

Rugae dimensions and their significance in forensic dentistry

Sanjayagouda B. Patil,
Manashvini S. Patil¹,
Smita B. R.¹,
Kavyashree G. Hebbar
*Departments of Prosthodontics,
and ¹Oral and Maxillofacial
Pathology, Shri Hasanamba
Dental College, Hassan,
Karnataka, India*

Address for correspondence:
*Dr. Manashvini S. Patil,
Department of Oral and
Maxillofacial Pathology, Shri
Hasanamba Dental College,
Hassan - 573 201, Karnataka, India.
E-mail: sbpatilmanu@gmail.com*

Abstract

Background: The palatal rugae are the ridges situated in the anterior part of the palatal mucosa, are unique to each individual, and can establish individual's identity. **Aims:** To establish the reliability of using the palatal rugae dimensions in identifying the different ethnic groups. **Settings and Design:** Many studies have established the reliability of using the palatal rugae patterns in identifying the different ethnic groups. However, no studies have been reported in the English language literature that uses the rugae dimensions to identify the different ethnic groups. **Materials and Methods:** A total of 60 subjects aged between 18–30 years comprising of 30 Kannada speaking and 30 Malayalam speaking individuals, with 15 males and 15 females, in each were considered for the study. The rugae patterns of these patients were traced on dental casts obtained with alginate impressions. A digital caliper was used to measure the different dimensions of the palatal rugae. **Statistical Analysis:** Statistical analysis was carried out using the unpaired 't' test. **Results and Conclusion:** The present study showed a significant difference in the palatal rugae dimensions among the Karnataka and Kerala individuals.

Key words: Ethnic background, forensic dentistry, forensic identification, forensic science, palatal rugae

Introduction

The palatal rugae are ridges situated in the anterior part of the palatal mucosa on each side of the medial palatal raphae and behind the incisive papilla. The pattern of orientation typical for the individual is formed by the 12th to 14th week of intrauterine life and remains stable from this time throughout the life until the oral mucosa degenerates at death, with exceptions for those patients who have undergone orthodontic treatment.^[1] The palatal rugae possess unique characteristics that could be used in paternity identification and in circumstances where

identification of an individual by fingerprint or dental record comparison is difficult. In this case, palatal rugae may be considered as an alternative source of comparative material.^[2] The palatal rugae are permanent (except in the individuals who have undergone orthodontic treatment), unique to each individual and can establish identity through discrimination.^[3,4] There seems to be a significant association between the rugae form and ethnicity; if a particular rugae pattern could be established for different ethnic groups, it would be an easy assignment for the forensic odontologist to help in the identification of an individual.

Various studies have been done to establish the reliability of using the palatal rugae patterns in the identification of different ethnic groups. Though, the rugae pattern is unique to individuals, interpretation of the rugae pattern is subjective. A subjective parameter considered for any analysis usually gives rise to inter-observer variability. To know the ethnic background in the English language literature, no studies have been done using objective parameters or palatal rugae.

Access this article online

Website: www.jfds.org	Quick Response Code
DOI: 10.4103/0975-1475.176967	

The purpose of this article is to analyze if there are any significant differences in dimensions of palatine rugae between the Kanada speaking and Malayalam speaking groups and between the males and females.

Materials and Methods

A total of 60 subjects aged between 18–30 years comprising of 30 Kannada speaking and 30 Malayalam speaking, with each group including 15 males and 15 females were considered for the study. The patients with complete set of dentition were considered in the study. The study sample was divided into four groups: (i) The Karnataka boys, (ii) the Karnataka girls, (iii) the Kerala boys and (iv) the Kerala girls. Since, this is an institution-based study, the number of subjects available for the Kerala boys group were limited. The study being comparative in nature, it required equal number of subjects in each group. Thus, the uniformity of the subjects was maintained for each group by selecting 15 random subjects for each group. The patients with systemic illness, orthodontic therapy, patients with palatal prosthesis and cleft lip or cleft palate patients were excluded from the study. The prevalence of Class II malocclusion is known to be higher among the Malayalam speaking. This group was used along with the Kannada speaking to compare and ascertain, if there would be any influence of the Class II malocclusion on the palatal rugae dimensions.

The procedures followed were in accordance with the ethical standards of the institutional committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 2000. The subjects were briefly explained about the study and written informed consent was obtained. The subjects were asked to rinse the oral cavity and alginate impressions of the maxillary jaw were made by an experienced prosthodontist. The rugae patterns were traced on dental casts obtained with alginate impressions. A digital caliper was used to measure the dimension of the palatal rugae [Figure 1]. The following dimensions were noted by meticulous examination of each cast.

- A-B distance: This is the distance between the most anterior point on the incisive papilla and the most medial point of the first primary rugae [Figure 2]
- A-C distance: This is the distance between the most anterior point on the incisive papilla and the most medial point of the last primary rugae [Figure 2]
- B-C distance: This is the distance between the medial points of the first and the last primary rugae. This distance is calculated by subtracting the A-B distance from the A-C distance [Figure 2].

The dimensions were measured on right and the left sides and the average of the two measurements was considered for the study. Statistical analysis was carried out using the unpaired *t* test. The Statistical Package for the Social

Sciences (SPSS) software was used for the statistical analysis. *P* value less than 0.05 was considered significant.

All the dimensions were measured by a single investigator who meticulously examined each cast and noted the measurements. The intra-observer calibration was carried by examining 10 casts from each group at two different intervals. The intra k value at two different moments was 0.8.

Results

- The A–B dimensions: The mean of A–B dimensions showed significant statistical difference among the Karnataka boys and Kerala boys [Table 1] and among the Kerala boys and girls [Table 2]. However, their mean dimensions were statistically not significant among the Karnataka and Kerala girls [Table 3] and among the Karnataka boys and girls [Table 4]
- The A–C dimensions: The A–C dimensions showed highly significant statistical differences between the Karnataka and Kerala boys [Table 5], among the Karnataka and Kerala girls [Table 6], and among the Karnataka boys and girls [Table 7] and among the Kerala boys and girls [Table 8]
- The B–C dimensions: There was a highly significant statistical difference between the B–C dimensions among the Karnataka and Kerala boys [Table 9], among the Karnataka and Kerala girls [Table 10], and among the Karnataka boys and girls [Table 11] and among the Kerala boys and girls [Table 12].

Discussion

Various classification systems have been proposed for the rugae patterns.^[5-11] Thomas CJ and Kotze proposed the reference points to measure the rugae pattern dimensions.^[12] Various studies have been done to correlate the rugae pattern with the different ethnic groups.



Figure 1: Digital vernier calipers

Table 1: Mean palatal rugae dimensions among Karnataka boys and Kerala boys at A-B distance

Groups	Mean	SD	Unpaired <i>t</i> value	<i>P</i>	Significance*
Karnataka boys	10.60	2.26	2.637	0.014	S
Kerala boys	8.08	2.93			

*S: Significant, *P*<0.05, SD: Standard deviation

Table 2: Mean palatal rugae dimensions among Kerala boys and Kerala girls at A-B distance

Groups	Mean	SD	Un paired t value	P	Significance
Kerala boys	8.08	2.93	4.209	0.000	HS*
Kerala girls	11.85	1.84			

*HS: Highly significant, $P < 0.05$, SD: Standard deviation

Table 3: Mean palatal rugae dimensions among Karnataka girls and Kerala girls at A-B distance

Groups	Mean	SD	Un paired t value	P	Significance
Karnataka girls	11.20	1.73	0.992	0.330	NS*
Kerala girls	11.85	1.84			

*NS: Non significant, $P < 0.05$, SD: Standard deviation

Table 4: Mean palatal rugae dimensions among Karnataka boys and Karnataka girls at A-B distance

Groups	Mean	SD	Un paired t value	P	Significance
Karnataka boys	11.60	2.26	0.810	0.425	NS*
Karnataka girls	11.20	1.73			

*NS: Non significant, $P < 0.05$, SD: Standard deviation

Table 5: Mean palatal rugae dimensions among Karnataka boys and Kerala boys at A--C distance

Groups	Mean	SD	Un paired t value	P	Significance
Karnataka boys	20.64	2.88	4.548	0.000	HS*
Kerala boys	14.03	4.83			

*HS: Highly significant, $P < 0.05$, SD: Standard deviation

Table 6: Mean palatal rugae dimensions among Karnataka girls and Kerala girls at A-C distance

Groups	Mean	SD	Un paired t value	P	Significance
Karnataka girls	18.49	2.71	3.289	0.003	S*
Kerala girls	21.54	2.34			

*S: Significant, $P < 0.05$, SD: Standard deviation

Table 7: Mean palatal rugae dimensions among Karnataka boys and Karnataka girls at A--C distance

Groups	Mean	SD	Un paired t value	P	Significance
Karnataka boys	20.64	2.88	2.101	0.045	S*
Karnataka girls	18.49	2.71			

*S: Significant, $P < 0.05$, SD: Standard deviation

Kotrashetti VS *et al.* compared rugae pattern among the Karnataka and Maharashtra population with the help of regression analysis.^[13] Their study gave a predictive value of 70%. Kallianpur S *et al.* carried out an anthropometric analysis of facial height, arch length, and palatal rugae. Their study concluded that the Indian and Nepalese have similar anthropometric characteristics with regard to facial height. However, arch length and palatal rugae characteristics vary between the two different ethnic groups.^[14] Shetty DK *et al.* carried a comparison of palatal rugae patterns in Kodava and Malayalam speaking population of South India, and found a significant difference between Malayalam speaking and Kodavas for wavy and unification pattern. Significant difference between sexes for straight rugae pattern among

Table 8: Mean palatal rugae dimensions among Kerala boys and Kerala girls at A-C distance

Groups	Mean	SD	Un paired t value	P	Significance
Kerala boys	14.03	4.83	5.413	0.000	HS*
Kerala girls	21.54	2.34			

*HS: Highly significant, $P < 0.05$, SD: Standard deviation

Table 9: Mean palatal rugae dimensions among Karnataka boys and Kerala boys at B-C distance

Groups	Mean	SD	Un paired t value	P	Significance
Karnataka boys	10.03	2.76	4.004	0.000	HS*
Kerala boys	6.02	2.72			

*HS: Highly Significant, $P < 0.05$, SD: Standard deviation

Table 10: Mean palatal rugae dimensions among Karnataka girls and Kerala girls at B-C distance

Groups	Mean	SD	Un paired t value	P	Significance
Karnataka girls	7.29	2.88	2.212	0.035	S*
Kerala girls	9.69	3.05			

*S: Significant, $P < 0.05$, SD: Standard deviation

Table 11: Mean palatal rugae dimensions among Karnataka boys and Karnataka girls at B-C distance

Groups	Mean	SD	Un paired t value	P	Significance
Karnataka boys	10.03	2.76	2.661	0.013	S*
Karnataka girls	7.29	2.88			

*S: Significant, $P < 0.05$, SD: Standard deviation

Table 12: Mean palatal rugae dimensions among Kerala boys and Kerala girls at B-C distance

Groups	Mean	SD	Un paired t value	P	Significance
Kerala boys	6.02	2.72	3.471	0.002	S*
Kerala girls	9.69	3.05			

*S: Significant, $P < 0.05$, SD: Standard deviation

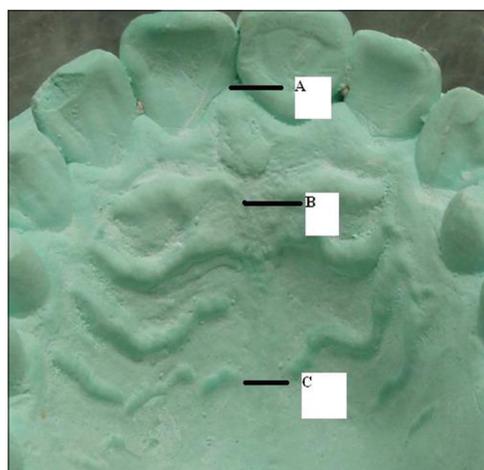


Figure 2: The three reference points considered for the study (A, B and C) to calculate the A--B, A--C and B--C distances

Malayalam speaking was also seen. They concluded that the differences in rugae shape between the two populations may be attributed to genetic factors and recent shared ancestry

has probably rendered their differences to moderate levels.^[15] A study investigated the morphology and individuality of palatal rugae among Jordanians. The predominant types of palatal rugae were primary, anterior, and wavy. This study provides evidence that the individuality of palatal rugae is not limited to certain ethnicity or population; but is more likely, a worldwide phenomenon.^[16]

In the present study, the palatal rugae dimensions have been analyzed using the three dimensions namely: A–B, A–C and B–C. The study showed that Karnataka boys had statistically significant, greater A–B, A–C and B–C dimensions compared to the Kerala boys. The Karnataka boys also had a greater A–C and B–C dimensions as compared with the Karnataka girls. Whereas, the Kerala girls had greater A–B, A–C and B–C dimensions as compared to the Kerala boys. The Kerala girls also had a greater A–C and B–C dimensions as compared with the Karnataka girls.

Summary and Conclusion

The present study showed a significant difference in the palatal rugae dimensions among the Karnataka and the Kerala boys, with the Karnataka boys having greater dimensions. The Kerala girls showed greater palatal rugae dimensions as compared to the Karnataka girls and Kerala boys. Since the study is first of its kind, many more studies in this regard could establish the reliability of using the palatal rugae dimensions in recognizing the different ethnic groups and in forensic identification.

References

1. Gegenbauer C. Die Gaumenleisten des Menschen. *Morphol Jahrb* Vierter Band 1878:573.
2. O' Shaughnessy PE. Introduction to forensic science. *Dent Clin North Am* 2001;45:217-27.
3. English WR, Robinson SF, Summitt JB, Oesterle LJ, Brannon RB, Morlang WM, *et al.* Individuality of human palatal rugae. *J Forensic Sci* 1988;33:718-26.
4. Harrison A. The palatal rugae in man. *Proc Acad Nat Soc* 1889;6:245.
5. Gorla C. Le rughe del palato in speciale rapporto coll anthropologia criminale e la psichiatria. Cited by: Lysell L. Plicae palatinae transversae and papilla incisiva in man. *Acta Odontologica Scandinavica* 1911. 1955;13:5–137.
6. Lysell L. Plicae palatinae transversae and papilla incisiva in man: A morphological and genetic study. *Acta Odontol Scand* 1955;13:5-137.
7. Carrea JU. Fotostenograms of palate folds, a new identification technic. *Dtsch Zahnarztl Z* 1955;10:11-7.
8. Basauri C. Forensic odontology and identification. *Int Crim Police Rev* 1961;16:45.
9. Lima OC. Rugoscopy (Correia Lima's process). *Rev Bras Med* 1968;25:806-7.
10. Caruso GP. The palatine folds. Results of a study of 100 models of the human palate from prenatal to old age. *Riv Ital Stomatol* 1969;24:423-92.
11. Tzatscheva L, Jordanov J. Plica palatinae transversae and papilla incisiva in Bulgarians. *Z Morphol Anthropol* 1970;62:276-84.
12. Thomas CJ, Kotze TJ. The palatal ruga pattern: A new classification. *J Dent Assoc S Afr* 1983;38:153-7.
13. Kotrashetti VS, Hollikatti K, Mallapur MD, Hallikeremath SR, Kale AD. Determination of palatal rugae patterns among two ethnic populations of India by logistic regression analysis. *J Forensic Leg Med* 2011;18:360-5.
14. Kallianpur S, Desai A, Kasetty S, Sudheendra U, Joshi P. An anthropometric analysis of facial height, arch length, and palatal rugae in the Indian and Nepalese population. *J Forensic Dent Sci* 2011;3:33-7.
15. 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.
16. Mustafa AG, Allouh M, Tarawneh I, Alrbata R. Morphometric analysis of palatal rugae among Jordanians: Further evidence of worldwide palatal rugae individuality. *Aust J Forensic Sci* 2014;46:53-63.

How to cite this article: Patil SB, Patil MS, Smita BR, Hebbar KG. Rugae dimensions and their significance in forensic dentistry. *J Forensic Dent Sci* 2016;8.

Source of Support: Nil, **Conflict of Interest:** None declared