

An anthropometric analysis of facial height, arch length, and palatal rugae in the Indian and Nepalese population

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Abstract

Introduction: A country such as India abounds with diverse population groups with distinct anthropometric characteristics. Among these, numerous Nepalese population groups are present in different states of India comprising one of the most common immigrant races. The aim of the study is to compare two distinct races, Indians and Nepalese on the basis of facial height proportions, arch length and palatal rugae patterns and assess their significance in racial identification. **Materials and Methods:** A total of 120 subjects comprising of 60 Indians and 60 Nepalese were selected, with each group including 30 males and 30 females. Facial heights were measured using sliding digital calipers, arch lengths with the help of a brass wire and rugae patterns were traced on dental casts obtained with alginate impressions. **Results:** Facial height measurements did not give significant results for racial or gender identification of given races. Differences between arch length parameters were found to be significant between the two population groups. Secondary and fragmentary palatal rugae forms were found to be more common in Nepalese than Indians. **Conclusion:** The Indian and Nepalese have similar anthropometric characteristics with regard to facial height. However, arch length and palatal rugae characteristics vary between the two races.

Key words: Anthropometry, arch length, facial height, Indian, Nepalese, palatal rugae

Introduction

The science of anthropometry has been utilized in diverse fields including anatomy, paleoanthropology, forensic sciences, cancer research, reconstructive, and cosmetic surgery.^[1-3] In a country like India, in addition to the extensive indigenous diversity, there are distinct migrant populations settled in various parts of the country. Populations of different races tend to have distinct anthropologic characteristics.

Anthropometry of the face and intraoral regions can help in the field of forensic odontology when common forensic data are unavailable.^[4] Different studies on dental anthropometry have utilized arch length, facial height, and rugae patterns as individual parameters.^[5-7]

The palatal rugae are irregular ridges on the mucous membrane covering the anterior part of the hard palate. In severely mutilated bodies and in bodies where postmortem changes are severe, application of conventional techniques such as fingerprinting, dental records and DNA analysis are limited and in such cases data from analysis of palatal rugae might help in establishing identity and the race to which the victim belongs. Rugae patterns have been found to be unique and stable topographical structures in the oral cavity.^[8,9] Studies on comparison of rugae patterns in different races as well as within the subsets of a single race have reported significant presentation patterns.^[7,10,11]

Access this article online	
Website: www.jfds.org	Quick Response Code 
DOI: 10.4103/0975-1475.85294	

The present study was instituted in the Indians and Nepalese with regard to facial height, arch length and palatal rugae since there were few anthropometric studies found in the literature.

Materials and Methods

The study sample comprised of 120 subjects, 60 each of Indian and Nepalese descent, with age range of 20–34 years and 20–35 years, respectively, with equal gender distribution. Ethical clearance and informed consent were obtained. The inclusion criteria applied included fully erupted permanent teeth with the exception of the third molar. The exclusion criteria included subjects with history of facial trauma, maxillofacial surgery, orthodontic treatment, craniofacial abnormalities, endocrine diseases and subjects of interracial origin.

For assessment of facial height, the anthropometric landmarks, the nasion (n), subnasale (sn) and gnathion (gn), were marked on the subject's face and measurements were taken with the help of a sliding digital calipers to estimate facial height [Figure 1]. The upper facial height (UFH) was the distance between "n" and "sn" and the lower facial height (LFH), the distance between "sn" and "gn".

The total facial height was measured as per the formula:

Total facial height (TFH) = UFH + LFH, where, the

$$\text{UFH proportion (UFH \%)} = \frac{\text{UFH} \times 100}{\text{TFH}}$$

$$\text{LFH proportion (LFH \%)} = \frac{\text{LFH} \times 100}{\text{TFH}}$$

The upper arch length (UAL) and lower arch length (LAL) was measured by the segment arch approach, with the help of Brass wire of 0.25 inch.^[12]

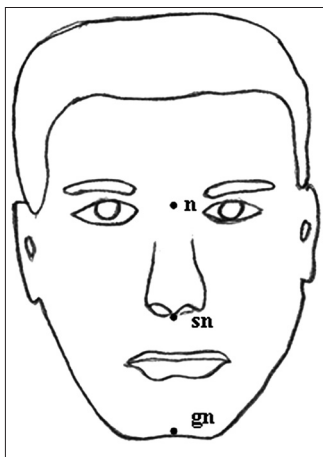


Figure 1: Anthropometric landmarks on the face

Alginate impressions were obtained from the maxillary arch of subjects, and then were poured in dental stone and analyzed for palatal rugae patterns [Figure 2]. Rugae shapes were categorized based on the classification of Thomas CJ and Kotze TJvW (1983).^[13] This classification includes patterns of rugae based on size, shape, unification, number, and direction.

According to size, the rugae were classified into primary rugae (≥ 5 mm), secondary rugae (3–5 mm), and fragmentary rugae (2–3 mm). The rugae were categorized according to shape as curved type (crescent shaped gently curving form), wavy type (curved rugae with a slight curve at origin or termination), straight type (running directly from their origin to termination), circular type (having a continuous ring), and non-specific type (without a pre defined form). Based on unification, two rugae having different origins joining at their lateral portions were termed converging, while two rugae with the same origin and immediate branching were considered diverging. Rugae were further classified based on their direction into forward-directed rugae, backward-directed, and horizontal rugae [Figures 2-4].

Results

In both races, lower facial height was significantly higher than upper facial height. Facial heights were found to be higher in males in both groups [Table 1]. Unpaired 't' test results between UFH, LFH and TFH in males and females did not show significant correlation. No statistically significant difference was found in facial height proportions between the two races.

Unpaired 't' test for arch length showed *P* value less than 0.05 for both arches, which was a statistically significant difference between arch lengths of both groups [Table 1]. Both upper and lower arch lengths were higher in Indians than in Nepalese and the difference in upper arch length

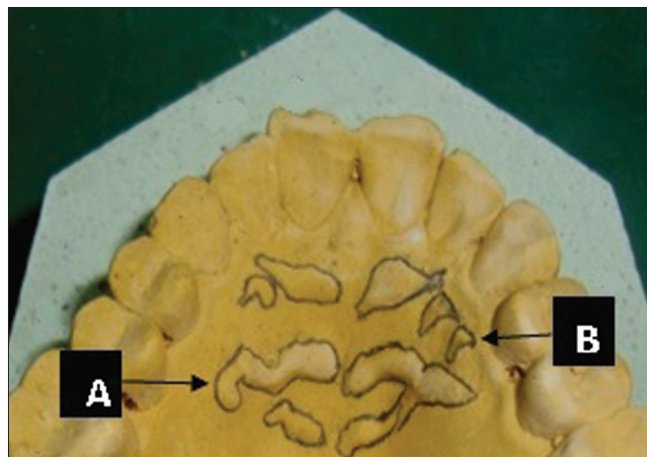


Figure 2: Wavy (A) and curved (B) rugae forms

was more pronounced than lower arch length. Upper arch lengths were significantly higher in males than in females in both races. Mean lower arch lengths were also slightly higher in males in both races but it was not statistically significant.

Most predominant shape of palatal rugae was wavy in both races, followed by curved in Indians and straight in Nepalese. Unification values were comparably similar between the Nepalese and the Indian group [Figure 5].

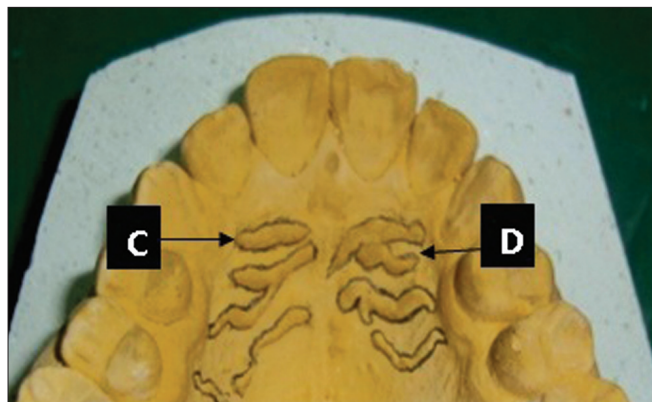


Figure 3: Straight (C) and non-specific (D) rugae forms

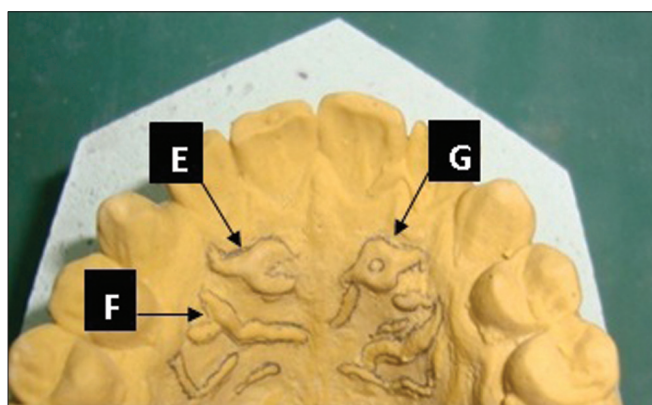


Figure 4: Posterior converging (E), posterior diverging (F) and circular (G) rugae forms

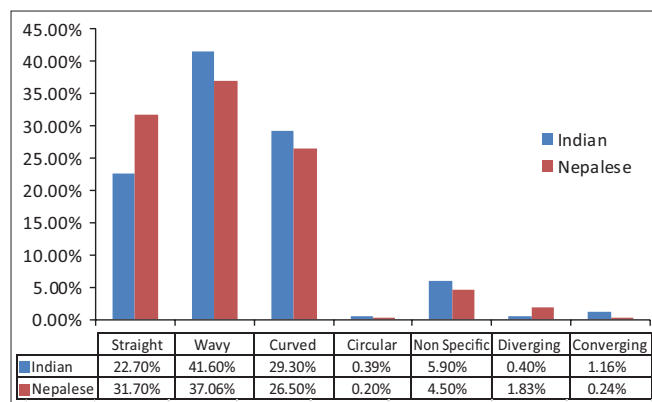


Figure 5: Frequencies of palatal rugae forms

There was a statistically significant association between rugae shapes and ethnicity (Chi-squared value = 10.98 with four degrees of freedom, $P < 0.05$). Straight forms were more common in Nepalese than Indians, 31.7% in Nepalese compared with 22.7% in Indians. No significant difference was seen between rugae patterns, according to size and direction or rugae numbers in both races [Table 2].

The average rugae numbers in the Indians were higher than in the Nepalese. Slightly higher numbers of rugae were present on the left side in the Nepalese than in the Indian group; however, the results were not statistically significant [Table 3].

Table 1: Comparison of facial height and arch length between two races

Component	Unpaired 't' test						
	Mean	SD	N	T value	D.F.	P value	Result
UFH							
IND	5.21	0.47	60	0.2756	118	0.7836	NS
NEP	5.18	0.46	60				
LFH							
IND	6.05	0.51	60	1.3032	118	0.1963	NS
NEP	6.20	0.52	60				
UAL							
IND	10.37	0.53	60	2.0850	118	0.0403	S
NEP	10.12	0.52	60				
LAL							
IND	9.45	0.53	60	2.2573	118	0.0253	S
NEP	9.2	0.46	60				

S - Significant; NS - Non significant; IND - Indians; NEP - Nepalese

Table 2: Palatal rugae numbers according to size and direction

Palatal rugae pattern	Palatal rugae numbers (n)		χ^2 value	The two-tailed P value	Result
	Indians	Nepalese			
According to size					
Primary	570	501	4.772	0.0920	NS
Secondary	160	171			
Fragmentary	46	66			
According to direction					
Forward	367	348	5.505	0.1383	NS
Backward	312	330			
Horizontal	79	57			
nonspecific	10	3			

NS - Non significant

Table 3: Average palatal rugae numbers in Indians and Nepalese

Ethnic group	No. of subjects	Age group	Sex	Number of rugae		
				Left	Right	Mean
Indians	30	20-34	Male	4.8	4.9	4.9
	30		Female	4.5	4.7	4.6
Nepalese	30	20-35	Male	4.6	4.3	4.4
	30		Female	4.3	4.2	4.2

Discussion

Anthropometric values have been used as tools in distinguishing characteristics within as well as between races. In the facial region, numerous parameters have been utilized to gather anthropometric data including facial length, nasal height, skull dimensions and interpupillary distance.

Studies have been conducted to assess the facial height measurements in different population groups including Caucasians, African and Asians. Other than the use of calipers, measurement of facial height has been done utilizing cephalometrics^[14] and photometry,^[15] Baral *et al.*,^[5] found significant upper and lower facial height values within four communities in the Nepalese population. In India, the Nepalese migrant population is distributed throughout, with dense pockets in the states that border Nepal. While official estimates in 2005 indicated around 950,000 Nepalese immigrants in India, the number may be much higher.^[16] Anthropometric characteristics unique to either of the populations may help to differentiate between them during forensic analysis.

In the present study, the lower facial height values were significantly higher than upper facial height in males of both races [Table 1]. The UFH and LFH proportions were 45.6% and 54.4% in the Nepalese, 46.4% and 53.6% in Indians indicating no significant difference between the two populations. These values were expectedly lower when compared to values of studies of facial heights of Canadians of Northern European origin, which show that LFH constitutes 59.5% of the TFH.^[17] Both UAL and LAL were higher in Indians than in the Nepalese with the difference in UAL being more pronounced between the two races than LAL. The UAL and LAL values were higher in males than females in both populations.

Uniqueness of rugae patterns in every individual and their stable anatomy through a lifetime means that they can be reliable parameters in forensic odontology and anthropometry. The number of rugae in Indians were more on the right side than the left side and vice versa in the Nepalese. Numbers of primary rugae were higher in Indians, while secondary and fragmentary rugae numbers were higher in the Nepalese. In a study by Dohke and Osato (1994)^[18] on the Japanese population, it was reported that numbers of rugae on the right side were fewer than on the left side taking into account both primary and secondary rugae. Their conclusions seem to be validated in our study wherein the Nepalese, who had more secondary and fragmentary rugae, exhibited fewer total rugae numbers on the left side. It has been considered that secondary and tertiary rugae may have greater discriminatory potential than the primary rugae as might be the case here.^[10]

In this study, the predominant shape of palatal rugae seen in both study groups were the wavy type, which was similar to results observed in Caucasian and Australians races.^[19] The second most predominant rugae shape in Indians was the curved type as seen in Australian aborigines and Caucasians; however, in the Nepalese it was the straight type. Straight rugae forms are uncommon in aborigines and Caucasians.^[19] In the present study, Circular rugae constituted 0.39% and 0.20% of rugae shapes in Indians and Nepalese, while it has been seen to be higher in aborigines and Caucasians with an incidence of 3.6% and 2.9%, respectively.^[19] Significant differences in rugae forms have also been reported within subsets of the Indian population indicating the diversity not only between but also within the races.^[20]

Other than intra and inter-observer variability, limitations to the use of rugae can also arise in edentulous cases due to poorly demarcated and non-complex rugae.^[21] Few studies have questioned the use of palatal rugae in forensic identification since variable stability of the rugae being an issue with regard to the type of rugae as well as in cases with orthodontic treatment and extractions.^[22] However, studies have shown that in spite of orthodontic treatment the shape of the rugae remain unaltered and only changes in their length have been perceived.^[23] Not unlike fingerprints, digital photographic records of palatal rugae might be of use in forensics.^[22]

Conclusion

Measurements of facial height, arch length, and palatal rugae were performed in Indian and Nepalese study groups. Facial heights did not give significant results for race or sex identification of the two races, but arch length measurements revealed significantly higher values in Indians than in the Nepalese study group with the values for UAL being more pronounced. Palatal rugae numbers were more on the right side than on the left side in the Indian group and vice versa in the Nepalese group. Overall, both population groups seem to have similar anthropometric characteristics with regard to facial height and rugae numbers. However, rugae shape revealed significant differences between the Indians and Nepalese. Secondary and fragmentary rugae numbers were higher in the Nepalese than in Indians. Some non-specific rugae shapes were found in both populations which provide scope for describing new rugae patterns in larger samples. However, these interpretations are based on limited sample size, so further work on larger samples can be of value in studying anthropometric characteristics not only between races, but also within populations.

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How to cite this article: Kallianpur S, Desai A, Kasetty S, Sudheendra US, 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.

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

FORM IV

Statement about ownership and other particulars about newspaper (Journal of Forensic Dental Sciences) to be published in the first issue every year after the last day of February

- | | |
|---|---|
| 1. Place of publication | : Mumbai |
| 2. Periodicity of its publication | : Semiannually (June and Decemeber) |
| 3. Printer's Name | : Mr. Hemant R. Manjrekar |
| Nationality | : Indian |
| Address | : B9-12, Kanara Business Center,
Off Link Rd, Ghatkopar (E), Mumbai - 400075, India.
Phone: 91-22-6649 1818 |
| 4. Publisher's Name | : Mr. Hemant Manjrekar |
| Nationality | : Indian |
| Address | : B9-12, Kanara Business Center,
Off Link Rd, Ghatkopar (E), Mumbai - 400075, India.
Phone: 91-22-6649 1818 |
| 5. Editor's Name | : Dr. B. Sivapathasundharam |
| Nationality | : Indian |
| Address | : Department of Oral and Maxillo Facial Pathology,
Meenakshi Ammal Dental College and Hospital,
Chennai - 600 095, Tamil Nadu, India. |
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