

# Rugae Profiling: A Pilot Study in Udaipur, Rajasthan

**Keywords:** Rugae pattern; Udaipur population differentiation

## Abstract

**Background:** Human identification either living or dead is a complex process and one of the main objective of forensic science. The most reliable method of identification is finger printing and DNA profiling, since no two sets of prints are alike. Finger print is most reliable tool provided it is obtained prior to decomposition of body and is not mutilated. It is of little value when body is identified 48 hrs after death or when it has burns, crush injury or had been under water for long. Therefore in such incidences where the routinely used methods of identification are compromised palatal rugae pattern can be used for personal identification.

**Aim and objective:** To study the rugae pattern in a sample of male and female population of Udaipur and to compare the patterns between the two groups, which may be an additional method of determining gender by using maxillary casts.

**Materials and methods:** The rugae pattern of 50 males and 50 females belonging to Udaipur was studied on maxillary casts.

**Results:** The Wavy pattern was found to be higher in Udaipur. There was no statistically significant difference in the mean value of number of rugae in males and females. There was a statistically significant difference in the circular and convergence pattern of rugae which was found to be higher among females than males ( $p < 0.05$ ).

**Conclusion:** The rugae patterns are genetically determined. The findings suggest that rugae are specific to a particular population and might have better utility in population differentiation. This method is simple and inexpensive to conduct and therefore can be applied in forensic odontology.

## Introduction

Identification of humans is a prime requisite for certification of death and for personal, social, legal and humanitarian reasons. Many events that take place in the human journey between the womb to the tomb result in human destruction. Violent and heinous activities shatter the lives of the victims, their relatives and families every day. Through the speciality of forensic odontology dentists play a little yet very important role in identification of victims of crime and disaster through dental records. Dental records may be inconclusive, as they may be incomplete as additional treatment might have been performed in time interval of creation of dental record and death of patient.

Rugoscopy, the study of palatal rugae can be used for individual identification and necro identification. Rugae are asymmetrical and irregular elevations of the mucosa located on the anterior third of palate. Studies have demonstrated that no two palates are alike in their configuration and that the characteristic pattern of the palate does not change as a result of growth [1]. They are protected from trauma by their internal position in the head and insulated from heat by tongue and buccal pads of fat [2]. Analysis of variables which make up the classification of rugae pattern contributes to individuality of rugae in different populations [3]. In genetically similar populations,



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rugae measurements may be inconclusive and hence rugae patterns can be helpful. Rugoscopy is advantageous over other methods because of its low cost, ease of use and can be used in cases of burns and decomposition where other methods of identification are compromised [4].

## Aim and objective

- 1) To study the rugae pattern in a sample of male and female population of Udaipur, Rajasthan.
- 2) To compare the patterns between the two groups, which may be an additional method of determining gender.

## Material and Methods

The sample comprised of 100 maxillary casts of 50 males and 50 females of an age group ranging from 12-30 years belonging to Udaipur, Rajasthan. They were randomly selected from Department Of Orthodontics, Pacific Dental College and Hospital, Udaipur, India. Exclusion criteria was children below the age of 12 years, presence of thumb sucking habit, existence of palatal lesion, congenital palatal deformity, orthodontic treatment and history of palatal surgery. The rugae were highlighted using a graphite pencil and the no. of rugae were counted and patterns were recorded according to classification given by Thomas and Kotze (Figure 1) [5].



Figure 1: Casts showing delineated pattern.

**Table 1:** Mean and standard deviation of total number of Rugae in Males and Females.

Sex	Total	Total no. of rugae	Mean	SD	P value
MALE	50	358	7.30	1.264	
FEMALE	50	348	7.102	1.239	0.344(NS)

t-test for difference of means (p<0.05- Significant)  
SD: Standard Deviation

**Table 2:** Rugae patterns in Males and Females.

Rugae Patterns	Sex	No. Of Cases	Mean	SD	p value	
Straight	Male	50	1.14	1.17	0.062(NS)	
	Female	50	1.69	1.14		
Curved	Male	50	1.22	0.24	0.078(NS)	
	Female	50	1.28	1.22		
Wavy	Male	50	3.18	1.62	0.096(NS)	
	Female	50	2.48	1.38		
Circular	Male	50	0.06	0.24	0.003(S)	
	Female	50	0.10	0.30		
Fragmentary	Male	50	0.95	1.22	0.069(NS)	
	Female	50	0.69	0.93		
Unification	Convergence	Male	50	0.06	0.408	0.006(S)
		Female	50	0.142		
	Divergence	Male	50	0.55	0.76	
		Female	50	0.65		

### Statistical analysis

- Two-sample t-test and Chi-Square tests were used for comparison of means in male and female subjects.
- A significance level of 5% was considered as critical value.

### Results

- There was no statistically significant difference in the mean value of number of rugae in males and females (Table 1).
- There was a statistically significant difference in the circular and convergence pattern of rugae which was found to be higher among females than males (p<0.05) (Table 2).
- The Wavy pattern was found to be higher in Udaipur (Table 2).

### Discussion

Transverse palatine folds or palatal rugae (PR) are asymmetrical and irregular elevations of the mucosa in the anterior third of the palate, arranged in a transverse direction from the palatine raphe located in the mid-sagittal plane [6,7]. Palatal rugae appear during the third month of intrauterine life from the connective tissue covering the palatine process of the maxillary bone [8]. English et al., [9] and Peavy and Kendrick [10] noted that the characteristic pattern of the palatal rugae did not change as a result of growth, remaining stable from the time of development until the oral mucosa degenerated at death. Van der Linden proved that the anterior rugae do not increase in length after 10 years of age. The qualitative characteristics like shape, unification and pattern remains same throughout life [11].

Thomas and Kotze studied the rugae patterns of 6 South African

populations to analyze the interracial difference. Their results indicate that rugae were unique to each ethnic group and can be used successfully as a medium for genetic research [5]. India is a country of genetic complexity. It does not always correlate to ethnicity, geography, or language. Therefore for creating forensic database in India instead of broad grouping of populations; differentiating small, well defined, clusters of populations is more helpful. The present study was taken up in view of the limited existing studies on rugae patterns in Indian populations, with an aim to study and compare the shape of palatal rugae in Udaipur population.

Studies have shown that trauma, thumb sucking habit in infancy, persistent pressure from orthodontic treatment and dentures may lead to changes in the rugae pattern [12]. Thus these factors were considered in exclusion criteria.

In the present study, the wavy pattern followed by straight was found to be higher in Udaipur population.

The results were consistent with the studies conducted in various part of India by Rachna Rath and Ajay Reginald [12], Eshani Saxena et al., [13]. Swetha S [14], Shetty DK et al., [15], Reddy et al., [16], S. Bhagwath, L. Chandra [17], Rezwana Begum Mohammed et al., [18], Suersh Babu et al., [19], Shubha C et al., [20], Kumar S et al., [21], S. Manjunath et al., [22], Mahabalesh Shetty [23], A. Saraf et al., [24] where wavy pattern was found to be most prevalent. The results were in contrast with the studies conducted by Baligi P et al., [25] and Kamala R et al. [26], where straight and curve pattern were found to be most prevalent respectively (Table 3).

The sinuous and curve rugae pattern were observed in Caucasian and Aboriginal Australians (Kapali et al.,) [27]. The unification pattern was found to be more in Chinese individuals (Reddy et al., [16]), Shetty et al. [28] found that in Indian males more number of curved rugae on both right and left sides was observed than Tibetan males. Also Tibetan females had more wavy rugae on right and left sides than Indian females. Studies by Nayak et al. [29] suggested that Southern Indians showed more number of straight and curved rugae than Western Indians. Similarly Paliwal et al., [30], found that Kerala population showed predominant straight rugae pattern on the right side of the palate among males when compared to Madhya Pradesh population. The aforementioned literature suggests that the rugae patterns are unique to certain populations.

In the present study, circular and convergence patterns were found to be higher in females of Udaipur than males. The result was consistent with studies conducted by A. Saraf et al., [24] and S. Bhagwath, L. Chandra [17], where convergence pattern was more prevalent in females than males. Studies done by Rezwana Begum Mohammed et al., [18], Seenivasan Madhankumar et al., [31], S. Manjunath et al., [22], and Mahabalesh Shetty, Premalatha K [23], showed that straight, unification and curved and straight pattern respectively were prevalent in females (Table 3). However in the present study the sample size was small so nothing much can be commented on the gender differentiation potential of rugae pattern.

The wavy pattern was found to be the most common in Udaipur. However the females in Udaipur had more circular and convergence

**Table 3:** Rugae pattern in different populations of India.

S.No	AUTHOR	YEAR	STATE/POPULATION	STUDY RESULTS
1.	Eshani Saxena et al. [13]	2015	Bhopal, Madhya Pradesh	Wavy most common Curve: females
2.	Swetha S [14]	2015	North and South Indian	Curved: North Indian Wavy: South Indian Converging: Males Diverging: Females
3.	Deeksha Kiran Shetty [15]	2015	Kodavian and Tibetans	Wavy: most common
4.	Rachna Rath and Ajay Reginald [12]	2014	Odisha/Andhra Pradesh	Wavy: Odisha Straight and Plaque like: Andhra
5.	Reddy et al. [6]	2014	North and South Indian, Chinese	Curved: North Indian Wavy: South Indian and Chinese
6.	Baligi P et al. [25]	2014	Pune, Maharashtra	Straight most common
7.	S. Bhagwath, L. Chandra [17]	2014	Meerut, Uttar Pradesh	Wavy followed by Curved most prevalent Converge type: females Circular type: males
8.	Rezwana Begum Mohammed et al. [18]	2014	Andhra Pradesh	Wavy most prevalent Straight : females Wavy, curved: males
9.	Suresh Babu et al. [19]	2013	West Godavri, Andhra pradesh	Wavy most prevalent Converging: males Diverging: females
10.	Shubha C et al. [20]	2013	North and South Indian OF Davangeree	Curve: North Indian Wavy: South Indian
11.	Seenivasan Madhankumar et al. [31]	2013	Chennai, Tamil Nadu	Straight most prevalent Unification pattern : females Curved pattern: males
12.	Kumar S et al. [21]	2012	Pondicherry, India	Wavy most prevalent No gender difference
13.	S. Manjunath et al. [22]	2012	Manipal, Karnataka	Wavy > curve most prevalent Curved, straight : females Wavy rugae : males
14.	Mahabalesh Shetty, Premalatha K. [23]	2011	Mangalore, Karnataka	Wavy most prevalent Curved, Straight: females Wavy : males
15.	A. Saraf et al. [24]	2011	Maharashtra	Wavy, Curved: most prevalent Converging : females Circular : males
16.	Kamala R et al. [26]	2011	Lucknow, Uttar Pradesh	Curve: most prevalent Converge: females Wavy: males

pattern as compared to males. Though this difference came out to be statistically significant but as the sample size taken was too small so commenting on the gender differentiation potential of rugae pattern isn't helpful. Therefore study on a larger sample size is needed to prove this gender difference. However this difference can be helpful in differentiating the people of Udaipur from other Indian populations where wavy pattern was found to be most common.

Thus the present study supported previous reports that palatal rugae played a significant role in population differentiation and could be used as genetic marker for research on population groups.

**Conclusion**

The rugae patterns are genetically determined. The findings suggest that rugae are specific to a particular population and might have better utility in population differentiation. In the present study following observations were drawn:

- 1) Wavy pattern was found to be more prevalent in Udaipur.
- 2) Convergence and circular pattern was found more in females than males.

This method is simple and inexpensive to conduct and therefore can be applied in forensic odontology.

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