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A Comparative Analysis of Palatal Rugae Number and Shape in Sex Determination among the Population of Rajasthan Using Dental Cast: An Institutional Study

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Abstract:
Background*: Forensic odontology plays an important role in the identification of human remains in mass disasters such as air crashes, and accidents. The study of palatal rugae patterns for human identification is called rugoscopy. Rugae pattern is used due to its stability and uniqueness and also in gender identification with regards to number and shape.*
Aims and Objectives*: To measure, compare, and evaluate the various measurements of palatal rugae observed on dental casts and assess its usefulness as an aid in sex determination among the population of Rajasthan state.*
Materials and Methods*: A retrospective study was done comprising a total sample size of 60 individuals classified into 2 groups comprising 30 males and 30 females. Measurements were done on dental casts. In this study, two parameters were measured and compared the palatal rugae number and shape.*
Measurements were made bilaterally, the average values calculated, and the results were tabulated and statistically analyzed.
Results*: This study observed that the overall measurements of the palatal rugae number more in males as compared to females. Straight, wavy, and circular rugae shapes were more predominant in males as compared to females. While, unification rugae shape was more predominant in females as compared to males, and each variable of palatal rugae was a significant predictor for gender determination.*
Conclusion: *The observation from the present study suggests that the palatal rugae measurements exhibit significant sexual dimorphism and the rugae can be used for gender determination for forensic analysis.*
Key Word*: Forensic odontology, Gender identification, Palatal rugae pattern, Rugoscopy, Sex dimorphism Dental casts.*

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I. Introduction

Human identification is one of the major fields of study in forensic science because it deals with the human remains and aims at establishing the identity. Dental investigation in human identification remains one of the most reliable and frequently applied methods by forensic odontologists, predominantly by the comparison of antemortem and postmortem records. Forensic dental identification mainly involves determining the gender, age, ethnic background, community etc. of the individual. [1]

Violence and nature instigated tragedies, take away millions of lives often. One of the most challenging situations in forensics is mass disasters where one comes across severely decomposed and fragmented bodies. Through the speciality of forensic odontology, dentists play a small but significant role in the identification of victims of crime and disaster through dental records.[2]

Forensic odontology is a speciality in dentistry, which occupies a primary place within the total spectrum of methods applied to medico-legal identification. DNA, fingerprint, and dental record comparisons are the most commonly used scientific methods of forensic identification. Constraints to the use of fingerprints occur in situations where the hands are charred or mutilated. Though teeth are more durable, it is however not practical to employ them in identifying the edentulous persons. A useful method of human identification in these circumstances is by examining the palatal rugae pattern (palatal rugoscopy). [3]

Palatal rugoscopy i.e., the study of palatal rugae is one of the simple techniques used by a forensic odontologist in human identification. Palatal rugae also called rugae palatinae or Plicae palatinae transverse refers to a series of transverse ridges on the anterior part of the palatal mucosa on each side of the median palatal raphe and behind the incisive papillae. The anatomic position of these transverse ridges aid in oral swallowing,

suction in children, and taste perception and they participate in speech especially 's' and 'sh' phonemes. In clinical dentistry, due to the stable nature of the palatal rugae, it aids as a landmark during orthodontic treatment, cleft palate surgeries, palatal prosthesis, and medico-legal identification. [2] Palatal rugae have been equated with fingerprints and are unique to an individual. It can be of special interest in edentulous cases and also in certain conditions where there are no fingers to be studied, such as burned bodies or bodies that underwent severe decomposition. [4]

In addition, rugae patterns may be specific to racial groups, facilitating population identification, which is essential in mass disasters. Even relatively similar population groups show differences in rugae patterns. Racial profiling using intraoral features other than the teeth may have relevance in odonto-stomatological identification in India where credible dental anthropological data is negligible. Rugae can resist the incidents of fire and high impact trauma and can also resist decomposition for up to 7 days. [5] Thus, the objective of the present study was to record the distribution of the predominant rugae pattern in the Rajasthan population and to compare the distribution of these parameters between males and females to know if gender determination is possible.

This study, measures, compares and evaluates the various measurements of the palatal rugae as an aid in sex determination on dental casts. This study establishes the baseline data of these parameters among the population of Rajasthan.

II. Material And Methods

A retrospective study was conducted on 30 males and 30 females from the Rajasthan population who attended the RUHS COLLEGE OF DENTAL SCIENCES, JAIPUR between the age group of 20-40 years. The study used ideal dental casts of dentate patients. All subjects were healthy individuals free of congenital anomalies, inflammation, trauma, or orthodontic treatment.

The impression of their maxillary arch was recorded using alginate and models were prepared immediately by pouring dental stone into the impressions. The models were free of voids or discrepancy, especially in the anterior two-thirds of the hard palate and the base of the model was trimmed parallel to the occlusal plane. The rugae were delineated using a sharp graphite pencil and recorded according to the classification given by Thomas and Kotze.

Study Design: Prospective open label observational study

Study Location: This was a hospital based retrospective study was carried out on patients of Department of Oral Medicine and Radiology at RUHS college of dental sciences, Jaipur, Rajasthan.

Study Duration: July 2019 to September 2019.

Sample size: 60 patients.

Thomas and Kotze [6] classify the rugae pattern into: Straight, wavy, circular, curved and unification. The shape and number of rugae were studied for gender identification and mean values were calculated. Each rugae was measured on right and left sides of the mid-palatine raphe.

Method of identification: A midline was drawn coinciding with that of the mid palatine raphae extending from the incisive papillae to the posterior-most extent of the rugae on the palate. This divided the rugae into two halves and the rugae in each half were highlighted using a lead pencil under the spotlight.

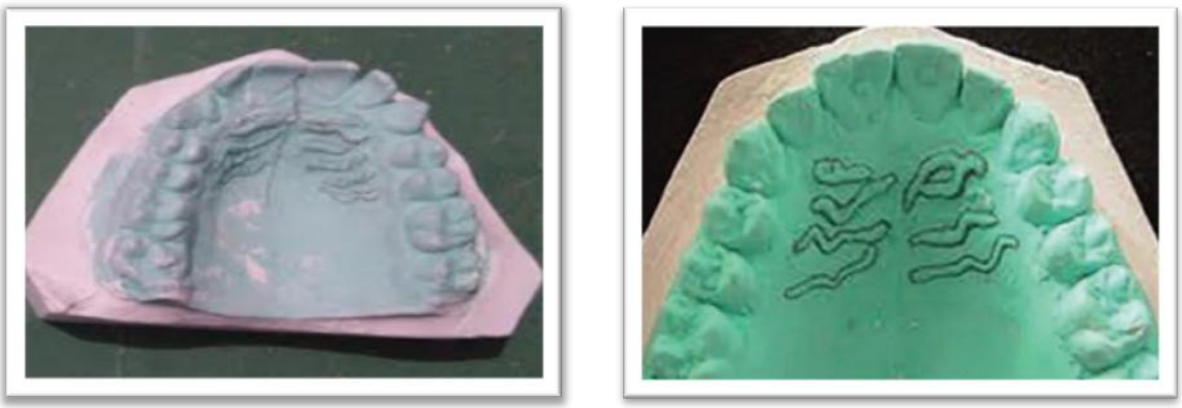


Fig. 1 Patient's dental cast with rugae highlighted using a lead pencil under the spotlight.

Statistical analysis

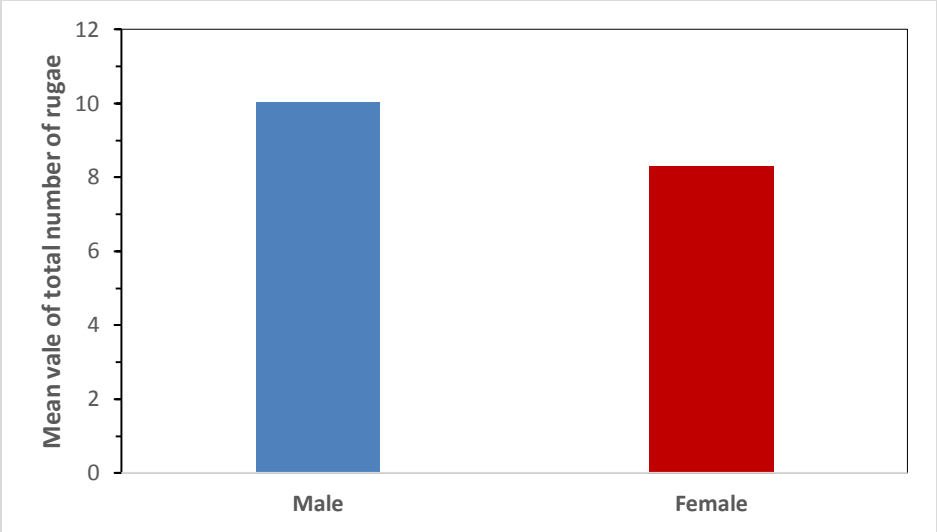
The data were analyzed using the discriminant procedure of the statistical package SPSS 24.0. Discriminant function analysis was used to determine variables that discriminate between male and female and is increasingly utilized for sex diagnosis from palatal rugae measurements.

III. Result

All the dental casts (30 males and 30 females, a total of 60) were thoroughly examined and statistically analyzed. The data shows that the total number of rugae in males was higher as compared to females. In this study, results showed that among the various shape of rugae (circular, unification, straight, wavy and curved) straight, wavy, and circular rugae was more predominant in males as compared to females. While unification rugae were more predominant in females as compared to males, and each variable of palatal rugae to be a significant predictor for gender determination the observed difference was found to be statistically significant.

Table: 1 Comparison between the total number of palatal rugae among the males and females

Gender	Number	Mean	Standard deviation	p-value	Remarks
Male	301	10.033	4.319	0.0001	Significant
Female	249	8.300	4.360		

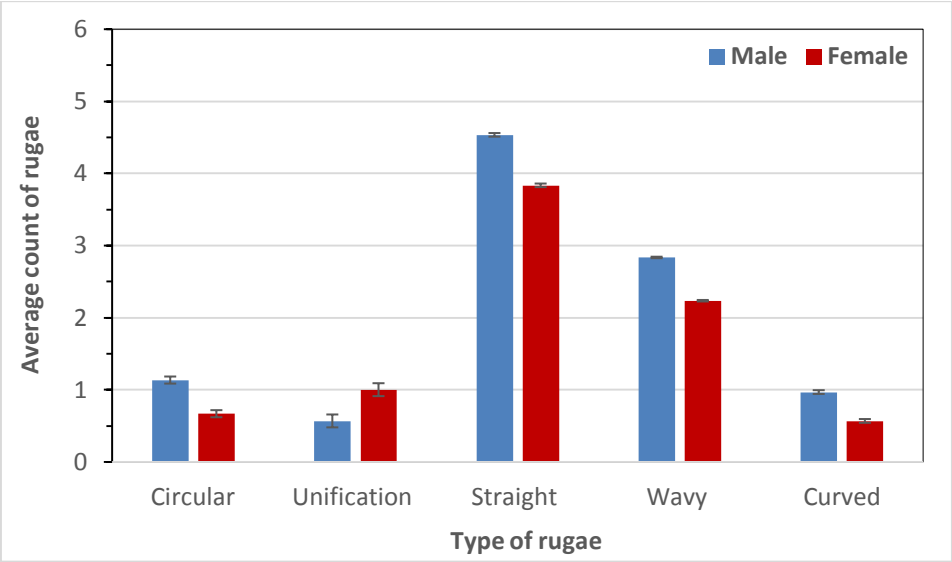


Graph 1. Comparison between the average number of palatal rugae among the males and females

Table 1 and graph 1 show mean values of total rugae number between males and females were 10.03 and 8.30, respectively. The difference in values between males and females was found to be statistically significant.

Table: 2 Comparison between the various shape of palatal rugae among the males and females

Parameters	Gender	Patient number	Total Number	Mean ± S.E.	S.D.	Significance level
Circular	Male	30	34	1.13	0.73	0.012
	Female	30	20	0.67	0.66	
Unification	Male	30	17	0.57	0.57	0.011
	Female	30	30	1.00	0.69	
Straight	Male	30	136	4.53	1.31	0.045
	Female	30	115	3.83	1.34	
Wavy	Male	30	85	2.83	0.95	0.017
	Female	30	67	2.23	0.94	
Curved	Male	30	29	0.97	0.76	0.042
	Female	30	17	0.57	0.73	



Graph: 2 Comparison between the various shape of palatal rugae among the males and females

Table 2 and Graph 2 showed that the total number of straight rugae were 136±4.53 in male, while in women were 115±3.83. However, among the various rugae, unification rugae were higher in females (30±1.0) as compared to males (17±0.57), which was least in males as compared to other rugae patterns. Furthermore, the female curved rugae were (17±0.57) least as compared to other rugae patterns, while the male curved rugae were (29±0.97), which was the second least number in all rugae patterns.

IV. Discussion

Palatoscopy, the study of palatal rugae patterns, is an important tool in sex determination, Forensic odontology, and Orthodontics. The study of palatal rugae patterns can be taken as a useful adjunct for human identification besides other known methods like fingerprints, dental records, and DNA studies. The present study was designed to compare the total number of rugae and the pattern, between male and female subjects in Rajasthan state, to identify and assess the total number and predominating patterns in them and to see whether they can be used as a reliable tool for identification. Many studies have been carried out in past on rugae patterns and it is a fact that no two palates are alike in their configuration. The palatal rugae are unique.

In this study observed that the overall measurements of the palatal rugae number more in males as compared to females. Straight, wavy, and circular rugae shape was more predominant in males as compared to females. Unification rugae shape was more predominant in females as compared to males, and each variable of palatal rugae was a significant predictor for gender determination.

V. Swabna *et al.* (2018) [7] studied to identify the gender by comparing the rugae patterns in males and females corresponding to number, shape, and size. They analyzed the diverging rugae pattern and converging rugae pattern was higher in females than in males and wavy, straight and curve rugae patterns were higher in males than in females.

Selvamani M *et al.* (2019) [8] analyzed and identified differences in the palatal rugae patterns and gender-wise distributions in three different populations (Kerala, Mahe and Puducherry) The palatal rugae pattern was analyzed for shape. They found the most common pattern was the wavy pattern (53.57%) followed by curved (18.22%) and straight (13.66%). The least was circular (1.3%). When compared between sex, the most common pattern was found to be wavy (male – 54.3% and female – 53.09%), while the curved pattern was more common among females (21.09%) than males (13.97%). The straight pattern was more common among males (18.8%) than females (10.18%). The least common pattern was found to be the circular in both sexes which accounted for around 1%.

Balgi P *et al.* (2014) [9] carried out a study to determine the gender differences in rugae patterns concerning the length, number, and shape. Included 50 patients (25 males, 25 females). They analyzed the average length of the rugae was greater in males than in females. The average numbers of rugae were the same in both males and females. The straight pattern was more commonly seen in females than in males.

Srikala P *et al.* (2017) [10] conducted a study on 100 subjects, 50 males and 50 females aged 18 to 25 years from S. N. Dental college, Kalaburgi. They found males and females showed predominantly wavy rugae shapes followed by straight, curved, and circular rugae. More number of rugae are found on the left side of the palate.

Khajuria RR *et al.* (2017) [11] carried out a study to determine the gender difference in rugae patterns with regards to the number and shape. Included a total of 50 students, 25 male and 25 female from the high school of Jammu. They found that the number of palatal rugae was higher among males and that straight type rugae were most prevalent among both sexes.

Dwivedi N *et al.* (2016) [12] carried out a study on a total of 500 subjects, 250 male and 250 female from OPD of Hitkarini Dental College and Hospital, Jabalpur. They found males showed a greater number of rugae than females. Which were similar findings to our study.Education Program (NCEP) report had proposed to lower target levels to even more aggressive LDL-C goals for very high-risk patients.

V. Conclusion

Palatal rugae can be considered a valuable tool in sex determination since it possesses resistance to damage and disintegration processes. We found that the dental cast's palatal rugae measurements were reliable for sex determination. Hence, we strongly suggest the use of palatal rugae as an aid for sex determination in forensic analysis. In view of these findings, further studies on more diverse populations to assess the significance of these parameters are recommended.

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