Palatal Rugae as an Indicator of Sexual Dimorphism

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ABSTRACT

Introduction
Palatoscopy or palate rugoscopy has been studied over the years to identify its unique characteristics to utilize for the human identification process. The unique anatomical location of the palatal rugae provides stability which along with the uniqueness of the palatal rugae pattern can contribute in human identification. Despite its simplicity and reliability, the palatal rugae is unexplored in the Nepalese population. The objective of the present study is to identify the rugae pattern and assess its sexual dimorphism.

Methods
This was a cross-sectional analytical study conducted in Tribhuvan University Dental Teaching Hospital (TUDTH). The characteristics of palatal rugae based upon number, length, shape, and unification were analyzed on 100 dental casts. The rugae patterns were marked with a black color graphite pencil under adequate illumination. The length of the rugae was measured with the help of a digital vernier caliper and brass wire. The independent sample T-test and Mann Whitney U tests were used to assess the sexual dimorphism.

Results
The predominant type of rugae according to the size in both males and females was primary rugae. According to the shape of the rugae, the predominant type of rugae was wavy followed by curved, straight, diverging, converging, and circular in both the sexes. However, no significant difference was seen in the rugae pattern in males and females.

Conclusion
Based on the findings of the present study, the use of palatal rugae for sex determination is not recommended.

Keywords
Human identification, palatal rugae, sexual dimorphism

INTRODUCTION

Palatal rugae also referred to as "Plica Palatine" or "Rugae Palatine" are anatomical folds or wrinkles located on either side of the median palatal raphae posterior to the incisive papillae.[1] The study of the palatal rugae known as Palatoscopy or palate rugoscopy. The unique nature of the palatal rugae to remain stable throughout life makes it an ideal choice for antemortem postmortem comparison.[2] The property of the palatal rugae, to not increase in length after 10 years of age, to have persistent shape, direction, and unification along with their protected anatomic location makes it an ideal contender for forensic human identification.[3,4] Despite its simplicity and reliability the palatal rugae is unexplored in the Nepalese population. The objective of the present study is to identify the rugae pattern and assess its sexual dimorphism.

METHODS

This was a cross-sectional analytical study conducted on dental casts taken for different treatment purposes like prosthodontic rehabilitation, orthodontic treatment, etc. The study was conducted in the Department of Oral Pathology and Forensic Dentistry, Tribhuvan University Dental Teaching Hospital (TUDTH), Institute of Medicine from June 2021 to August 2021. The ethical approval was taken from the Institutional Review Committee of the Institute of Medicine. Fifty males and fifty female casts were used from the convenience sampling method. The casts with palatal pathologies, edentulous, history of any previous trauma or palatal surgeries, or cleft palate, were excluded from the study.

The rugae patterns were marked with a black color graphite pencil under adequate illumination (Figure 1). The length of the rugae was measured with the help of a digital vernier caliper (Precise) and brass wire. The number, length, shape, and unification of the palatal rugae were recorded based on the classification by Thomas and Kotze et al. and Kapali et al. which is as follows.[5,6]

Based on length

- Primary: =/> 5 mm
- Secondary: 3-5 mm
- Fragmentary: 2-3 mm
- Rugae less than 2 mm were not considered for any categorization

Based on shape

- Straight: rugae that ran directly from origin to termination
- Curved: a simple crescent shape that curved gently
- Wavy: serpentine or slightest bend at the termination or origin of curved rugae
- Circular: rugae with definite continuous ring formation

Based on unification (Rugae joined at origin or termination)

- Divergent: two rugae began from the same origin but immediately diverge
- Convergent: rugae with different origin join on lateral portions

Data were entered in Microsoft Excel sheet and analyzed in Statistical Package of Social Sciences Version 21. For descriptive statistics, frequency, percentage, mean and standard deviation were calculated. Independent sample T-test was used for normally distributed data and data having no normal distribution Mann-Whitney U test was used to assess the role of palatal rugae in sex identification.

Figure 1. Palatal rugae shape traced on the dental cast

Table 1. Overall distribution of the morphology of palatal rugae (n=100)

Characteristics	Mean	SD	Median
Age	21.70	5.88	9
Total rugae	8.90	1.70	7
Based on length			
Primary	7.09	2.23	0
Secondary	0.69	1.04	0
Fragmentary	0.56	1.12	0
Based on shape			
Straight	0.51	1.00	0
Wavy	1.06	1.54	0
Curved	6.27	2.61	6
Circular	0.07	0.29	0
Based on unification			
Converging	0.25	0.54	0
Diverging	0.54	0.78	0

Table 2. Gender wise frequency distribution and percentages of morphological characteristics of rugae pattern (n=890)

Characteristics	Total	Males	Females
Total no of rugae	890	456 (51.24%)	434 (48.76%)
Based on length			
Primary	709	352 (49.65%)	357 (50.35%)
Secondary	69	32 (46.38%)	37 (53.62%)
Fragmentary	56	33 (58.93%)	23 (41.07%)
Based on shape			
Straight	51	19 (37.25%)	32 (62.75%)
Wavy	627	320 (51.04%)	307(48.96%)
Curved	106	56 (52.83%)	50 (47.17%)
Circular	7	4 (57.14%)	3 (42.86%)
Based on unification			
Converging	25	15 (60%)	10 (40%)
Diverging	54	25 (46.30%)	29 (53.70%)

RESULTS

A total of 890 rugae were traced from 100 study samples. The mean age was 21.70±5.88 years. The mean age in males was 21.32±5.41 years and the mean age in females was 22.08±6.33 years.

The most common type of rugae according to size was primarily followed by secondary and fragmentary. The most common type of rugae according to shape was wavy followed by curved, straight, divergent, and convergent (Table 1).

The predominant type of rugae in both males and females was primary rugae according to size. According to the shape of the rugae, the predominant type of rugae was wavy followed by curved, straight, diverging, converging, and circular in both the sexes (Table 2). No significant difference was seen in the rugae pattern in both the sexes (Table 3).

DISCUSSION

Bajracharya et al. found primary rugae to be more predominant than the secondary and fragmentary in Nepalese subjects. In the same study, the wavy pattern was more prevalent followed by curved, straight, and circular. There was no statistically significant difference between the sexes in the palatal rugae number and pattern.[6] These findings are similar to the present study. A similar study was conducted by Santos and Calder on the Portuguese population which showed no significant sexual dimorphism in the rugae shape.[7]

Smirti et al. evaluated 252 casts for palatal rugae

Table 3. Overall distribution of the morphology of palatal rugae (n=100)

Characteristics	Male (mean±SD)	Female (mean±SD)	Male (median)	Female (median)	p-value
Total rugae	9.12±1.65	8.68±1.743	9	8.5	0.11*
Based on length					
Primary	7.04±2.67	7.14±1.74	7	7.0	0.82*
Secondary	0.64±1.00	0.74±1.08	0	0.0	0.63**
Fragmentary	0.66±1.22	0.46±1.01	0	0.0	0.44**
Based on shape					
Straight	0.38±0.88	0.64±1.10	0	0.0	0.22**
Wavy	6.40±2.68	6.14±2.55	6	6.0	0.62*
Curved	1.12±1.44	1.00±1.64	1	0.0	0.31**
Circular	0.08±0.34	0.06±0.24	0	0.0	0.98**
Based on unification					
Converging	0.30±0.61	0.20±0.45	0	0.0	0.44**
Diverging	0.50±0.74	0.58±0.84	0	0.0	0.73**

*Independent sample t-test   **Mann- Whitney U test

pattern which had the wavy pattern as the most prevalent followed by curved, straight, and circular in both the sexes which is alike to the present study. There was no significant difference between the sexes except for the circular pattern.[8]

Azab et al. studied palatal rugae in Egyptian population. They reported wavy to be the most prevalent followed by straight and circular shapes. Converging type was more common than diverging type of rugae. There was no significant difference between the sexes except for the curved shape which was significantly higher among the females.[9]

In a similar study done by Ahmed and Hamid, the male showed a higher number of rugae. The primary rugae were predominant in both the sexes compared to the secondary and fragmentary. The wavy followed by curved and straight was the most prevalent in males and females. These findings are similar to our study. However, they found primary, converging, and nonspecific rugae patterns sexually dimorphic. Regression analysis was done to assess sexual dimorphism in the same study which showed the continuous variables have nonsignificant differences.[10]

Shrestha et al. have reported wavy as the most predominant shape followed by straight, circular in Nepalese subjects. The primary rugae were the most prevalent in both the sexes followed by secondary and fragmentary. These findings are similar to our study. However, a significant difference was seen in females in secondary, fragmentary straight, and perpendicular directed palatal rugae.[11] These findings are conflicting with the findings of the present study.

On the contrary, the study done by Gautam et al., showed males to have a higher number of palatal rugae compared to the females which were statistically significant. The straight pattern was more common in both the sexes than other patterns. However, there was no statistically significant association between the palatal rugae pattern and sex.[12]

A study done on the Iranian population by Sheikhi et al. to assess palatal rugae pattern for sex and ethnicity association showed straight as the most common shape followed by wavy and curved. The most common rugae shape in their study in males were straight (26%) then wavy (21%) and branching with divergence (16%). The most common rugae shape in females were straight (26%) followed by wavy (21%) and curved (17%). These findings are not in accordance with the present study. The sexing of the casts could not be done based on the stepwise discriminant function analysis.[13]

In another study, there was no difference in the average numbers of rugae in both the sexes. However, the average length of the rugae was more

in males than in females. The straight pattern was frequently seen in females than in males. However, there was significant differences in parameters like length and shape (straight pattern) in both the sexes. This study favors palatal rugae as a tool for sexual dimorphism due to the significant differences seen in the length and shape of rugae patterns.[14]

A study on Nalgonda children demonstrated wavy as the predominant rugae pattern in both the sexes followed by curved than straight and circular. Primary rugae appeared to be the most prevalent than secondary and fragmentary types in either of the sexes. The number of primary rugae in females and secondary rugae in males was significantly more than their counterparts. The diverging type was higher in males than the converging type in both sexes and on both sides of the palate.[15]

According to Godicherla et al., the wavy pattern was the most predominant type in males (62%) while the curvy pattern was predominant in females (54%). The difference between the males and the females for curvy, wavy, and straight rugae patterns was found to be statistically significant. The females had a statistically higher proportion of convergence type of unification of rugae compared to the males. Males had a significantly higher number of divergence types of unification of rugae in comparison to females.[16]

Madhankumar et al., found the straight and the curved forms to be the most predominant rugae shapes in both sexes. This study favors palatal rugae as a complementary technique for human identification based on the total no of rugae and the unification pattern of rugae with a significant difference.[17]

Though some of the studies have shown statistically significant differences between the rugae number, size, and shape the findings are not uniform. The study of the pattern of the rugae in the Nepalese population demonstrated a dissimilar pattern from the other population. The genetics may have a role to play in the embryogenesis process and the postnatal growth resulting in differences in rugae patterns between different populations.

CONCLUSION

Based on the findings of the present study, the use of palatal rugae for sex determination is not recommended. The possible differences found in the palatal rugae concerning the length, shapes, and unification in different populations and among different studies within the same population demands further studies.

FINANCIAL SUPPORT

CONFLICT OF INTEREST

The author(s) declare that they do not have any conflicts of interest with respect to the research, authorship, and/or publication of this article.

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