Gender Difference in Palatal Rugae Patterns among Adult Bengali Population in Chattogram

Sarah Fatima Sumaiya[1*]   Md Ashrafuzzaman[2]   Tamanna Begum[3]   Manjur E Mahmud[4]
Baishakhi Bhowmik[5]   Urmila Chowdhury[6]   Mohammed Morshed Alam[4]

Abstract

Background : The anatomical fold on the front portion of the hard palate is known as the palatal rugae. They are distinct and do not change during life, making them perfect for use as an identification tool when other options are unavailable. The aim of our study is to determine gender differences in palatal rugae pattern among the Bengali population in Chattogram of Bangladesh.

Materials and methods: A total of 200 Bengali male (100) and female (100) populations aged 18 years and above were studied. The data was assessed based on the Thomas and Kotze classification. The student's t-test was used to compare all quantitative data.

Results: Curved and straight type palatal rugae were significantly higher ($p < 0.05$, $p < 0.001$ respectively) in males than females. Wavy and circular type palatal rugae were higher in females than males and the difference was significant ($p < 0.001$, $p < 0.05$ respectively). The female exhibited a higher converging palatal rugae $p > 0.05$. The male exhibited a higher diverging palatal rugae $p < 0.001$.

Conclusion: The Bengali population of Chattogram has a distinctive pattern and sexual diversity of palatal rugae. That can be used to reliably identify subjects and gender differences in the Bengali population.

Key words: Human identification; Palatal rugae; Rugoscopy.

Introduction

J.B Winslow defined the palatal rugae for the first time in general anatomy in 1732.[1] One of the most distinguishing characteristics of palatal rugae is that they do not cross the midline and are numbered independently on each side of the hard palate from anterior to posterior.[2] Rugae form during the third month of development inside the womb.[3] Their characteristics do not alter after this time. The palatal rugae are complete at birth, with their characteristic shape, length, width, prominence, position, and direction providing a unique pattern for each individual.[4] They are unaffected by aging and, under normal circumstances, stay consistent throughout life. Its number is constant and does not alter as a result of growth, aging, tooth extraction, or disease.[5-6]

In forensic medicine, the analysis of palatal rugae patterns is considered a significant tool in determining sex.[7] Palatine rugae have been deemed a trustworthy identifying method since 1988, even in severely damaged bodies such as those caused by fire.[8] It has been noted that the palatal rugae patterns of siblings, twins and even their parents have no similarities.[9-10] They are protected from damage and high temperatures by their internal position within the mouth. The palatal rugae are unaffected even in burned patients.[11]

For human identification, several identification technologies are utilized, such as fingerprints, DNA analysis, and so on. However, because of postmortem changes caused by time, temperature, and humidity, visual identification and the use of fingerprints have considerable limits. Although DNA profiling is reliable, using it in large populations is costly and time-consuming.[12] Because of its distinctive qualities, palatal rugae could be an alternative to fingerprints in situations where it is difficult to identify a deceased person. As a result, palatal rugae can be successfully used for human identification.[6] The goal of this study is to examine and evaluate the palatal rugae pattern in normal adult males and females in the Bengali community of Chattogram, Bangladesh.

Materials and methods

The study was a population-based cross-sectional study conducted in the Department of Anatomy, Chittagong Medical College, Chattogram, Bangladesh.

1. Lecturer of Oral Microbiology
    Chittagong Medical College, Chattogram.

2. Professor of Anatomy
    Chittagong Medical College, Chattogram.

3. Assistant Professor of Orthodontics and Dentofacial Orthopedics
    Chittagong Medical College, Chattogram.

4. Assistant Professor of Oral and Maxillofacial Surgery
    Chittagong Medical College, Chattogram.

5. Lecturer of Anatomy
    Chittagong Medical College, Chattogram.

6. Assistant Professor of Anatomy
    Chittagong Medical College, Chattogram.

*Correspondence: Dr. Sarah Fatima Sumaiya
            Cell : 01814 20 05 13
            E-mail: sarahfatima803@gmail.com

Patients attending Dental OPD of Chittagong Medical College were randomly selected and after consideration of exclusion criteria, 200 patients were finally selected for this study. The total duration of the study was one year, extending from July 2020 to June 2021. Palatal impression models were collected from all participants. The study included those who did not have removable or set partial dentures or braces. People with cleft lip, cleft palate, and other palate and lip anomalies, as well as people with injured hard palates, were excluded from the study. People who lived outside of Chattogram or who refused to give their consent were also excluded from the study. All participants gave their informed consent.

Patients' mouths were washed with chlorhexidine mouth wash (0.12 percent). Hard plaster was used to cast an alginate imprint on the subject's hard palate. The rugae patterns were marked with a Hard Black (HB) pencil and examined using Thomas and Kotze[13] categorization, which is the simplest, most practical, and standardized method. Palatal rugae were found to be curved, wavy, straight, and circular in shape. Unification was measured as diverging or converging Palatal rugae in the samples. For identification and counting palatal rugae, a metallic needle with a sharp point and magnifying glass was used. To examine the gender difference in rugae patterns in the current sample, a statistical analysis was performed using the student's t-test. The entire study procedure was carried out in compliance with the Institutional Ethical Committee's ethical requirements.
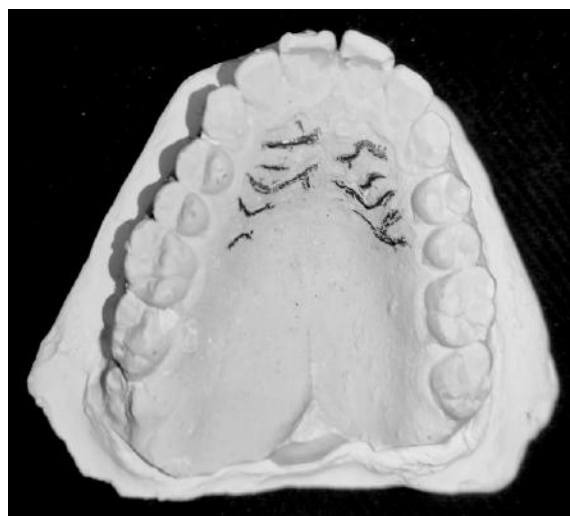

Figure 1 Taking maxillary impression

Figure 2 Cast showing various types of palatal rugae

Rugae	Shape and Unification
Straight	
Curved	
Wavy	
Circular	
Converging	
Diverging	

Figure 3 Various types of palatal rugae of Thomas and Kotze classification

Results

All the casts (100 male and 100 females, a total of 200) were thoroughly examined and statistically analyzed.

While analyzing the shape of the palatal rugae [Table I] it was observed that the mean total number of curved and straight type palatal rugae was higher in males than females. Curved type palatal rugae were found to be statistically significant $p < 0.05$ and straight type palatal rugae were found to be statistically very highly significant $p < 0.001$. The mean total number of wavy and circular type palatal rugae was higher in females than males. Wavy type palatal rugae were found to be statistically very highly significant $p < 0.001$ and circular type palatal rugae were statistically significant $p < 0.05$.

Table I Number of the various shapes of palatal rugae among the males and females

Shape	Curved		Wavy		Straight		Circular	
Gender	Male	Female	Male	Female	Male	Female	Male	Female
Mean	3.29	2.84	2.65	3.99	3.08	2.2	0.24	0.43
Standard Deviation	± 1.71	± 1.44	± 1.45	± 1.67	± 1.67	± 1.75	± 0.47	± 0.66
t- value	2.0144		5.6726		3.5036		2.3029	
p value	0.0453		0.0001		0.0007		0.0234	
Remark	Significant		Very highly significant		Very highly significant		Significant	

While analyzing the unification of the palatal rugae [Table II] it was observed that the female exhibited a higher mean value of the number of converging palatal rugae as compared to males, and the observed difference was found to be statistically not significant $p > 0.05$. The male exhibited a higher mean value of the number of diverging palatal rugae as compared to the female and the observed difference was found to be statistically very highly significant $p < 0.001$.

Table II Total number of the unifications of palatal rugae among the males and females

Unifications	Converging		Diverging	
Gender	Male	Female	Male	Female
Mean	0.33	0.35	1.58	0.49
Standard deviation	± 0.55	± 0.66	± 1.22	± 0.67
t- value	0.2283		8.0794	
p value	0.8199		0.0001	
Remark	Not Significant		Very highly significant	

Discussion

The study of palatal rugae to determine a person's identification was first proposed in 1932 by a Spanish investigator Trobo Hermosa.[1] According to literature, no two palates are the same in their configuration, and rugae patterns are similar but not identical amongst twins. Few writers have investigated the diversity of rugae patterns and their potential for sex discrimination among various ethnic groups, with mixed results.[13,14]

In our study, both males and females have shown the curvy type of palatal rugae is more in males where the mean is 3.29 ± 1.71, and less in females where the mean is 2.84 ± 1.44. This difference is statistically significant p-value <0.05. The mean of wavy type palatal rugae in males is 2.65 ± 1.45 and in females is 3.99 ± 1.67. Females exhibited a higher mean value of the number of wavy palatal rugae as compared to males. The difference here is statistically very highly significant because the

p-value is <0.001. The mean of straight type palatal rugae in males is 3.08 ± 1.67 and for the female is 2.2 ± 1.75. Male exhibited a higher mean value of the number of straight palatal rugae as compared to females. The difference here is statistically very highly significant because the p-value is <0.001. The mean of circular type palatal rugae in males is 0.24 ± 0.47 and in females is 0.43 ± 0.66. Females exhibited a higher mean value of the number of circular palatal rugae as compared to males. The difference here is statistically significant because p-value is <0.05. A similar study done by Nallamilli et al. found the shape of palatal rugae exhibited a highly significant sex difference in the curved type, which was found to be higher in males p value was < 0.001, and in the wavy type which was higher in females, the p-value was < 0.001. The straight type of palatal rugae was more in males than female.[14] Mohamed, in Iraq, conducted a study and found the most common shape in the (120) cases was the wavy (37.95), followed by the curved (33.56), straight rugae (24.94), circular (2.58), and the angle (1.63) was seen. The curve palatal rugae were more in males with a mean of 2.433 ± 1.06 than in females with a mean of 2.366 ± 0.901 ($p < 0.05$). The straight palatal rugae were more in males with a mean of 1.85 ± 1.74 than in females with a mean of 1.71 ± 1.09 ($p < 0.05$). The wavy palatal rugae were more in females with a mean of 2.95 ± 1.015 than in males with a mean of 2.488 ± 1.268 ($p < 0.05$).[15] Mittal et al. found that the differences in palatal rugae pattern distribution for male and female subjects were statistically significant. The males showed a higher percentage for straight types of palatal rugae with a mean of 1.1000 ± 1.031 than females with a mean of 0.9310 ± 0.997. Where females had a higher percentage of circular rugae pattern with a mean of 0.5517 ± 1.088 than males with a mean of 0.4333 ± 0.93526. When rugae patterns of both the groups were compared, the results were found to be statistically significant $p < 0.05$.[16] Ibeachu et al. performed a study in Nigeria and found a significant association between the tribe and sex with palatal rugae pattern distribution. The Igbo of Nigerian males had more curves and straight rugae than females with a p-value <0.001. Where the Igbo female had wavier and more circular palatal rugae than males with a

p-value <0.001. These findings are nearly similar to the present study.[17] Madhankumar et al. found that the mean of curved type of palatal rugae was more in males 2.32 ± 1.412 than in females 1.74 ± 1.270. The mean of wavy type of palatal rugae was more in females 2.04 ± 1.703 than males 1.95 ± 1.583 and circular type of palatal rugae was also more in females than males. The mean of straight type of palatal rugae was more in females 5.08 ± 2.253 than males 4.79 ± 2.174 which were statistically not significant.[18] Malekzadeh et al performed a study and found palatal rugae shapes in males with observed mean as wavy (3.52 ±1.72), curve (2.61 ± 2.68), and circular (0.09 ± 0.34). While in females were observed mean as wavy (3.51 ± 1.71), curve (3.18 ± 2.14), and circular (0.03 ± 0.17) patterns. There were no statistically significant differences in the wavy, curve, and circular shape of palatal rugae between males and females. The straight was significantly more common in males than in females (P-value 0.01). The least common form in both sexes was the circular rugae.[19] Bajracharya et al. performed a study on 200 Nepalese subjects, 100 male and 100 female, and found that there was no statistically significant association between the gender groups and palatal pattern of palatal rugae. Females were more curved and straight palatal rugae than males but males had wavier palatal rugae than females with a p value of 0.147.[5] This study did not show any gender difference. These results have shown dissimilarity from the present study. This dissimilarity may be due to ethnic variation.

Our study revealed the mean number of converging palatal rugae shows that the female 0.35 ± 0.66 exhibits a higher mean value of the number of converging palatal rugae as compared to male 0.33 ± 0.55 and the observed difference is found to be statistically not significant as the value of p > 0.05. The mean number of diverging palatal rugae shows 1.58 ± 1.22 in males exhibiting a higher value compared to females 0.49 ± 0.67 and the observed difference is found to be statistically very highly significant as the value of p < 0.001. Similar results were presented in the study done by Saxena et al conducted a cross-sectional study in Bhopal city. The study result showed that the mean number of converging rugae was higher among the females 0.43 ± 0.72

followed by males 0.40 ± 0.81. The difference in the mean number of converging rugae between the gender groups was not statistically significant with a p value of 0.59. The mean number of diverging rugae was higher among males 0.36 ± 0.54 compared to females 0.33 ± 0.58. The difference in the mean number of diverging rugae between the gender groups was statistically not significant with a p-value of 0.84.[7] Harchandani et al carried out a study on 100 individuals and found that the unification pattern of rugae was compared between the genders in the western Indian group. The unification pattern of rugae was compared between the genders in the northern Indian group which was considered to be significant. The western Indian group showed more significance. In comparing both the populations, a greater number of palatal rugae was divergent in males whereas females had convergent unification.[20] Gadicherla et al conducted a study in Bengaluru from an age range of 4 to 16 years were examined for different rugae patterns. The study result showed that females had a significantly higher proportion of unification convergent type of rugae as compared to males. On the other hand, males had a significantly higher number of unification divergent types of rugae in comparison to females with a p-value < 0.001.[21]

A Lucknow study done by Kamala et al. stated that females had a significantly higher mean proportion of unification converging rugae as compared with males.[10] According to Faisal et al. a study in the Saudi population on rugae pattern they found that the converging type of unification was higher in females with a highly significant difference.[9] Mohamed in Iraq conducted a study and found the converge shape rugae was more in males with a mean of 0.633 ± 0.780 (p < 0.05) than in females with a mean of 0.483 ± 0.747 (p < 0.05). The diverge shape palatal rugae was more in male with mean 0.11 ± 0.323 (p < 0.05) than in female with mean 0.033 ± 0.181 (p < 0.05).[15] Pramanik et al. observed that there is no sexual dimorphism in the unification pattern of primary rugae.[22] These observations were unlike or disagree with the present study, which may be due to different sample sizes and ethnicity.

Limitation

The sample size was relatively small. So, the result obtained from the present study may not be fully representative of the normal reference values for the whole normal adult Bengali population of Chattogram.

The study was based on the manual measurement procedure. That might have produced minor errors of measurement and observation that could have been avoided if sophisticated computer-based methods were used.

Conclusion

The Bengali population of Chattogram has a unique pattern and sexual diversity of palatal rugae, according to this study. Palatal rugae that were curved, straight, and diverging were more common in males. Females had more wavy, circular, and converging palatal rugae than males. In the Bengali community of Chattogram, the study discovered a considerable gender difference in palatal rugae patterns, which can be used as a reliable tool for sex discrimination and individual identification. This would motivate others to conduct additional studies in this area in order to create a standard database for the biometric application.

Recommendations

Larger samples should be used and should be taken from different parts of Bangladesh for making the study fully representative.

For increasing the reliability of the findings, further studies may be done by using digital models, digital scanners, and computer software programs.

The result of the study can be used as basic data for further research, biometric analysis, and multidisciplinary studies.

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Contribution of authors

SFS - Conception, design, drafting, acquisition of data, interpretation of data, manuscript writing, and final approval.

MA- Conception, critical revision and final approval.

TB- Data collection and final approval.

MEM- Drafting, data analysis and final approval.

BB- Data collection, critical revision, and final approval.

UR- Data collection, drafting and final approval.

MMA-Data collection, critical revision of version and final approval.

Disclosure

All the authors declared no competing interest.

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