

Comparison of palatal rugae pattern among Indian and Tibetan population

Jagadish Hosmani,
Nikita Bhujang Gadekar,
Vijayalakshmi S.
Kotrashetti,
Ramakant Nayak,
Deepa Babji,
Sudhir Mishra

Department of Oral Pathology
and Microbiology, Maratha
Mandal's NGH Institute of Dental
Sciences and Research Centre,
Belgaum, Karnataka, India

Address for correspondence:
Dr. Jagadish Hosmani,
Department of Oral Pathology
and Microbiology, Maratha
Mandal's NGH Institute of
Dental Sciences and Research
Centre, Belgaum - 590 010,
Karnataka, India.
E-mail: jhosmani@gmail.com

Abstract

Introduction: Palatoscopy is the study of palatal rugae pattern to establish the identity of a person. The palatal rugae are permanent and unique to each person and can establish identity through discrimination (via casts, tracings, or digitized rugae patterns). In addition, rugae pattern may be specific to racial groups facilitating population identification (which may require postdisasters). Hence, they can be used in postmortem identification provided an antemortem record exists. **Aim:** To determine the palatal rugae pattern and to assess the predominant palatal rugae pattern in Indian and Tibetan (in Mundgod Taluka, Karnataka) populations. **Materials and Methods:** The impressions of the maxillary arch were made for a total of one hundred adults comprising fifty Indian and fifty Tibetan populations aged between 20 and 40 years, and the dental cast was made using dental stone. The rugae were highlighted by a sharp graphite pencil on the cast under adequate light and a magnification lens. Rugae patterns were assessed using Thomas and Kotze and Kapali *et al.* classification. **Results:** Total number of palatal rugae in Indian population (461) was more than Tibetan population (351). Moreover, Indian population showed predominantly wavy (43.60%) rugae pattern, whereas Tibetan showed curved (38.2%) rugae pattern. **Conclusion:** This suggests that there is a difference in the rugae pattern between Indian and Tibetan populations. Hence, palatal rugae pattern can be used as one of the methods in determining the ethnicity.

Key words: Forensic, identification, Indian population, palatal rugae, Tibetan population

Introduction

Palatoscopy is the study of palatal rugae pattern used to establish the identity of a person. In recent years, palatoscopy has gained its prime importance in forensic odontology. According to the Glossary of Prosthodontic, rugae are anatomical folds or wrinkles; the irregular fibrous connective tissue located on the anterior third of the palate.^[1] They are also called “plica palatinae” or “rugae palatine.”


Anatomically, it is positioned inside the oral cavity surrounded by lips, buccal pad of fat, and teeth which also give protection in cases of trauma and incineration.^[2] Odontometrical analysis, fingerprints, and DNA comparisons are usually the widely used techniques, providing secure identification. However, these techniques cannot be applied in certain cases and in such situations, when an individual's identification by other methods is difficult, palatal rugae may be considered as an alternative

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source of information and for identification which enables the search field to be narrowed.

Palatal rugae are highly unique to individual and are consistent in shape throughout life. Sassouni *et al.* have stated that no two palates are alike in their configuration and that the palato-print does not change during growth. They are considered to be stable throughout life (following completion of growth) although there is considerable debate on the matter.^[3] Once formed, they do not undergo any change except in length (due to normal growth), whereas other qualitative characteristics such as shape, direction, and unification remain in the same position throughout a person's entire life.^[4] Despite difficulties in describing palatal rugae patterns qualitatively and quantitatively, their uniqueness to individuals provides a potentially reliable source of identification in forensic science (via casts, tracings, or digitized rugae patterns) provided an antemortem record exists. In addition, rugae pattern may be specific to racial groups facilitating population identification.^[5-7]

When Tibet became an autonomous region of China in 1959, a large number of Tibetans migrated as refugees to India (Bir-Himachal Pradesh, Bylakuppe-Mysore, Gurupura-Hunsur, Kollegal, Mundgod-Uttara Kannada), forming Tibetan Resettlement Colonies. One of them, at Mundgod, a town 65 km South-East of Dharwad, has a population of about 10,000–15,000.^[8] Tibetans are phenotypically diverse. They belong to distinct Mongoloid type race with euryprosopic (wide face) and brachycephalic head and teeth are broad and short, whereas Indians are assumed to be a mixture of "Dravidian race" with an "Aryan race," identified as a subrace to the Caucasoid.

Hence, these Tibetans settled in India form a unique set of population having characteristic traits. Recording of evidence related to dental and oral structures of these Tibetans and comparing them with the dental and oral characteristics of Indians will play a positive role in identification in case of any mass disaster. Thus, the present study was aimed to determine the palatine rugae pattern and to assess the predominant palatine rugae pattern in Indian and Tibetan (in Mundgod Taluka, Karnataka) populations.

Materials and Methods

Cleft palate and cleft lip, wearing removable partial dentures, fixed partial dentures and braces, and history of inflammation or trauma were excluded from the A total sample of one hundred adults comprising fifty Indians and fifty Tibetans (in Mundgod Taluka, Karnataka) aged between 20 and 40 years was considered. Twenty-five males and 25 females in each group were included in the study. Participants with abnormalities of palate and lips like the study.

Following the written consent from the participants, detailed case history was recorded with emphasis on geographic origin. Subsequently, impression of maxillary arch was made using condensation silicone impression material (Zetaplus, Zhermack Company, Italy) and dental casts were made using dental stone for interpretation. The method of rugae recording used in this study was based on the classification given by Thomas and Kotze and Kapali *et al.*^[5,9] These classifications include number: total number of rugae; shape: straight, wavy, curved, circular, and nonspecific; unification: diverging and converging.

Considering that the rugae originate from the mid-palatine raphe and terminates transversely, the shapes of individual rugae were classified into four major types:

1. Straight - Runs directly from the origin to termination
2. Curvy - A simple crescent shape which was curved gently
3. Wavy - Serpentine form
4. Circular - A definite continuous ring formation.

Any other form which did not match the above-mentioned shape then it was classified as nonspecific.

In addition, a specific pattern called unification occurs when rugae have two arms which are joined either at their origin or termination.^[10] They can be subdivided into diverging and converging type. A diverging pattern occurs when two rugae begin from the same origin but immediately diverge transversely. Similarly, a converging pattern occurs when two rugae arise with different origins and converge transversely [Figure 1].

The rugae were highlighted using a sharp graphite pencil on the cast under adequate light and a magnification lens. Comparison of the number, shape, and unification of palatal rugae were analyzed between both population [Figure-2] using descriptive statistics [Table 1] and comparison between the means using Mann-Whitney U-test (SPSS 10.0

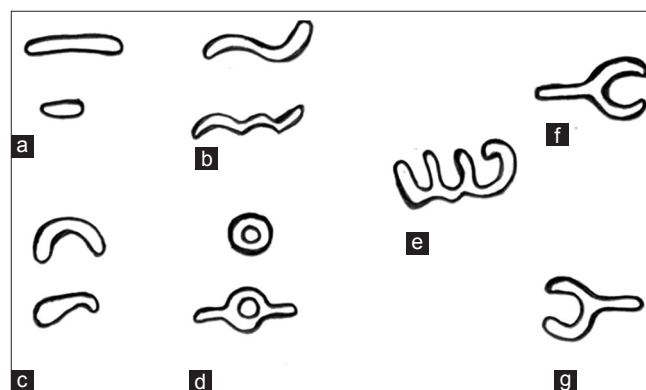


Figure 1: Schematic representation of palatal rugae patterns: (a) straight, (b) wavy, (c) curved, (d) circular, (e) nonspecific, (f) diverging, and (g) converging

Inc, Chicago, IL, USA). The level of statistical significance is at $P < 0.05$.

Results

Our study showed Indian population with a significantly higher number of total rugae when compared to the Tibetan population [Figure 3]. The predominant rugae pattern was straight and wavy in Indians, whereas Tibetans showed curved pattern predominantly ($P < 0.05$) [Table 2 and Figure 4].

When unification of the rugae was analyzed, diverging type was higher in number than converging type, in both the population with statistical significance ($P < 0.05$) [Table 2].

The other parameters of shape-circular, nonspecific pattern, and converging type of unification were statistically

insignificant when compared in both the population ($P > 0.05$) [Table 3].

Discussion

The palatal rugae appear in the 3rd month of intrauterine life, from the covering connective tissue in the palatine process of maxillary bone, and its development and growth are mutually controlled by epithelial-mesenchymal interactions, where specific extracellular matrix molecules are spatiotemporally expressed during development.^[11] Palatal rugae develop as localized regions of epithelial proliferation and thickening. Fibroblasts and collagen fibers then accumulate in the connective tissue beneath the thickened epithelium and assume distinct orientation.

Palatoscopy was first suggested by Allen^[12,13] as an alternate method for identification. Palatal rugae were first described

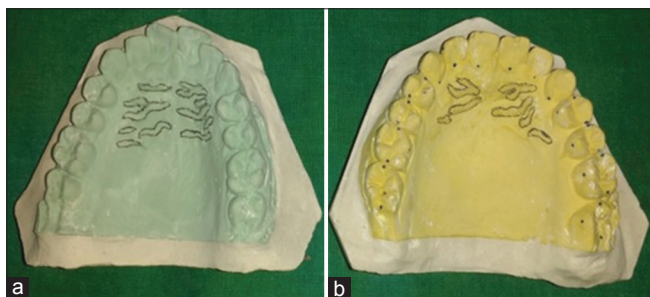


Figure 2: Delineation of palatal rugae pattern on the cast (a) Indian and (b) Tibetan

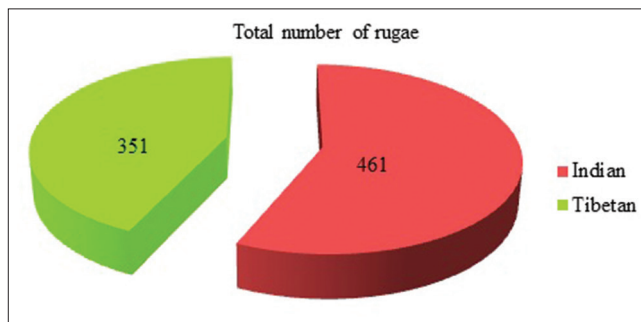


Figure 3: Distribution of total number of palatal rugae

Table 1: Descriptive statistics of total number and shape of rugae pattern in both the populations

Population	Mean	SD	Minimum	Maximum	Percentiles		
					25 th	50 th (median)	75 th
Indian (n=50)							
Number of rugae	9.2200	1.81029	6.00	13.00	8.0000	9.0000	10.0000
Straight	2.0200	1.30133	0	6.00	1.0000	2.0000	3.0000
Wavy	4.0200	1.63495	1.00	7.00	3.0000	4.0000	5.0000
Curved	1.8400	1.11319	0	4.00	1.0000	2.0000	2.2500
Circular	0.1800	0.38809	0	1.00	0	0	0
Nonspecific	0.0600	0.23990	0	1.00	0	0	0
Converging	0.0800	0.27405	0	1.00	0	0	0
Diverging	1.0200	0.86873	0	3.00	0	1.0000	2.0000
Population	1.0000	0.00000	1.00	1.00	1.0000	1.0000	1.0000
Tibetan (n=50)							
Number of rugae	7.0200	1.72011	4.00	11.00	6.0000	7.0000	8.0000
Straight	1.2000	1.10657	0	4.00	0	1.0000	2.0000
Wavy	2.2800	1.42914	0	5.00	1.0000	2.0000	3.0000
Curved	2.6800	1.23619	1.00	5.00	2.0000	2.5000	4.0000
Circular	0.1000	0.30305	0	1.00	0	0	0
Nonspecific	0.0400	0.19795	0	1.00	0	0	0
Converging	0.1600	0.42185	0	2.00	0	0	0
Diverging	0.5600	0.78662	0	3.00	0	0	1.0000
Population	2.0000	0	2.00	2.00	2.0000	2.0000	2.0000

SD: Standard deviation

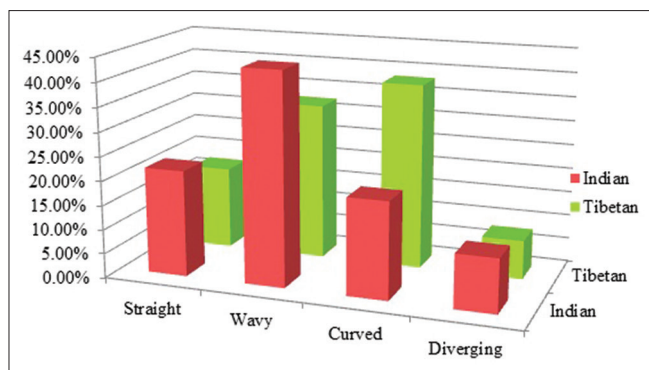


Figure 4: Distribution of different patterns of palatal rugae

Table 2: Distribution of different types of rugae pattern in both the populations

Mean population	Total rugae	Shape (%)			Unification diverging (%)
		Straight	Wavy	Curved	
Indian	461	21.90	43.60	19.90	11.05
Tibetan	351	17.10	32.40	38.20	8
Mann-Whitney U-test (significance)	0	0.002	0	0.002	0.005

Statistically significant at $P < 0.05$ level and nonsignificant at $P > 0.05$

Table 3: Distribution of different types of rugae pattern in both the populations

Mean population	Total rugae	Shape (%)		Unification converging (%)
		Circular	Nonspecific	
Indian	461	1.95	0.70	0.90
Tibetan	351	1.40	0.60	2.30
Mann-Whitney U-test (significance)	0	0.251	0.648	0.328

Statistically significant at $P < 0.05$ level and nonsignificant at $P > 0.05$

by Winslow (1753), and the earliest illustration of them was given by *et al.* (1775).^[14] Most studies are based on systems devised by Lysell and Thomas and Kotze, although they may differ in detail. The palatal rugae have been considered equivalent to the fingerprint and are unique for each individual.^[15]

English *et al.* reported the accuracy of identification of palatal rugae patterns by four investigators and two teams to be 100%, except for one investigator who achieved only 88% correct matches.^[16] The study by Ohtani *et al.*^[16] achieved 94% correct matches where they examined the accuracy rate of identification in edentulous cases. Limsons and Julian^[15] who compared the rugae patterns using computer software observed the percentage of correct matches which ranged from 92% to 97%.

Palatal rugae are not only unique to an individual but also show the definite racial and ethnic variations, hence are considered to have a population-specific configuration. These features make palatal rugae an important point in identifying a specific population group in mass disasters.

Hauser *et al.* compared the rugae pattern of Swazi and Greek populations and found definite differences in the rugae pattern between them. They also found that the degree of development of rugae was dependent on the growth of the palate.^[17] Furthermore, comparison of rugae patterns between African and European population revealed that the former had statistically greater numbers of unifications and circular rugae.

Our study showed the Indian population had significantly higher number of total rugae than the Tibetan population. A study on similar lines was carried out by Shetty *et al.*,^[7] wherein the palatal rugae of Tibetans (settled in Bylakuppe, Mysore) were compared to the population of Mysore. They found out that Tibetans in their study predominantly had a wavy palatal rugae pattern, whereas our current study revealed a curved pattern of rugae predominantly in the Tibetans (in Mundgod Taluka, Karnataka). When comparisons were drawn between Indians, straight and wavy patterns were prominent in our study in contrast to the curved pattern which predominated in the Mysoreans evaluated in the study of Shetty *et al.*

Several studies have been conducted in the field of orthodontics and prosthodontics to determine the palatal rugae stability during normal growth and in patients with cleft lip and palate and also their usefulness as a landmark to analyze the tooth movement.^[8,18-20]

Kashima's study among Indian and Japanese children reported that Japanese children had more rugae than Indians.^[21] Thomas and Kotze studied the rugae patterns of six South African populations to analyze the interracial difference. They found that rugae were unique to each ethnic group and can be used successfully as a medium for genetic research.^[9] Kapali *et al.* study reported Australian Aborigines had more rugae than the Caucasoids. Australian Aborigines and Caucasoids showed wavy and curved rugae most prevalent while straight, circular, and unification are less common.^[5]

El-Fotoh MM and El-Sharkawy GZ conducted a study in the Egyptian population to record, describe, and classify the palatal rugae. They found out that the rugae pattern was absolutely unique to an individual and could be used for identification. Fahmi *et al.* in their study among Saudi male and female populations reported an increased incidence of circular-shaped rugae among females than males.^[22] Vishlesh *et al.* study done among Manipuri and Karnataka populations noted that the straight and wavy shapes were more prominent in both the group, with Manipuri population showing more of divergent pattern when compared to Karnataka.^[23]

Conclusion

Palatal rugae pattern is considered to be unique to an individual; hence, their use in forensic identification is of greater importance. The rugae are also considered to have population-specific configuration and can be successfully used in population identification. In the present study, there is a significant difference between the total number of palatal rugae and shape pattern-straight, wavy, and curved between Indian and Tibetan population. Hence, to conclude we believe that rugae shape have great utility in population differentiation along with individual identification and should be examined in detail on larger samples and with a wider age range to substantiate the findings of the present study.

In future, studies on dental and oral characteristics of Tibetans settled in various parts of India can be carried out and comparisons can be drawn. This would help us to identify the most prominent characteristics in this unique ethnic group and can be used as a medium for genetic research.

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Conflicts of interest

There are no conflicts of interest.

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