

Comparison of palatal rugae patterns in Kodava and Malayalee populations of South India

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Introduction

Person's identity is a difficult task in cases of traffic accidents, acts of terrorism or in mass disaster situations. Visual identification, use of dental records, fingerprints, and DNA comparisons probably are the most common techniques used in this context, allowing fast and secure

Abstract

Introduction: The palatal rugae pattern is unique to humans and may be specific to ethnic groups hence useful in population identification in forensic dentistry. The present study has been carried out to analyze the rugae pattern in two populations in and around Coorg, with objectives to analyze the palatal rugae pattern among Kodavas and Malayalees and to analyze the rugae pattern between sexes within each group. **Materials and Methods:** The sample comprised two population groups in Coorg namely Kodavas and Malayalees, ($n=30$) from each group, age-range of 18-30 years, equally distributed between the sexes. The rugae pattern were categorized as 'straight,' 'wavy,' 'curved' 'circular', and 'unification'. Pairwise comparison for two populations was done using non-parametric Mann-Whitney test. Mann-Whitney two-tailed test was used to test the difference between sexes. **Results:** Wavy pattern (100%) was highest among Kodavas. There was a significant difference between Malayalees and Kodavas for wavy (Mean = 5.867 and 8.400) and unification patterns (Mean = 2.267 and 1.000). Significant difference between sexes for straight rugae pattern (Mean, males = 2.267, females = 1.200) among Malayalees was seen. **Conclusion:** The differences in rugae shape between the two populations (wavy and unification patterns) may be attributed to genetic factors and recent shared ancestry has probably rendered their differences to moderate levels.

Key words: Forensic dentistry, palatal rugae, population study

reliable identification. However, visual identification and use of fingerprints are limited by post-mortem changes associated with time, temperature, and humidity.

Teeth are more durable than other parts of the body but identification via dental records may prove to be inconclusive, because dental treatment might have been performed between the creation of a dental record and the person's death. Although DNA profiling is accurate, it is expensive and time-consuming for use in large populations. It is a well-established fact that the rugae pattern is as unique to humans as are his or her fingerprints and it retains its shape throughout life hence it can be useful as an identification method.^[1] The anatomical position of the rugae inside the mouth is surrounded by cheeks, lips, tongue, buccal pad of fat, teeth, and bone which keeps them well-protected from trauma and high temperatures.^[2,3]

Access this article online	
Website: www.jfds.org	Quick Response Code 
DOI: 10.4103/0975-1475.119768	

Their application in forensic dentistry has been immense as they have been equated with fingerprints and are unique to an individual. The rugae are well protected by the lips, buccal pad of fat and teeth and hence, survive post-mortem insults.

Palatal rugae have been shown to be highly individualistic and consistent in shape throughout life^[4] but there is considerable debate on the matter. However, Thomas and Van Wyk^[5] successfully identified a severely burnt edentulous body by comparing the rugae to those on the victim's old denture indicating, among other things, that rugae are stable in adult life. Thus, palatal rugae appear to possess the features of an ideal forensic identification parameter because of its uniqueness, post-mortem resistance, and stability. Hence, they can be used in post-mortem identification provided an ante-mortem record exists. In addition, rugae pattern may be specific to racial groups facilitating population identification which may be required post-disaster. In fact, differences in rugae pattern have been found in relatively similar population groups. Racial profiling using intra-oral features other than the teeth may have relevance in odontostomatological identification especially in a country like India where, credible dental anthropological data is negligible.^[5]

The present study has aimed at analysing the rugae pattern in two populations in and around Coorg, with objectives to analyze the palatal rugae pattern among Kodavas and Malayalees and to analyze the rugae pattern between sexes within each group.

Materials and Methods

The sample comprised of two population groups namely Kodavas and Malayalees who were residents of Coorg, Karnataka. The sample included 30 participants from each group, within an age range of 18-30 years, equally distributed between the sexes. Individuals with full set of dentition and individuals within the specified age limit were included in the study. The oral examination of all the study subjects was carried out by a single investigator. A group of 10 casts in each population were studied for palatal rugae pattern. The investigator was trained and calibrated for two successive days. Each cast was meticulously examined and the findings were compared to know the diagnostic variability agreement. The agreement was found to be 80%. A convenient sample of 30 individuals in each group equally divided among the sexes was selected among patients attending dental college in Virajpet. The study was carried for 2 months. Before conducting the study the ethical approval was obtained from the Institutional Ethical Committee. Prior to the study the details of the examination procedure was explained to the study subjects and written informed consent was obtained from each participant.

The rugae pattern was recorded according to the classification given by Kapali *et al.*,^[5] Rugae were categorized as 'straight,' 'wavy,' 'curved', and 'circular'. In addition, if rugae had two arms, it was categorized as 'unification' [Figures 1 and 2]. All rugae were considered for the study, irrespective of their length. 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 test the difference between sexes.

Results

The present study was carried out among patients attending Dental College, Virajpet, to analyze if there was a difference in rugae pattern in two populations namely Kodavas and Malayalees. The following results were obtained. Percentage distribution of different rugae patterns among Kodavas [Figure 3] showed that wavy pattern (100%) was highest among Kodavas followed by straight (80%), curved (63.3%)

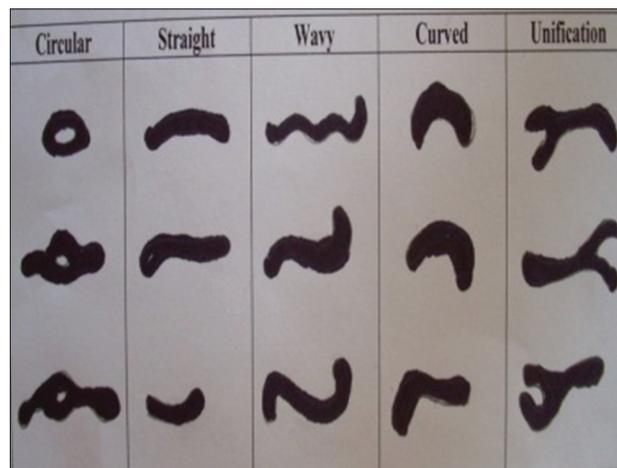


Figure 1: Diagrammatic representation of different types of rugae pattern

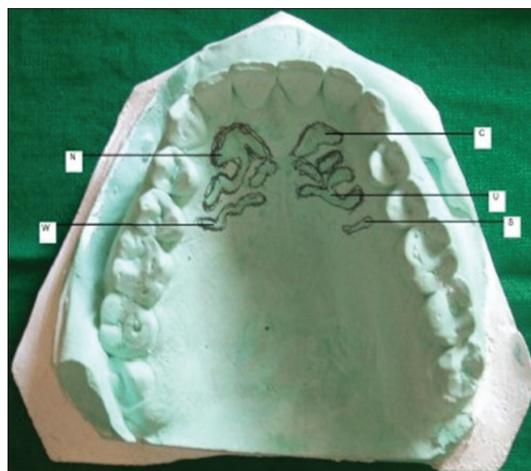


Figure 2: Different types of rugae pattern delineated on maxillary cast (C-curved, S-straight, U-Unification, W-wavy, N-non-specific rugae patterns)

and unification (43.3%) patterns, respectively. Circular and non-specific pattern was totally absent in this group. Figure 4 showed percentage distribution of different rugae patterns among Malayalees. The figure showed that wavy (80%) and straight (80%), patterns were highest among Malayalees followed by curved (70%), unification (56.7%) and non-specific (16.7%) pattern. Circular pattern was totally absent in this group.

Table 1 gives the pairwise comparison of two populations for rugae pattern. Mann-Whitney test was used for pairwise comparison of mean values of two populations. There was a significant difference between Malayalees (mean = 5.867) and Kodavas for wavy (mean 8.400), respectively and unification pattern (Mean = 2.267 and 1.000, respectively). Table 2 shows the mean difference between the sexes for distribution of rugae pattern in the two populations. Distribution of rugae pattern according to the sexes showed that there was a significant difference between sexes (Mean for males = 2.267 and females = 1.200, respectively) for straight rugae pattern among Malayalees but the differences in rugae pattern for Kodavas was insignificant.

Discussion

Palatal rugae due to their special features have been widely used in population identification. There are several ways to analyze palatal rugae. Intraoral inspection is probably the most commonly used and also the easiest and the cheapest method. However, it can create difficulties if a future comparative analysis is required. The other detailed and complex techniques include oral photography, calcorugoscopy, stereoscopy, and stereophotogrammetry. However, because of its simplicity, cost-effectiveness and reliability, the study of maxillary cast is the most widely used technique.

Although there are numerous classifications of palatal rugae based on length and shape^[6] there are difficulties in observing, classifying, and interpreting the limitless and minute variations in palatal rugae, and there is a need to have a simple and reliable method for classification of palatal rugae. Hence the classification based on the shape was used for the study. While observation of rugae shape is a subjective process, it is relatively easy to record and does not require complex instrumentation. It may not depict

some of the more intricate rugae patterns but, perhaps, complex patterns induce more observer errors. In addition, significant differences between population groups have been revealed in earlier studies indicating the applicability of rugae shape in population differentiation.^[2]

The present study used stone casts for duplication of palatal rugae and previous studies has shown accuracy in rugae tracings using stone casts.^[2,7] The percentage distribution of rugae patterns in different population showed that the wavy pattern was 100% in Kodavas followed by 80%

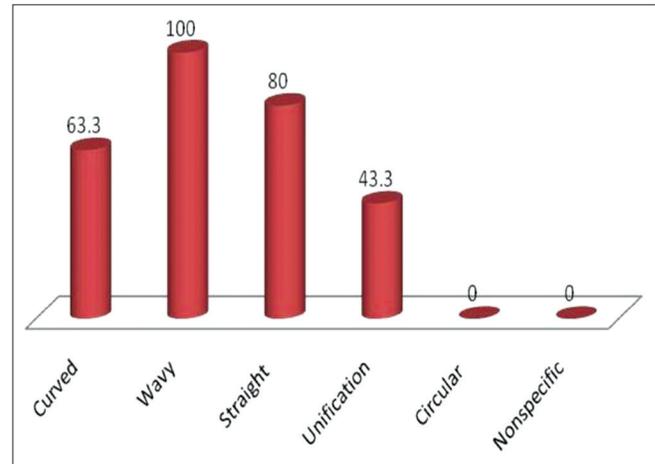


Figure 3: Percentage distribution of different rugae patterns among Kodavas

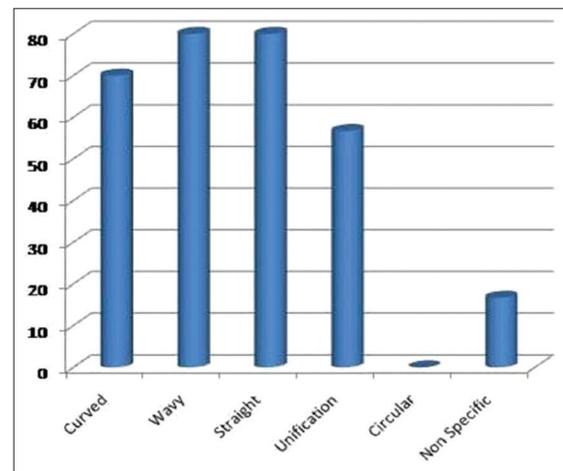


Figure 4: Percentage distribution of different rugae patterns among Malayalees

Table 1: Pairwise comparison of two populations for rugae pattern (combined males and females)

Population	Details of analyses	Parameters			
		Curved	Wavy	Straight	Unification
Malayalees and Kodavas	Mean value for Malayalees	3.067	5.867	3.467	2.267
	Mean value for Kodavas	2.667	8.400	2.867	1.000
	Observed value of test Statistic	0.866	-2.010	0.975	2.124
	Critical value	1.960	1.960	1.960	1.960
	P value	0.387	0.044	0.330	0.034
	Decision	Non-significant	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
Malayalees	Mean values for males	1.800	2.200	2.267	1.200
	Mean values for females	1.267	3.667	1.200	1.067
	Observed value of test Statistic	1.153	-1.807	2.023	0.328
	Critical value	1.960	1.960	1.960	1.960
	P value	0.249	0.071	0.043	0.743
	Decision	NS	NS	Significant at 5% level ($P < 0.05$)	Non-significant
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

in Malayalees. Unification and curved pattern was more among Malayalees. Straight pattern was equally distributed among Kodavas and Malayalees with a prevalence of 80% each. Non-specific pattern was more among Malayalees and circular pattern was totally absent among Kodavas which was similar to the results of study done by Kapali.^[8]

Comparison for two populations revealed that there was a significant difference between Malayalees and Kodavas for wavy and unification pattern.

Distribution of rugae pattern according to sexes showed that there was a significant difference between genders for rugae pattern with higher mean value for males than females for straight rugae pattern among Malayalees.

Pairwise comparison for two populations revealed that there was a significant difference between Kodavas and Malayalees for wavy and unification pattern.

Studies done by Preeti *et al.*,^[5] on two Indian populations showed that wavy and curved pattern were the most prevalent rugae shapes in the study groups, followed by straight rugae. Unifications were few in number while circular rugae were not observed.

Studies done by Kapali *et al.*,^[8] on Australian Aborigines and Caucasians revealed that the most common shapes in both ethnic groups were wavy and curved forms, whereas straight and circular types were least common.

Study done by Vishlesh Arora^[9] revealed that significant difference was observed between rugae pattern in two populations belonging to Karnataka and Manipur.

There was a significant difference between males and females for straight rugae pattern among Malayalees. Study results by Faisal M. Fahmi^[7] showed that the females

showed a significant difference in the converge type while the males had a significant difference in the circular type indicating that palatal rugae in addition to other methods such as visual, fingerprints, and dental characteristics has a role in forensic sciences.

Studies done by Shetty *et al.*,^[10] showed that Indian males had more number of curved rugae on both right and left sides than Tibetan males and females had more wavy rugae on right and left sides than Indian females.

The characteristic pattern of the palatal rugae did not change as a result of growth, remaining stable from time of development until the oral mucosa degenerated at death^[11,12] and hence can be used in population identification.

Conclusion

In conclusion, palatal rugae pattern is considered to be unique to an individual and their use in forensic identification has been advocated and applied. The rugae are also considered to have population-specific configuration. The characteristics of palatal rugae shape in two populations from Coorg have been studied using dental casts obtained from maxillary impressions using alginate. Wavy pattern was highest in both the population groups. Circular pattern was totally absent in both the racial groups. Significant differences between the two populations were observed in wavy and unification patterns and a significant difference between Malayalee males and females was seen for straight rugae pattern. The differences in rugae shape between the two populations may be attributed to genetic factors although recent shared ancestry has probably rendered these differences to moderate levels. It has been recognized that the above interpretations are precluded by limited sample size and, therefore, the preceding analysis should only be considered as preliminary. Nevertheless it is believed that rugae shape have great utility in population

differentiation and should be examined in detail in large samples to further validate the study findings.

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How to cite this article: Shetty DK, Machale PS, Savant SC, Taqi SA. Comparison of palatal rugae patterns in Kodava and Malayalee populations of South India. *J Forensic Dent Sci* 2013;5:85-9.
Source of Support: Nil, **Conflict of Interest:** None declared