

Morphological analysis of palatal rugae pattern in central Indian population

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Abstract

Aim: The aim of this study was to analyze the morphological study of palatal rugae pattern in a central Indian population and to determine sex differentiation. **Objectives:** To investigate the distinctive rugae patterns of the study population and determine the contribution of rugae patterns in gender identification. **Material and Methods:** The present cross-sectional study was conducted among a Central Indian population with a sample size of 500 participants. The study involved 250 males and 250 females who were randomly selected from the outpatient department of Oral Medicine Diagnosis and Radiology, Hitkarini Dental College and Hospital, Jabalpur, Madhya Pradesh. After collection of impression, casts were made and analyzed to evaluate the palatal rugae pattern in a central Indian population by using Thomas and Kotze classification (1983) for number, shape, direction, and unification of palatal rugae pattern. The statistical analysis was carried out using Mann-Whitney test and Chi-square (χ^2) tests for categorical variables. **Result:** Males showed more number of rugae than females [$P = 0.00 (\leq 0.001)$]. Males had more number of wavy rugae pattern whereas females showed more number of straight rugae patterns [$P = 0.00 (\leq 0.001)$]. Males showed more backwardly directed rugae whereas females showed more forwardly directed rugae [$P = 0.00 (\leq 0.001)$]. The unification did not show any significant difference. **Conclusion:** This study showed that there was a significant relationship between palatoscopy, human identification, and sex determination. Thus, palatoscopy can be considered as a cost effective, easy, unique, and stable method for human identification.

Key words: Direction of rugae pattern, human identification, palatoscopy, Thomas Kotze classification, unification

INTRODUCTION

Human identification is of paramount importance among humans at social and legal levels.^[1] Determination of a person's identity is a difficult job^[2] in cases of traffic accidents, acts of terrorism, and mass disasters.^[3] Visual identification, finger printing, and DNA comparison are the most common techniques employed in forensic identification for fast and reliable identification.^[4,5] However, DNA testing is very costly

and cannot be conducted for everyone. Fingerprinting also cannot be performed in certain cases such as burn victims.^[2] Hence, analysis by dental arches, cheiloscropy, antemortem periapical radiographs, pulp and gingival morphology, missing teeth, restorative material, palatal rugae, etc. can be considered to be sources of comparative material because mouth allows for a myriad of possibilities.^[6] Identification of an individual is possible which can legitimize the identification process, even in highly difficult circumstances.^[7] The palatal

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rugae pattern will not be modified even in cases of severe illness, chemical injury, or trauma.^[7]

Palatal rugae also called “plicae palatinae transversae”^[8] and “rugae palatine” are asymmetrical and irregular elevations of the mucosa located in the anterior third of the palate, made from the lateral membrane of the incisive papilla and arranged in transverse direction from palatine raphe located in the mid sagittal plane.^[9] The pattern orientation is formed by approximately 12th to 14th week of prenatal life. It is a well-established fact that the rugae pattern is as unique to a human as his/her fingerprints and it retains its shape throughout life.^[10] Even in twins, patterns are similar but not identical. The anatomical position of the rugae inside the mouth surrounded by the cheeks, lips, tongue, buccal pad of fat, teeth, and bone keeps them well-protected from trauma and high temperatures.^[9] Thus, they can be reliably used as a reference landmark during forensic identification. Palatoscopy is the study of hard palate anatomy to establish a person’s identity.^[5] Palatal rugae pattern of an individual may be considered to be a useful tool for sex determination and identification,^[4] which is also supported by a study conducted in 2012 by Manjunath *et al.* The palatine rugae could be used as a reference landmark during forensic identification of an individual. Many victims of natural disasters such as fires and floods can be identified by dental means. Many criminal investigations have included the use of dental evidence.^[5] The advantage of palatal rugae is its internal position, which leads to stability and perenity.^[3,6] It is a cost-effective, noninvasive, and easily available mode for human identification.

The aim of the present study is to analyze the morphology of palatal rugae patterns in central Indian population by studying the cast.

MATERIALS AND METHODS

This was a cross-sectional community-based study. The present clinical study was planned and designed in the Department of Oral Medicine and Radiology, Hitkarini Dental College and Hospital, Jabalpur, Madhya Pradesh, India. Ethical clearance was obtained by the college ethical committee.

Collection of data

All individuals who participated in the study were recruited from patients attending the outpatient Department of Hitkarini Dental College and Hospital

from 2013 to 2015. All the participants were of Indian origin. A detailed case history was recorded in a specially designed proforma [Annexure 1] for the study. Thorough clinical examination was performed, patients were informed about the study, and a written consent was obtained.

On the basis of result obtained from pilot study using n-master software 2.0 version the sample size came out to be 497 which was then rounded off to 500 (95% confidence interval and 5% allowable error and 80% power of the study). Five hundred healthy adult participants were then equally divided into 250 males and 250 females according to the below inclusion and exclusion criteria.

Inclusion criteria

Patients in the age group 17–25 years were considered for the study, and 250 healthy males and 250 healthy females were included in each group.

Exclusion criteria

Participants with palatal abnormalities such as cleft palate, soft tissue protuberances, trauma of palate, and patients with braces, were excluded from the study.

Impressions were made and then poured by dental stone to prepare cast. The rugae seen as elevated impression were marked on these casts using a black permanent marker pen [Figure 1] under adequate light, which enhanced the clarity of the pattern on the cast. A divider with an adjustable screw and measuring scale were used to measure the rugae. The palatal rugae were then analyzed on these casts on the basis of primary rugae, number of rugae, direction, unification and pattern, using the classification by Thomas and Kotze [Figures 2 and 3]. All the relevant data thus collected was entered in a proforma.

Statistical analysis

The collected data were sorted, tabulated, and subjected to statistical analysis. The data obtained was transferred to Microsoft Excel then to the Statistical Package of Social Sciences (SPSS) version 19 for analysis. The Mann–Whitney U test was used to assess the significant difference of the total number of each type of palatal rugae between males and females. Descriptive statistical analysis was applied using SPSS to obtain the means and standard deviation from the data of each category.

RESULT

Table 1 and Graph 1 show statistically significant difference [$P = 0.000 (<0.001)$] with total number of

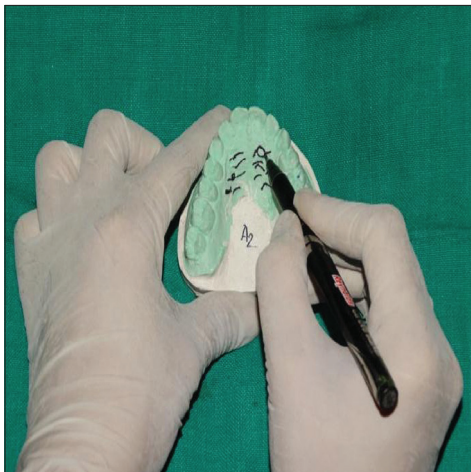


Figure 1: Marking of palatal rugae

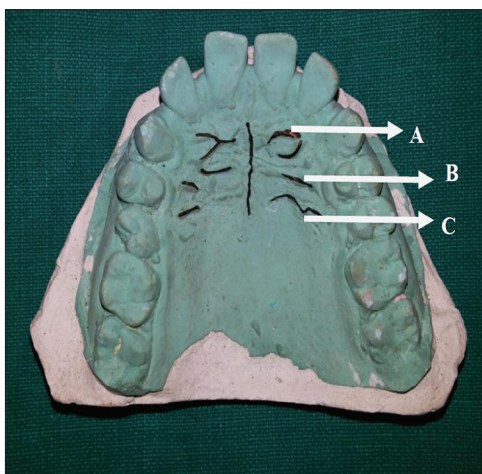


Figure 2: Shape of pattern – A: curved pattern, B: straight pattern, C: wavy pattern



Figure 3: Shape of pattern – Circular rugae pattern

rugae. Males exhibited higher number of rugae with a mean and standard deviation of 10.52 ± 2.64 among study population. Females had a less number of rugae with a mean and standard deviation of 9.60 ± 2.08 . Table 2 and Graph 2 show statistically significant difference [$P = 0.000 (<0.001)$] between shapes of rugae pattern. Males showed more wavy rugae pattern with 129 (51.6%) followed by straight rugae pattern 80 (32.0%), curved rugae pattern 35 (14.0%), and circular rugae pattern 06 (2.4%). Females presented

Table 1: Number of rugae among study population

Gender	Number of rugae			
	Mean \pm SD	Median	Minimum	Maximum
Male (n=250)	10.52 \pm 2.64	10.00	05	19
Female (n=250)	9.60 \pm 2.08	9.00	06	15
Over all (n=500)	10.06 \pm 2.42	10.00	5	19
Mann Whitney U test	MW= 24525.500, P=0.000 (<0.001), Significant difference			

Table 2: Comparison of shape of rugae among study population

Gender	Shape of rugae				Total
	Curved	Wavy	Straight	Circular	
Male {n(%)}	35 (14.0)	129 (51.6)	80 (32.0)	06 (2.4)	250 (100.0)
Female {n(%)}	20 (8.0)	85 (34.0)	138 (55.2)	07 (2.8)	250 (100.0)
Total {n(%)}	55 (11.0)	214 (42.8)	218 (43.6)	13 (2.6)	500 (100.0)
Chi-square test	$\chi^2 = 28.646, df=3, P=0.000 (<0.001)$ Significant difference				

more straight rugae pattern with 138 (55.2%) followed by wavy rugae pattern 85 (34.0%), curved rugae pattern 20 (8.0%), and circular rugae pattern 07 (2.8%). Overall, it was observed that straight rugae pattern was more in number 218 (43.6%). Graph 3 shows no significant difference with unification of rugae among study population. Converging unification was found to be more common among study population. Graph 4 shows significant difference [$P = 0.000 (<0.001)$] between direction of rugae between the genders among study population. Males presented with more number of backwardly directed rugae with 167 (66.8%). The females presented more forwardly directed rugae with 156 (62.4%).

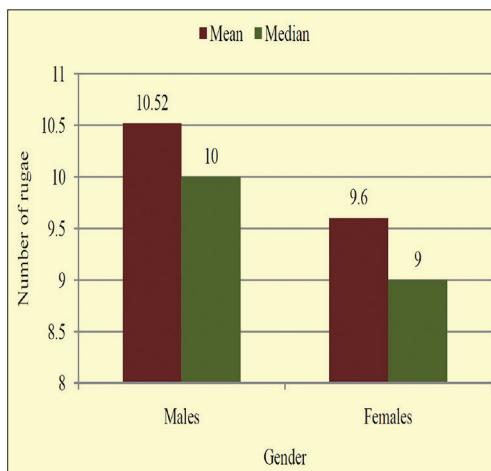
DISCUSSION

Palatoscopy or palatal rugoscopy is the study of palatal rugae in order to establish a person's identity. Transverse palatine folds or palatal rugae are asymmetrical and irregular elevations of the mucosa located in the anterior

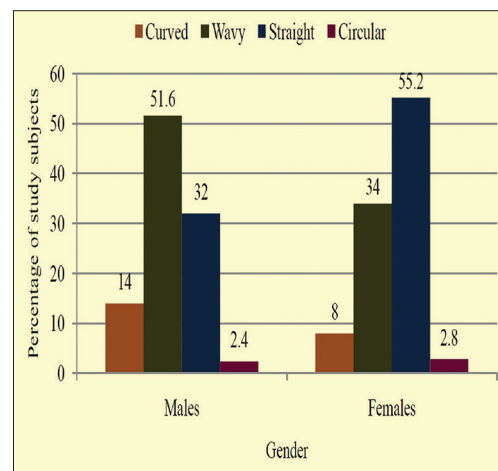
third of the palate, made from the lateral membrane of the incisive papilla and arranged in transverse direction from palatine raphe located in the mid-sagittal plane.^[11]

Palatoscopy is very useful in identification of decomposed or burnt bodies when fingerprint data are missing.^[11] Palatoscopy is a valuable technique in aeronautical accidents, pilots antemortem data is used for identification purpose.^[11] It is the most valuable technique in a aeronautical accidents in order to ensure identification of pilots making use of ante-mortem data.^[11]

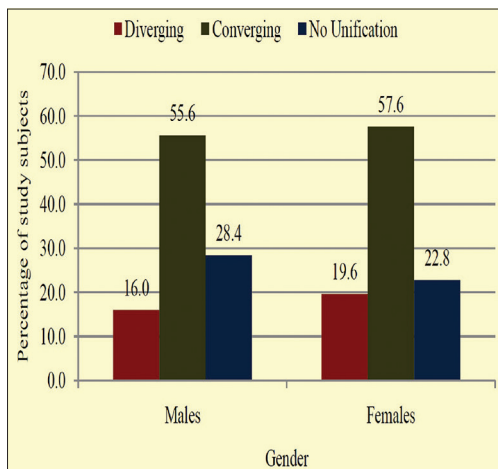
In our study, males had more number of rugae when compared to females 10.52 ± 2.64 with $P < 0.001$ which was statistically significant. This result was in agreement with a study conducted by Indira *et al.*^[12] where number of rugae were slightly higher in males. Bing *et al.*^[13] also found in his study that the number of rugae were higher in males. Hermosilla *et al.*^[14] and Balgi *et al.*^[13] also found higher number of rugae in males; whereas



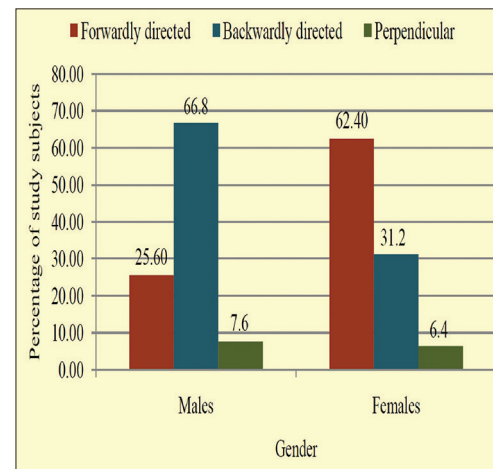
Graph 1: Number of rugae among study population



Graph 2: Comparison of shape of rugae among study population



Graph 3: Comparison of unification of rugae among study population



Graph 4: Comparison of direction of rugae among gender

Verma *et al.*^[15] and Manjunath *et al.*^[16] found that there was more rugae in females. In our study, males were having more wavy rugae with 129 (51.6%). Manjunath *et al.*,^[16] Sharma *et al.*,^[17] Saraf *et al.*,^[11] Kamala *et al.*,^[18] Nagalaxmi *et al.*,^[19] and Bing *et al.*^[13] also found wavy pattern to be higher in males. In contrast, Babu *et al.*^[20] found wavy pattern to be common in both the genders where males were having 4.82 ± 1.91 and females were having 4.74 ± 1.91 . Our study found that females had more straight rugae with 85 (34.0%). Balgi *et al.*^[13] and Manjunath *et al.*^[16] also found straight pattern to be more common in females. Our study observed that males with 40 (16.0%) diverging type of rugae, 139 (55.6%) converging type of rugae and females with 49 (19.6%) diverging type of rugae, 144 (57.6%) converging type of rugae. Therefore, there was no significant difference in unification between males and females because P value was > 0.05 . Manjunath *et al.*,^[16] Narang *et al.*,^[7] Sharma *et al.*,^[17] Azab *et al.*,^[21] and Rajan *et al.*^[22] also did not find any significant difference for unification between males and males. Studies conducted by Chandra *et al.*,^[23] Fahmi *et al.*,^[24] and Saraf *et al.*^[11] found converging type of rugae to be higher in females. Nagalaxmi *et al.*^[19] and Babu *et al.*^[25] found diverging type to be higher in females. Ibeachu *et al.*^[26] found diverging type to be more prominent in males.

Our study conducted in a central Indian population observed that males were having more backwardly directed rugae with 64 (25.6%). Manjunath *et al.*^[16] and Shetty *et al.*^[3] also observed backwardly directed rugae in males. Females were having more forward-directed rugae with 156 (62.4%) ($P < 0.001$). Reddy *et al.*^[28] found forward-directed rugae more commonly in north and south Indian population. Verma *et al.*^[15] also found forward-directed rugae to be more common. However, studies conducted by Azab *et al.*^[21] and Saxena *et al.*^[27] did not find any significant difference with direction of rugae between males and females. The study only involves the data for central Indian population.

CONCLUSION

Dental identification has always played a role in natural and manmade disaster situations and in mass casualties normally associated with aviation disaster. Because of the lack of comprehensive fingerprint database, dental identification continues to be crucial. The central dogma of dental identification is that postmortem dental remains can be compared with antemortem dental records, including written notes, study casts, and radiographs to confirm identity. The palate not only represents a suitable repository for such unique and

identifying features they also survive most postmortem events that can disrupt or change other body tissues. Thus, further studies are needed to investigate the possibility that there is a distinct ethnic difference in the palatal rugae morphology in human identification.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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