

A study of the palatal rugae pattern among male female and transgender population of Bhopal city

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Abstract

Context: Transgenders are highly disadvantaged people, deprived of adequate opportunities of earning a respectable living. The forensic literature has emphasized on two genders, male and female, the existence of a third gender (Transgenders) is almost negligible in the literature, and this makes it compulsive to determine their identity through forensic approaches at the time of disasters. Previous studies have demonstrated that no two palatal rugae pattern are alike in their configuration and this unique feature has led us to undertake a study to establish individual identities using palatal rugae pattern. **Aims:** The purpose of this study was to compare the palatal rugae pattern among male, female, and transgender population of the Bhopal city. **Settings and Design:** This study was cross sectional in nature and conducted on a convenience sample of 148 subjects selected from Bhopal city, Madhya Pradesh. The study involved 49 males, 51 females, and 48 eunuchs in the age range of 17 to 35 years. **Materials and Methods:** Maxillary impression using alginate impression material was made and the cast was prepared using die stone on palatal area and dental stone as a base. The palatal rugae pattern was assessed on the basis of number, length, shape, direction, and unification. **Statistical Analysis Used:** One way ANOVA was used for comparing the mean values between different genders. The multiple pairwise comparisons were done with the Bonferroni *post hoc* correction. The statistical significance was fixed at 0.05. **Results:** The statistically significant difference with regard to some parameters like number of rugae, fragmentary rugae, wavy rugae, curve rugae, forwardly directed, and backwardly directed rugae between transgender and other gender groups were present. **Conclusion:** The difference in the parameters of the palatal rugae pattern among the transgender population and the other gender group is attributed to be the genetic make-up and sexual dimorphism.

Key words: Forensic identification, palatal rugae, rugae pattern, sex assessment, transgender

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Introduction

Transgender population also known as eunuchs in western countries or *hijaras* in India are a ubiquitous lot in the world. The word *hijra* is derived from the Arabic root *hjr*, in India is a sense of 'leaving one's tribe'. They are physiological males who have a feminine gender identity, adopt feminine gender roles, and wear women's clothing.

In India many hijras live in well-defined, organized, all-hijra communities, led by a guru. They are a highly disadvantaged people who are generally shunned by their families. Deprived of adequate opportunities of earning a respectable living, they are mostly forced to survive either through prostitution or by extorting money from families celebrating a wedding or the birth of a child by appearing uninvited in their midst and dancing and singing lewd songs.^[1] Accessing healthcare, employment, or education becomes almost impossible for them and because of the deprivation most of the hijras are illiterate and their existence in the society becomes negligible.^[1,2]

World has come across many disasters such as natural disasters (tsunami, earthquake) or man-made disasters (plane crash, accidents, and war) from time to time. The identification of a given individual in these disasters is always questionable. These disasters lead into many casualties and the identification of the bodies during these circumstances becomes a big task.^[3] So to determine the unidentified body many forensic approaches such as DNA analysis, fingerprinting, and dental comparisons have been utilized. In forensic dentistry, the oral cavity plays a very important role because of the unique anatomy of teeth. It is widely acknowledged that in some forensic situations, there are limitations to identification of the deceased by fingerprints, DNA and dental records and during these situations, different and less used techniques such as palatoscopy and cheiloscopy are useful.^[4]

Palatoscopy or palatal rugoscopy is the name given to the study of palatal rugae in order to establish a person's identity.^[5] The palatal rugae, like fingerprints, do not change during the life of the individual. They are protected from trauma and high temperatures because of their internal position in the oral cavity, surrounded and protected by lips, cheeks, tongue, teeth, and bone.^[6] Palatal rugae are irregular, asymmetric ridges of the mucous membrane extending laterally from the incisive papilla and the anterior part of the palatal raphe.^[7] Previous studies have demonstrated that no two palatal rugae pattern are alike in their configuration and that the characteristic pattern of the palate does not change as a result of growth. However, some events may contribute to changes in the pattern of palatal rugae such as finger sucking in childhood and persistent pressure due to orthodontic treatment. Furthermore, it has been reported that extractions can produce a local effect on the direction of the palatal rugae.^[8]

This unique feature has led us to undertake a study to establish individual identity using palatal rugae pattern. Many studies have been done to acknowledge the palatal rugae pattern in males and females, but no study has yet been done to assess the rugae pattern of transgenders. So, this study is an attempt to assess and compare the palatal rugae pattern among males, females, and transgender population residing in the Bhopal city.

Materials and Methods

This study was cross sectional in nature and conducted on a convenient sample of 148 subjects selected from Bhopal city, Madhya Pradesh. The study involved 49 males, 51 females, and 48 eunuchs in the age range of 17 to 35 years. The study participants were selected on the basis of inclusion and exclusion criteria.^[9]

Inclusion criteria

- Subjects in the age range of 17-35 years,
- Subjects without braces,
- Without removable partial dentures,
- Without fixed partial dentures.

Exclusion criteria

- Subjects with abnormalities of palate and lips like the cleft palate and left lip
- Subjects wearing partial dentures and braces
- Patients having the history of orthodontic treatment were also excluded.

After selecting the participants, informed consent was obtained and maxillary impressions were made using alginate impression material and the study models were prepared using die stone and dental stone. All the selected casts were free from air bubbles or voids, especially at the anterior third of the palate. The rugae pattern on the study models were traced with the black marker pen, this enhanced the clarity of the pattern on the cast. The assessment of the palatal rugae pattern was done using Thomas and Kotze classification.^[3] This classification was categorized under the following heading.

- Based on the number: The total numbers of rugae on the right and left sides of mid palatine raphe were counted
- Based on the length of the rugae: The rugae was classified into three types based on their length as specified beneath,
 - Primary >5 mm
 - Secondary 3 to 5 mm
 - Fragmentary <3 mm.

Rugae less than 2 mm were disregarded. A ruga's length was determined by measuring its greatest dimension regardless of its shape using a divider. The measurement on the divider was then translated into millimeters using a stainless steel scale.

- Predominant Shape: The rugae was classified into one of the following shapes based on their appearance
 - Curved: They had a crescent shape and curved gently. Evidence of even the slightest bend at the origin or termination of a ruga led to it being classified as a curved ruga
 - Wavy: If there was a slight curve at the origin or termination of a curved ruga, it was classified as wavy
 - Straight: They run directly from their origin to termination

- Circular: Rugae that form a definite continuous ring were classified as circular
- Predominant direction: The direction of the ruga was determined by measuring the angle formed by the line joining its origin and termination and the line perpendicular to the median raphe. The rugae were classified into two categories based on the direction
 - Forwardly directed rugae were associated with positive angles
 - Backwardly directed rugae were associated with negative angles
- Unification of rugae. Unification was said to have occurred when two rugae were joined at their origin or termination. The rugae were classified into two categories based on the unification
 - Diverging – If two rugae had the same origin from the midline but immediately branched
 - Converging – Rugae with different origins from the midline, but which joined on their lateral portion.

The assessment of palatal rugae pattern was done by one trained and calibrated examiner. To determine the intraexaminer reliability, the examination was repeated two times on 10 selected casts at a gap of 3 h.

Results

Statistical analysis was done using SPSS version 19 (IBM company © copyright 1989, 2010 SPSS) using relevant statistical tests. One way ANOVA was used for comparing the mean values between different genders. Wherever, ANOVA yielded significant results, the multiple pairwise comparisons were done with the Bonferroni *post hoc* correction. The statistical significance was fixed at 0.05.

A total of 148 participants were selected for the study. Among these, 51 were females, 49 were males and 48 were transgender population. The age range of the study population was 17 - 35 years with a mean age of 26 years and a standard deviation of 5.6.

The study casts prepared from the selected population were examined for palatal rugae pattern using Thomas and Kotze classification.

The study compared the number of rugae, length of rugae (primary, secondary and fragmentary), shape of rugae (straight, wavy, curved, and circular), direction of rugae (forwardly directed, backwardly directed, and perpendicular) and the unification (converging and diverging) pattern between different gender groups.

Number of rugae

There was a statistically significant difference in the mean number of rugae between transgender population and other genders (males and females) [$P = 0.004$, Table 1].

Length of the rugae

The study found no statistically significant difference in the mean number of primary rugae and secondary rugae between the different gender groups ($P = 0.2$) and ($P = 0.76$), respectively. However, the mean number of fragmentary rugae was significantly less among eunuchs than compared to males and females ($P = 0.03$). The *post hoc* test revealed a statistically significant difference between males and eunuchs ($P = 0.007$) as well as between females and eunuchs ($P = 0.01$). The difference between males and females was not statistically significant ($P = 1.00$) [Table 2].

Shape of the rugae

The difference between the mean number of straight rugae and circular rugae was not statistically significant between the gender groups ($P = 0.22$) ($P = 0.14$). However, the mean number of curve rugae was more among females (4.94 ± 2.52) compared to males (4.59 ± 2.34) who in turn had a higher mean number compared to eunuchs (3.6 ± 2.05). The difference in the mean number of curve rugae between the gender groups was statistically significant ($P = 0.016$) the *post hoc* test revealed a significant difference between females and eunuchs ($P = 0.01$). Also the mean number of wavy rugae was more among eunuchs (6.89 ± 1.47) compared to males (6.32 ± 2.03) who in turn had a higher mean number

Table 1: Comparison of mean number of rugae between different gender groups

Gender	Number of rugae (mean±SD)
Males	12.6±2.7
Females	12.7±2.9
Transgender	11.1±2.1
Statistical inference	F value: 5.6 df: 2 P value: 0.004
Post hoc test	Male-female: 0.9 Male-transgender: 0.01 Females-transgender: 0.00

SD: Standard deviation

Table 2: Comparison of mean number of length of the rugae between different gender groups

Rugae length	Sex	Mean±S.D	P value	F value	Post-hoc value
Primary	Male	7.70±1.93	0.2	1.5	NA
	Female	7.71±2.05			
	Transgender	7.14±1.44			
Secondary	Male	3.85±2.71	0.76	0.27	NA
	Female	4.15±2.78			
	Transgender	3.79±2.37			
Fragmentary	Male	1.06±1.32	0.003	6.11	Males vs females: 1
	Female	1.01±1.37			Males vs trans: 0.007
	Transgender	0.31±0.71			Females vs trans: 0.01

NA: Not associated; S.D: Standard deviation

compared to females (5.96 ± 2.04). The difference in the mean number of wavy rugae between the gender groups was statistically significant ($P = 0.04$). The *post hoc* test revealed a statistically significant difference females and eunuchs ($P = 0.04$) [Table 3].

Direction of the rugae

The mean number of forwardly directed rugae was higher among the eunuchs (6.25 ± 1.80) followed by males (5.16 ± 2.58) who in turn had a higher number compared to females (4.17 ± 2.68). The difference in the mean number of forwardly directed rugae between the gender groups was statistically significant [$P = 0.001$, Table 1]. The *post-hoc* test revealed a significant difference between females and eunuchs ($P = 0.001$). The mean number of backwardly directed rugae was higher among the eunuchs (3.68 ± 2.27) followed by males (3.10 ± 2.48) who in turn had a higher number compared to females (2.50 ± 1.57). The difference in the mean number of backwardly directed rugae between the gender groups was statistically significant ($P = 0.02$). The *post hoc* test revealed a significant difference between females and eunuchs ($P = 0.02$). The difference in the mean number of perpendicular rugae between the gender groups was not statistically significant ($P = 0.47$) [Table 4].

Unification of the rugae

The mean number of converging rugae was higher among the females (0.43 ± 0.72) followed by males (0.40 ± 0.81) who in turn had a higher number compared to eunuchs (0.29 ± 0.61). The difference in the mean number of converging rugae between the gender groups was not statistically significant ($P = 0.59$). The mean number of diverging rugae was higher among the eunuchs (0.37 ± 0.68) followed by males (0.36 ± 0.54) who in turn had a higher number compared to females (0.33 ± 0.58). The difference in the mean number of diverging rugae between the gender group was not statistically significant ($P = 0.84$) [Table 5].

Discussion

Human identification is an important aspect of forensic science and many attempts have been made in order to find out safe means for human identification that may allow recognition, avoidance, or detection of errors and simultaneously preclude changes or alterations of numbers or individuals. Several signaling processes have been proposed for human identification, some of which are good but complicated, for example, Genomic and mitochondrial DNA from the pulp, dentin or cementum of teeth or desquamated cells in saliva are vital to the forensic process of identification,^[4] while others are bad and present failures like the role of dental restorations, prosthesis, and radiological identification.^[10,11] Palatoscopy or palatal rugoscopy is the study of palatal rugae in order to establish a person's identity. Palatal rugae pattern is unique in all individuals, and are protected from trauma

Table 3: Comparison of mean number of shape of the rugae between different gender groups

Rugae shape	Sex	Mean±S.D	P value	F value	Post-hoc value
Straight	Male	0.59±1.15	0.22	1.49	NA
	Female	0.70±1.22			
	Transgender	0.35±0.56			
Curve	Male	4.59±2.34	0.016	4.22	Males vs females: 1 Males vs trans: 0.1 Females vs trans: 0.01
	Female	4.94±2.52			
	Transgender	3.60±2.05			
Wavy	Male	6.32±2.03	0.04	3.10	Males vs females: 0.9 Males vs trans: 0.4 Females vs trans: 0.04
	Female	5.96±2.04			
	Transgender	6.89±1.47			
Circular	Male	0.00±0.00	0.147	1.93	NA
	Female	0.03±0.19			
	Transgender	0.00±0.00			

S.D: Standard deviation

Table 4: Comparison of mean number of direction of the rugae between different gender group

Rugae direction	Sex	Mean±S.D	P value	F value	Post-hoc value
Forwardly directed	Male	5.16±2.58	0.000	0.92	Males vs Females-0.12 Males vs Trans-0.08 Females vs Trans-0.00
	Female	4.17±2.68			
	Transgender	6.25±1.80			
Backwardly directed	Male	3.10±2.48	0.02	3.74	Males vs Females-0.50 Males vs Trans-0.54 Females vs Trans-0.02
	Female	2.50±1.57			
	Transgender	3.68±2.27			
Perpendicular directed	Male	0.81±0.92	0.47	0.75	NA
	Female	0.60±0.82			
	Transgender	0.66±0.85			

NA: Not associated; S.D: Standard deviation

Table 5: Comparison of mean number of unification of the rugae between different gender group

Unification of rugae	Sex	Mean±S.D	P value	F value	Post-hoc value
Converging rugae	Male	0.40±0.81	0.59	0.52	NA
	Female	0.43±0.72			
	Transgender	0.29±0.61			
Diverging rugae	Male	0.36±0.54	0.84	0.16	NA
	Female	0.33±0.58			
	Transgender	0.37±0.68			

NA: Not associated; S.D: Standard deviation

by their internal position in the head and insulated from heat by the tongue and buccal fat pads, unlike fingerprints

that can get destroyed.^[12] Once formed, they do not undergo any changes except in length, due to normal growth, remaining in the same position throughout an entire person's life. The structure of palatal rugae is unchanged and are not altered by chemicals, heat, disease, or trauma, or, if they are destroyed, are reproduced exactly on the same site they were located. However, some events may contribute to changes in the pattern of palatine rugae, such as finger sucking in childhood and persistent pressure due to orthodontic treatment.^[13] It has been shown that the total number of rugae does not change throughout early childhood and adolescence, but changes in rugae number were observed in elderly individuals. Rugae pattern shows changes with respect to length in early childhood and hence remaining constant in life.

In a study by Kamala *et al.* age-wise comparison of rugae pattern observed total number of rugae were maximum in age groups 3 to 5 years, while the number of rugae was minimum in the age group 51 and above ($n = 1525$). It was noted that the mean number of rugae showed a slight decreasing trend with increasing age.^[14] The analysis of human palatal rugae has been suggested as a method for identification in 1889 by Allen.^[15] Many classifications on palatal rugae patterns were established. Most studies use classification proposed by Lysell,^[16] Thomas and Kotze.^[17] The classification by Thomas and Kotze to assess rugae pattern according to their number, length, shape, direction, and unification was used in the present study. In the field of forensic dentistry, rugoscopy is still in its infancy. This study was an attempt to determine the differences in the palatal rugae pattern (number, length, shape, direction, and unification) among male, female, and transgender population in Bhopal city.

In our study, the mean number of rugae was found to be significantly lower among the transgender population, compared to males and females and there was no statistically significant difference in the mean numbers of males and females. The result of the present study with respect to the mean number of rugae between male and female is similar to the study conducted by Narang *et al.*^[18] on the North Indian population and Mahabalesh *et al.*^[9] in the Mangalorean population, India. Whereas, Shwetha *et al.*^[19] reported that males had more number of rugae than females in their study on Mysorean and Tibetan populations.

A study by Paliwal *et al.*^[7] on two different populations in India (Madhya Pradesh and Kerala) and Mahabalesh *et al.*^[9] found the mean number of primary rugae was not significantly different between male and female. This is in agreement with this study in which mean number of primary rugae was not significantly different between male and female. However, the mean numbers of fragmentary rugae among transgender populations were significantly

less than male and females in our study. Manjunath *et al.*^[3] conducted a study to determine the differences in the rugae pattern among the Indian males and females amongst the population in Manipal, Karnataka. This study found a significant difference in the mean number of curve rugae between males and females. The results of our study with regard to the gender distribution of curve rugae were consistent with the findings of this study. Shetty *et al.*^[9] in their study found the mean number of wavy rugae to be more among males compared to females. Although, the mean number of wavy rugae among transgenders in our study was significantly more compared to males and females, the distribution of wavy rugae among males and females were somewhat similar to the findings of this study.

This study found a significantly higher mean number of forwardly directed and backwardly directed rugae among transgenders compared to other groups. The post-hoc test revealed a significant difference between females and transgenders but not between males and females, males, and transgenders. A study by Manjunath *et al.*^[3] and Narang *et al.*^[18] found the mean number of forwardly directing rugae to be significantly higher among females as compared to males, but the incidence of backwardly directing rugae and perpendicular rugae were more in males compared to females, which was in contrast to the study conducted by Narang^[18] where the mean number of backwardly directing rugae and perpendicular rugae were found to be more in females compared to males. This study reveals that there was no statistically significant difference in the distribution of mean number of converging and diverging rugae between the gender groups studied. The results were comparable to the study by Narang *et al.*^[18] in which no significant difference was present between males and females in relation to converging and diverging rugae but the results were in disagreement with the study by Faisal *et al.*^[20] on the rugae pattern in a Saudi population where it was found that converging rugae were significantly higher among females compared to males. The differences in the rugae pattern between males and females, as well as the contradictory findings between different studies may be because of differences in the race, ethnicity, genetic-make-up of the populations investigated. This study is the first of its kind to assess and compare the rugae pattern between males, females and transgender population. The results of our study need to be further validated with large study samples, especially involving transgender population, which is a rarely explored group.

Conclusion

Palatal rugae, also called plicae palatinae transversae and rugae palatina, refer to the ridges on the anterior part of the palatal mucosa, each side of the median palatal raphe and behind the incisive papilla. Rugae patterns have been studied for various purposes, published reports

being mainly in the fields of anthropology, comparative anatomy, genetics, forensic odontology, prosthodontics, and orthodontics.^[21] The uniqueness and stability of palatine rugae make them very useful in forensic identification.^[22] This study was taken up as there was a lack of published literature comparing the palatal rugae pattern among the transgender population. We assessed and compared the rugae pattern among males ($N = 49$), females ($N = 51$), and transgender population ($N = 48$) in Bhopal city, Madhya Pradesh, India. The assessment of rugae was made based on Thomas and Kotze's classification. The statistically significant difference with regard to some parameters like number of rugae, fragmentary rugae, wavy rugae, curve rugae, forwardly directed, and backwardly directed rugae between transgenders and other gender groups suggest the possibility of sexual dimorphism. However, the small sample size and convenient sampling employed in the study are potential drawbacks. This necessitates the need for further studies with large sample size and random sampling to validate the results of this study.

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