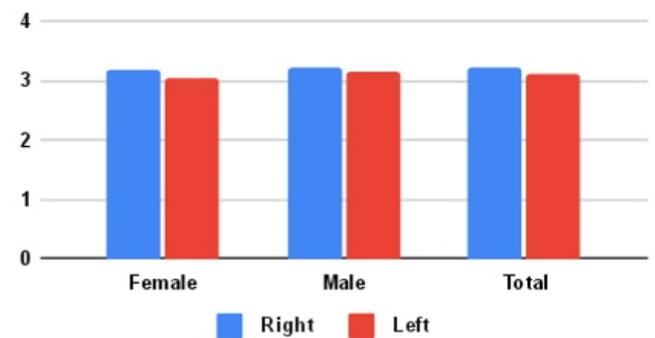
The mean rugae count on the right side was 3.21 (SD=0.46), and on the left side, it was 3.11 (SD=0.32), with no statistical difference between males and females. [Graph 2] The quantitative analysis revealed a total count of rugae ranging from 5 to 8. Among males, one sample had the highest count of 8 rugae, while another sample had the lowest count of 5 rugae both of which were 4.2%. Among females, 75% had the lowest count of 6 rugae, and 25% had a maximum of 7 rugae [Graph 3].

Length of Palatal Rugae

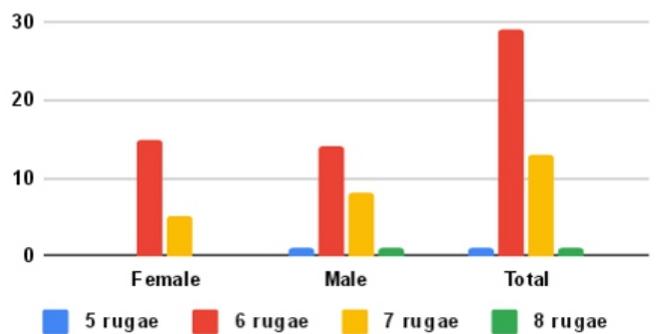
There was no difference in rugae length between the left and right sides of male and female subjects [Graph.4 and Graph.5]. The third rugae had the greatest length, with a mean of 13.85 (SD=1.48) in females and 14.25 (SD=2.45) in males on the left side. The first rugae had a length of 10.21 in both males and females.



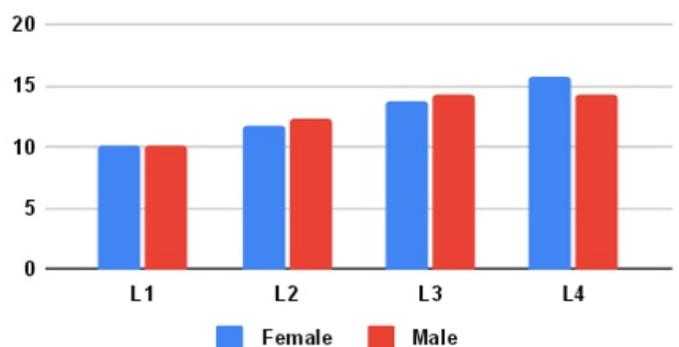
Graph 1: Comparison of mean no of rugae among males and females



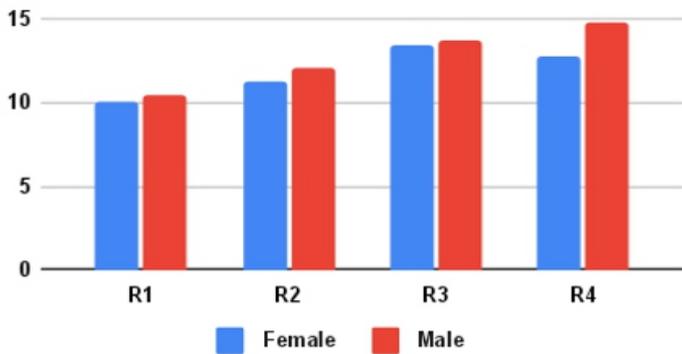
Graph 2: Comparison of mean no of rugae among right and left side



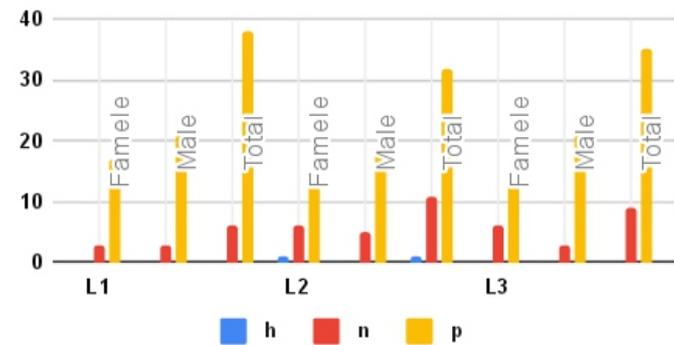
Graph 3: The distribution of rugae count from minimum to maximum in both male and female samples



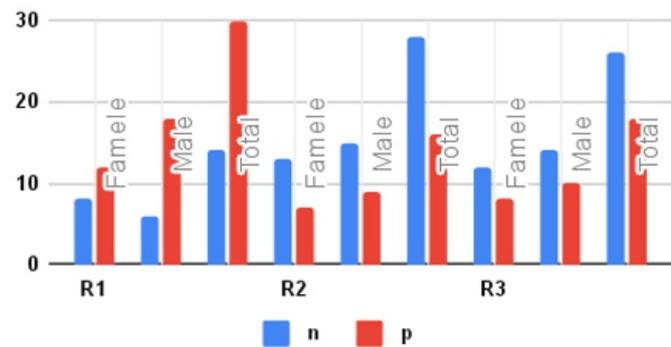
Graph 4: Comparison of rugae length on the left side of male and female subjects



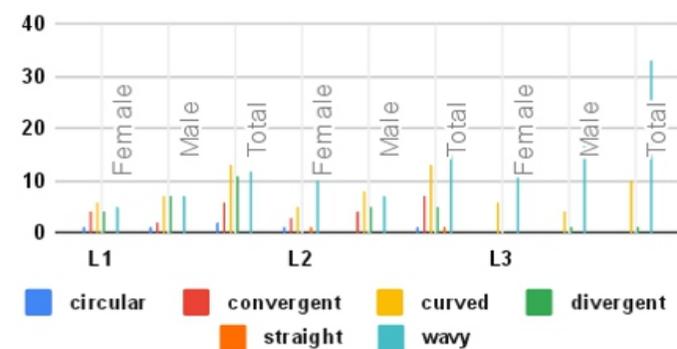
Graph 5: Comparison of rugae length on the right side of male and female subjects



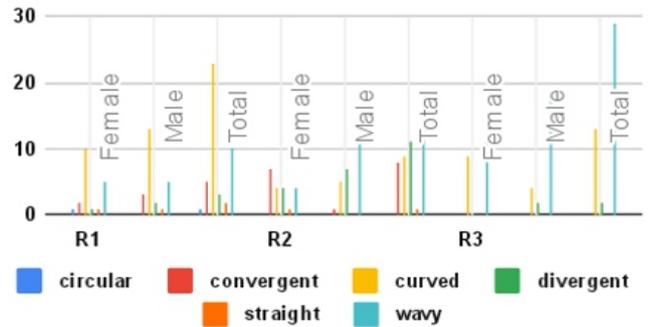
Graph 6: Comparison of angle on left side of male and female subjects



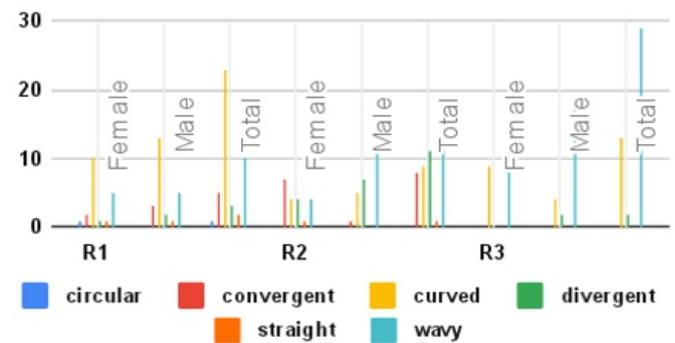
Graph 7: Comparison of angle on right side of male and female subjects



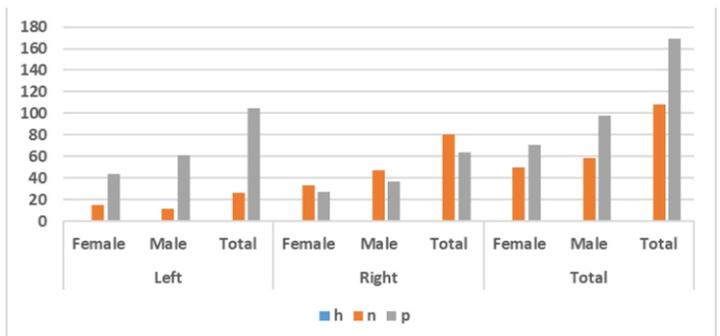
Graph 8: Comparison of shape of rugae on left side



Graph 9: Comparison of shape of rugae on right side



Graph 10: Comparison of shape of rugae among males and female



Graph 11: Comparison of angulation of rugae among males and females

Angle of Palatal Rugae

For L1, L2, and L3, most subjects had positive angles in both male and female subjects. L1 (86%), L2 (72.70%), L3 (73.50%) showed a non-significant difference in angle between male and female subjects [Graph.6]. For R1, (68.20%), most subjects had a positive angle in both male and female subjects. For R2 (63.60%) and R3 (59.10%), most subjects had a negative angle in both male and female subjects, with no significant difference in angles between genders [Graph.7]. On the left side, the most common angle among males and females was positive, with no difference in angle between genders. On the right side, the most common angle among males and females was negative, with no difference in angle between genders [Graph 11]



Shape of palatal rugae

Between the sexes, there was no discernible variation in the L1, L2, and L3 rugae form. For L1, the most common shape was wavy, curved, and divergent for males and curved for females. For L2, the most prevalent forms were curved in males and wavy in females. For L3, both the male and female have a wavy rugae form [Graph 8].

There was no appreciable difference in the shape of R1, R2, and R3 rugae between the sexes. The most common type of R1 rugae was curved in both male and female subjects. For R2 rugae, the most prevalent forms were wavy for men and convergent for females; and. The most prevalent forms of R3 rugae were wavy in males and curved in females [Graph 9]. There was no appreciable difference in the shape of R1, R2, and R3 rugae between the sexes. There was no difference in the most prevalent form between the two genders on the right and left sides, which was wavy [Graph 10].

Discussion

Due to their uniqueness, palatal rugae patterns are essential for identifying people on multiple fronts, including gender. A thorough assessment of the current state of research on palatal rugae preceded the conception of this study. While previous research has shown regional differences, its examinations have mostly used maxillary casts. By using state-of-the-art technology—more precisely, 3D intraoral scans—our research, on the other hand, made sure that our analysis was as accurate, precise, and reliable as possible. For the first time, every palatal rugae was measured with meticulous monitoring to detail up to three decimal places. Additionally, there were few publications that contrasted the palatal rugae on the left and right sides of the MPR (Mid-Palatine Raphe). We concluded that the palate is asymmetrical and that palatal rugae are diverse in size and shape, which is consistent with many previous research. Consistent with our results, research by Jayashankar Pillai et al.⁸ demonstrated that, independent of gender, palatal rugae were oriented forward on the left side and backward on the right. Comparably, research on the children of Davangere⁹ and Rahul Gaikwad et al.¹⁰ showed no variation in the number or length of rugae based on gender. The results of Prethi Nayak et al.¹¹ support our own findings, which indicated that wavy shapes predominated and were more commonly observed to be curved or wavy. On the other hand, a demographic study conducted in Saudi Arabia revealed that females had rugae that were oriented

backward¹². The patterns on the right and left sides of our research in West Uttar Pradesh differed, but there was no gender association.

While our study demonstrated this difference to be statistically insignificant, studies in the Western Indian¹⁴ population indicated statistically significant gender variations in the amount of rugae. We did not validate the conclusion by Divya Shetty et al.¹⁵ that females had more rugae than men in our investigation. Additionally, they observed that females tended to exhibit divergent patterns, while men tended to exhibit convergent patterns. In contrast, we discovered that rugae form was gender-neutral, with wavy shapes being the most prevalent.

Conclusion

We found no significant differences between genders in terms of rugae count, length, or angles. Despite variations in findings across studies, our research contributes to the broader understanding of palatal rugae and encourages further exploration into regional and population-specific variations.

Limitations

- Sample size: more data variance would have been found in our analysis if we had used a larger sample size.
- Location: Our data would have been more diversified if we had covered a larger region.

Future Perspective

A similar multicentred trial to access a wider strata of population

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