Original Research

Palatal Rugae Patterns as a Bioindicator for Forensic Identification in Kodava and Tibetan Populations of India

Deeksha Kiran Shetty[1], Sheetal Mali[2], Hegde Deepak Divakar[3], Patil Amit[2], Edake Dhairaysheel[4], Unadkat Harsh[2]

Contributors:
[1]Assistant Professor, Department of Public Health Dentistry, Bharti Vidyapeeth Deemed University Dental College and Hospital, Kharghar, Navi Mumbai, Maharashtra, India; [2]Assistant Professor, Department of Conservative Dentistry and Endodontics, Bharti Vidyapeeth Deemed University Dental College and Hospital, Kharghar, Navi Mumbai, Maharashtra, India; [3]Reader, Department of Conservative Dentistry and Endodontics, Bharti Vidyapeeth Deemed University Dental College and Hospital, Kharghar, Navi Mumbai, Maharashtra, India; [4]Consulting Endodontist, Fortis Hiranandani Hospital, Vashi, Navi Mumbai, Maharashtra, India.

Correspondence:
Dr. Shetty DK. Department of Public Health Dentistry, Bharti Vidyapeeth Deemed University Dental College and Hospital, Kharghar, Navi Mumbai, Maharashtra, India. Email: contactmedicalwriter@gmail.com

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Abstract:

Background: Palatal rugae are distinct to each individual and are highly specific to each individual as their fingerprints. Rugae pattern are specific to different racial groups making it convenient for population identification. Palatal rugae retain their shape throughout life and hence can be useful as an identification tool. The present study aimed at analyzing the differences in rugae pattern among Kodavas and Tibetan populations of Coorg, India and to examine if there was a difference in the rugae pattern between males and females within each group.

Materials and Methods: The study comprised of 30 participants between 18 and 30 years of age, equally distributed between genders from each group. Examination of maxillary cast after tracing the rugae patterns was carried out. Rugae pattern was classified as "straight," "wavy," "curved," "circular" and "unification." Statistical analysis was done using SPSS 16 software. Non-parametric Mann–Whitney test was used for pairwise comparison of two populations. Mann–Whitney two-tailed test was used to test the difference between males and females.

Results: Results showed that wavy pattern was highest for both the groups. Circular rugae were totally absent in both the groups. There was a significant difference between Kodavas (mean = 1.000) and Tibetans (mean = 0.13) for unification pattern (P = 0.001).

Conclusion: Palatal rugae patterns can be used as a bioindicator for human identification.

Key Words: Kodavas, palatal rugae pattern, population identification, Tibetans

Introduction

Palatal rugae refer to the ridges on the anterior part of the palate on each side of the median palatal raphe and behind the incisive papilla. Histologically they consist of an accumulation of fibroblasts and collagen fibers in the connective tissue underneath the thickened epithelium assuming a distinct pattern and orientation. Their applications have been done in various fields such as anthropology, genetics, forensic sciences, comparative anatomy, and dentistry.[1] Investigators have suggested that palatal rugae are unique to each individual, and they fulfil five elementary technical requirements: Individuality, immutability, perennity, practicability, and possibility of classification to be used as an identification method.[2] A range of forensic science techniques are used to make a positive identification of the deceased victims, some of these are visual identification, use of fingerprints, DNA profiling and odontology. Palatal rugae are highly specific to each individual as their fingerprints. Identification of the badly mutilated body has been done using rugae patterns on patients denture in the past.[3] Rugae pattern are specific to different racial groups making it convenient for their identification in a mass disaster situation. Rugae pattern is unique to humans and it retains its shape throughout life and hence it can be useful as an identification method.[2] The palatal rugae are well located within the maxilla protected by the structure of the head. Tongue and buccal pad of fat within the cheeks gives it thermal protection. Moreover, teeth and alveolar ridges provide additional protection against postmortem insult.[4,5]

The present study has aimed at analyzing the rugae pattern in two populations in Coorg, India, namely Kodavas and Tibetans and find out if there was a difference in the rugae pattern between males and females within each group.

Materials and Methods

The study was conducted among Kodavas and Tibetans who were the residents of Coorg, India. The study sample included 30 participants with equal number of males and females between 18 and 30 years of age from each group; all the participants had full set of dentition. A single investigator, carried out the examination of maxillary casts after tracing the rugae patterns. Following training and calibration of the investigator around 10 casts in each group were studied for palatal rugae patterns. Each cast was carefully examined, and the findings were compared to know the diagnostic variability agreement using Kappa statistics. There

was 80%. agreement. Convenient sampling technique was used. The study participants were selected among patients attending Dental College in Coorg. The study lasted for 2 months. Before conducting the study, ethical approval was obtained from the Institutional review board. Prior to the study written informed consent was taken from each participant prior to the study. The rugae pattern was recorded according to the classification given by Kapali *et al.*[6] Rugae pattern was classified as "straight," "wavy," "curved," "circular" and "unification." All rugae were included for the study. Statistical analysis was done using SPSS 16 software. Pairwise comparison for two populations was done using non-parametric Mann–Whitney test. Mann–Whitney two-tailed test was used to assess the difference between genders.

Results

Graph 1 (Kodavas) and Graph 2 (Tibetans) show the percentage distribution of rugae patterns. The Graphs 1 and 2 show that wavy pattern was highest for both the groups. Non-specific pattern was absent among Kodavas, whereas the circular pattern was totally absent among both the groups.

Table 1 gives the pairwise comparison of mean values of two populations for rugae pattern. Mann–Whitney test revealed that there was the significant difference between Kodavas (mean = 1.00) and Tibetans (mean = 0.13) for unification
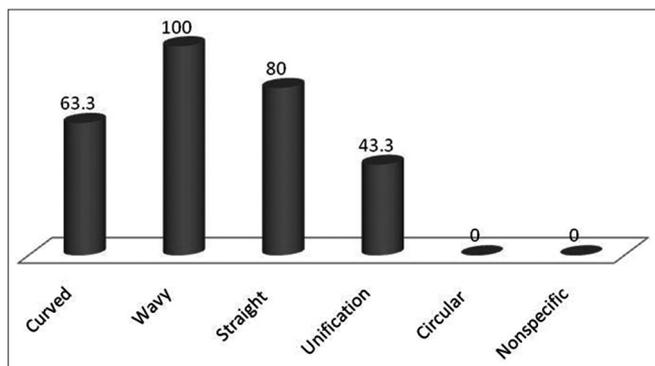
Graph 1: Percentage distribution of different rugae patterns among Kodavas.
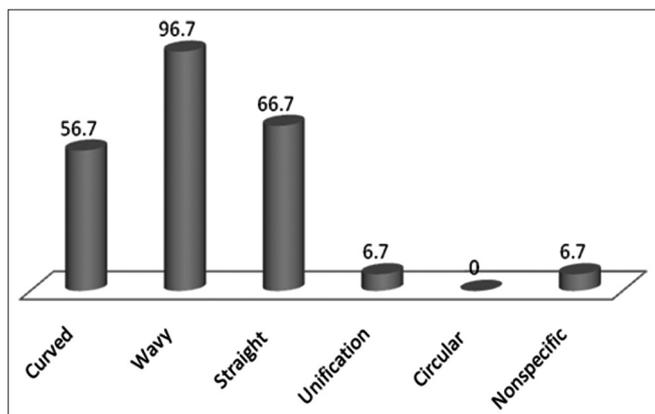
Graph 2: Percentage distribution of different rugae patterns among Tibetans.

pattern ($P = 0.001$) was significant. However, there was an insignificant difference between males and females for distribution of rugae patterns (Table 2).

Discussion

There are several techniques for analyzing palatal rugae. They range from complex procedures like stereoscopy, calcorrugoscopy, oral photography to simpler methods like intraoral replication and inspection of palatal rugae. Study of the maxillary cast for rugae pattern is the most simple and reliable method.

Palatal rugae show minute variations in its presentations. Numerous classification of palatal rugae has been done based on length, shape, number, and direction. Most of the methods mentioned above are quite complex and cumbersome to apply. Tracing and visualization of rugae shape on the maxillary cast has been considered the most simple and reliable method. Though it has the disadvantage of being subjective it is considered to be the most simple and reliable method. The use of stone casts for the duplication of palatal rugae from the maxillary tissues is justified, as reported by earlier studies that have shown 79% accuracy in rugae tracings using stone casts.[4,7,8]

In literature the consensus of opinion is that although the number and length of rugae pattern may be affected by age, palatal growth, arch expansion, orthodontic treatment or loss of teeth; the pattern of palatal rugae remain fairly stable throughout life[5,9-12] hence use of palatal rugae pattern in population identification is warranted.

The percentage distribution of rugae patterns between the two populations showed that wavy pattern of palatal rugae was present in 100% of Kodavas. Unification, straight and curved patterns were more among Kodavas compared to Tibetans. Non-specific pattern was seen more among Tibetans. The circular pattern was absolutely absent in both the groups. There was significant difference between Kodavas and Tibetans for unification pattern. Dominant presence of wavy and curved patterns among Australians aborigins,[6] presence of curved patterns among Indian males.[13] Significant differences in rugae patterns among Kannadigas and Manipuris[14] have emphasized the fact that certain patterns are more common in certain populations stressing its importance in population identification. Distribution of rugae pattern according to gender showed that there was no significant difference between male and females for rugae pattern among Kodavas and Tibetans.

Conclusions

Palatal rugae patterns in two populations groups from Coorg have been studied. Wavy pattern was most common seen in both the population groups. The circular pattern was absolutely absent in both the ethnic groups. Significant difference between the two populations were found for unification patterns. The differences in rugae patterns between two populations may

Table 1: Pair wise comparison of two populations for rugae pattern (combined males and females).					
Population	**Details of analyses**	**Parameters**			
		Curved	**Wavy**	**Straight**	**Unification**
Kodavas and Tibetans	Mean value for Kodavas	2.667	8.400	2.929	1.000
	Mean value for Tibetans	1.400	9.467	4.133	0.133
	Observed value of test statistic	1.868	−0.523	−1.417	3.605
	Critical value	1.960	1.960	1.960	1.960
	P	0.062	0.601	0.157	0.001
	Decision	Non-significant	Non-significant	Non-significant	Significant

Table 2: The mean difference between the sexes for distribution of rugae pattern in the two populations.					
Population	**Details of analyses**	**Parameters**			
		Curved	**Wavy**	**Straight**	**Unification**
Kodavas	Mean values for males	1.267	4.667	1.133	0.600
	Mean values for females	1.400	3.733	1.733	0.400
	Observed value of test statistic	−0.507	1.812	−1.438	0.993
	Critical value	1.960	1.960	1.960	1.960
	P value	0.612	0.070	0.151	0.321
	Decision	Non-significant	Non-significant	Non-significant	Non-significant
Tibetans	Mean values for males	0.733	5.000	2.733	0.000
	Mean values for females	0.667	4.467	1.400	0.133
	Observed value of test statistic	0.295	0.547	1.463	−1.439
	Critical value	1.960	1.960	1.960	1.960
	P value	0.768	0.585	0.144	0.150
	Decision	Non-significant	Non-significant	Non-significant	Non-significant

be attributed to hereditary factors however migration of the population from the region of origin might have influenced the results to a moderate level. It should be noted that the above procedure does not require any advanced technology Limited sample size is one of the limitation of the study. Nevertheless palatal rugae patterns can be used as a bioindicator in population identification and should be examined in detail in large samples to further validate the study findings.

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