



## Characterization of Palatal Rugae, Incisive Papilla and Palatine Raphe Patterns in Nepalese Population from Central Nepal

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### ABSTRACT

*Identification of an individual is an important aspect of forensic medicine in addition to which study of the various morphological characteristics of an individual has applications in the field of anthropology. The study of palatal rugae forms an important basis of human identification especially due to mass disasters where routinely used techniques may not be helpful. This study aimed at evaluating the palatal rugae on the basis of shape and size and also the shape of the dental arch and incisive papilla along with the length of mid-palatine raphe and the canine-papilla-canine relation. The study was conducted in 200 individuals (males and females) visiting Dhulikhel hospital, Central Nepal. The results suggested that primary rugae showing wavy shape were the most common pattern in both the gender. Significant differences were observed in curved rugae type between males and females. Primary rugae showed significant differences between males and females on the left side of the maxillary arch. In addition, the most common shape of dental arch was parabolic, incisive papilla showing triangular forms were predominant along with long mid palatine raphe and the most common canine-papilla-canine relation being of the posterior type. It can be concluded that evaluation of palatal rugae along with the incisive papilla and mid-palatine raphe can be an important tool for identification of an individual and for evaluating various ethnic populations.*

**KEYWORDS :** Anthropology, Central Nepal, Forensics, Incisive papilla, Mid-palatine raphe, Palatal rugae

### INTRODUCTION:

By nature every individual is unique in his or her own way and personal identification is the proof. Personal identification of a person forms an integral part of forensic sciences, which could get complicated in cases of postmortem, mass disasters scenarios involving mutilated bodies that have undergone damage beyond recognition. (Filho IEM, 2009; Indira A, 2011). Appropriate identification of the deceased is very important to claim certification of death and for personal, social and legal reasons (Filho IEM, 2009; Madhan Kumar S, 2013). According to Arbenz, 1988 identification means demonstrating that a person or one of his or her characteristics being examined is the same as observed in a previous situation (Filho IEM, 2009).

Techniques like analysing the teeth, fingerprints and DNA comparison are most frequently applied, as it allows fast and secure identification process. But still these techniques cannot be applied always, and in some cases, less commonly used techniques have to be implicated. Oral cavity structures like teeth, palatal rugae are resistant to decomposition compared to the other structures of the body. Hence they serve as an alternate source for identification especially when the identification of the deceased gets difficult or fails due to adverse situations. Few studies have been undertaken to observe the alteration of palatal rugae due to thermal changes and decomposition and have concluded that burn victims with pan facial third degree burns did not sustain any alterations in the rugae pattern, and when changes

were noted, they were less pronounced than the generalized state of the body (Shukla D, 2011).

Allen, 1889 suggested that palatal rugae can be used as one of the methods of identification (Indira AP, 2011). Palatoscopy/ rugoscopy is a study of the palatal rugae, used for individual identification and necro identification. Palatal rugae are irregular elevations and projections seen in the transverse direction from the palatine raphe located in the mid-sagittal plane of the mucosa seen on the anterior third of the palate. These rugae have significant characteristic features as they are unique patterns in each individual and remain stable from the time of development until death. Even in extreme cases of trauma or incineration the rugae remains somewhat protected, by their internal position in the head and they are insulated from heat by the lips, tongue, buccal fat pads, teeth and bone (Nayak P, 2011). Rugae are also used in situations where the finger prints are not available. However, rugoscopy can be applicable for identification of an individual, only when there is available ante-mortem information for comparison such as dental casts, tracings or digitized rugae patterns (Nayak P, 2011).

Studies done by English (1988) and Peavy (1967) have demonstrated that the uniqueness of the palatal rugae is maintained throughout life and does not change as a result of growth and it also remains stable from the time of development until the oral mucosa degenerated at

death. Vander Linden proved that the anterior rugae do not increase in length after 10 years of age. Also qualitative characteristics of the palatal rugae such as shape, direction and unification remains stable throughout life. In contrast Hauser G (1989), observed in their study that the mean rugae count changes moderately in adolescence and increases markedly as the age increases with a peak change observed between 35-40 years of age. But Lysell (1955) observed a decrease in the count of rugae from 23 years onwards. There are some factors which contribute to changes in rugae pattern that includes trauma, extreme finger sucking in infancy and continuous pressure applied during orthodontic tooth movement and dentures (Shukla D, 2011).

Palatal rugae also serves as a tool for characterizing and comparing various ethnic populations as evident from the various studies done world-wide. In addition to the various patterns of palatal rugae, the incisive papilla and median palatine raphe can also contribute in this aspect of identification of individuals and characterization of different populations. Hence, this study was undertaken to characterize the patterns of palatal rugae, dental arch, incisive papilla and median palatine raphe in Nepalese population visiting the tertiary health centre of central Nepal.

### MATERIAL AND METHODS:

The study was approved by the Institutional review committee of Kathmandu University School of Medical Sciences and was undertaken from September 2015 to September 2016 in the department of Oral medicine, Kathmandu University School of Medical Sciences, Dhulikhel, Nepal. The study population included 200 patients aged between 17-25 years who were devoid of any congenital abnormalities, inflammation, trauma, and those wearing partial dentures. They were divided basically into two groups on gender which comprised 49 male participants and 151 female participants. The study population were explained about the objectives, methodology and an informed consent was obtained. Alginate impressions were taken in maxillary perforated impression trays and dental stone casts were made. The positive replicas of the palatal rugae obtained on the cast were high lightened using 0.5mm (HB) lead pencil and were observed under adequate light and magnification. Digital Vernier calliper of 0.01mm accuracy was used to measure the length of the rugae and were recorded according to the classification given by Thomas and Kotze based on the size of the palatal rugae. (Primary rugae: >5mm, Secondary rugae: 3-5mm, Fragmentary rugae: 2-3mm and rugae measuring less than 2mm were discarded).

Shape of the individual palatal rugae were classified according to Kapali et al. as curved, wavy, straight, circular, and branched. Apart from the shape and size of palatal rugae, the shape of the maxillary arch, incisive papilla, length of mid-palatine raphe and canine-papilla-canine relation were also recorded so that it provides an additional information on identity of the individual which is given in table no. 5. The data thus obtained was documented in profoma and statistical analysis was done using IBM SPSS 20.0 software. Chi square test was performed to compare the data obtained. 'p' value of  $\leq 0.05$  was considered to be statistically significant.

### RESULTS:

This cross-sectional study was conducted on a study sample of 200 participants. Among the total 200 study participants, majority of them were females representing 75.5% (n=151) of the sample and 24.5% (n=49) were males. A total of 2118 rugae were observed in the entire study population. The palatal rugae were assessed on the basis of shapes and compared between males and females. The results have been shown in table no.1. The rugae were also evaluated according to their sizes and categorised as primary, secondary and fragmentary (Table no. 2) following which further comparisons were done between the right and left sides (Table no. 3) and compared between both genders (Table no. 4) for the primary type of rugae only.

The shape of the dental arch and incisive papilla, length of the mid-palatine raphe and canine-papilla-canine relation has been depicted in table no. 5.

### DISCUSSION:

This study aimed at characterizing the various patterns of palatal rugae, incisive papilla, mid-palatine raphe as well as the shape of

the dental arch in the Nepalese population in South Central Nepal. The patterns of palatal rugae were assessed according to their size, shape and its extension. The most common shape of rugae encountered in this study was of the wavy type which comprised a total of 25.74 % (n=192) of the total sample. Similar results were observed by the study conducted by Bajracharya D et al in Nepalese population who found wavy type to be the most common shape of rugae (Bajracharya D, 2013). The second most common shape of rugae was found to be the curved type followed by branched, straight, circular and point forms of palatal rugae. The study done by Bajracharya D et al also observed the curved type as the second most common type followed by the straight, branched and circular forms of rugae (Bajracharya D, 2013). Similar results, were observed in the study done by Kapali S et al who also observed wavy and curved forms to be the most common types as observed in Australian Aborigines and Caucasians (Kapali S, 1997). Contrasting results were observed in other studies, where Shukla D et al and Indira AP et al who found that the curved and the line forms were commonly observed in the different Indian populations (Shukla D, 2011; Indira AP, 2012). Shubha C et al observed that curved forms were most commonly encountered in North Indian Population whereas wavy forms in South Indian population (Shubha C, 2013). According to Hermosilla VV et al, sinuous form of palatal rugae were the predominant type followed by the curved type in their study population (Hermosilla VV, 2009). Comparison between males and females suggested that the wavy form was the most common type in both the genders. The curved form was second most common in both genders and showed significant differences among males and females ( $p=0.04$ ) whereas no gender based differences were observed in relation to other shapes of palatal rugae. A larger sample size is required to obtain more reliable results. In the studies done by Madhankumar S et al and Sekhon HK et al it was observed that females had predominantly wavy form of rugae whereas males showed the circular type (Madhankumar S, 2013; Sekhon HK, 2014). Shetty M on the other hand suggested that curved forms were more commonly seen in females and wavy form in males in their study on Mangalorean population (Shetty M, 2011).

Furthermore, comparison was done for the various types of rugae according to their sizes between the right and the left quadrant. It was observed that there was no significant difference among these. However, primary type were the most commonly observed rugae size in both males and females. Similar results were seen in another study done on Nepalese population with respect to the distribution of different sizes of rugae among males and females (Bajracharya D, 2013). The results obtained by Popa MF et al and Subramanian P et al were also similar to our study (Popa MF, 2013; Subramanian P, 2015). Madhankumar S et al found that the primary type were more common in females as compared to males (Madhankumar S, 2013). Further, Kapali S et al suggested that the number of primary rugae were significantly higher in the Aboriginal population as compared to the Caucasian's and also suggested that the length of rugae altered with age and was related to the palatal growth and development (Kapali S, 1997). The rugae were also compared based on the quadrant distribution among males and females. No significant differences were found between males and females for primary type of rugae on the right side. However, on the left side there was a significant difference between males and females for primary rugae. Similar results were observed in Aboriginal population for the right side and contrasting for the left side (Kapali S, 1997). Bajracharya D et al found that there were no significant differences with respect to primary rugae on both right and left sides (Bajracharya D, 2013). Shwetha et al suggested that primary rugae was more common in the males of Mysore whereas it was predominant in the Tibetan female population()

The shape of the maxillary arch also were assessed and it was observed that the most common shape was parabolic (78.5%) followed by hyperbolic (14%) and elliptical shape (7.5%). The results obtained by Filho IEM et al in their study varied from our results wherein the dental arch showed a hyperbolic shape in 70% of the study population followed by parabolic (21), elliptical (8%) and the epsilon (1%) forms (Filho IEM, 2009).

In contrast to the various studies in literature evaluating rugae patterns in population evaluation, we employed to include additional parameters which can be used to supplement the various rugae patterns. These included the shape of incisive papilla and the length of

the mid palatine raphe. The shape of the incisive papilla was evaluated among males and females in the study population and it was observed that the most common type was triangular (43%) followed by elliptical (34.5 %) and then thin (22.5%). The length of the mid palatine raphe was evaluated among the study population. It was observed that none of the individuals showed short raphe. Long raphe were encountered in 77.5% cases and 22.5% cases showed medium type of mid-palatine raphe.

**Conclusion:**

The characterization of Nepalese population of central Nepal suggests that primary type is the most common size with wavy shape of palatal rugae being the most prevalent type showing no significant differences between males and females hence can be used to determine the ethnicity. Also, the dental arch shows a parabolic shape frequently. Incisive papilla exists in a triangular form in most of the individuals and long mid palatine raphe being commonly observed in this population. Thus, evaluation of the rugae pattern along with incisive papilla and mid palatine raphe combined with other methods serves as an important alternative for the identification of an individual providing a significant contribution in cases of criminal investigation as well as in mass disasters.

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**CONFLICT OF INTERESTS: Nil**

**TABLES:**

**Table no.1: Comparison of palatal rugae between males and females on the basis of shape.**

Rugae shape	Total individual n (%)	Males		Females		chi square value	P value
		n	%	n	%		
Curved	165 (22.12)	45	24.72	120	21.28	14.184	0.04*
Wavy	192(25.74)	47	25.82	145	25.71	7.846	0.79
Straight	126(16.89)	26	14.29	100	17.73	6.772	0.34
Circular	33 (4.42)	8	4.40	25	4.43	1.050	0.59
Branched	164(21.98)	41	22.53	123	21.81	3.217	0.67
Point	66 (8.84)	15	8.24	51	9.04	4.283	0.51

<0.05 is statistically significant

**Table no. 2: Comparison of palatal rugae between males and females on the basis of size.**

Type of rugae (Total)	Males (%)	Females (%)	Chi-square value	P value
Primary (200)	49 (24.5)	151 (75.5)	7.386	0.69
Secondary (102)	27 (26.47)	75 (73.53)	3.661	0.60
Fragmented (81)	19 (23.46)	62 (76.54)	10.822	0.09

**Table no. 3: Comparison of right and left side of palatal rugae**

	Right side		Left side	
	Mean	S.D.	Mean	S.D.
Primary	4.46	1.29	4.41	1.10
Secondary	0.43	0.80	0.51	0.84
Fragmented	0.49	0.91	0.30	0.72

**Table no.4: Comparison of primary rugae on each side between males and females.**

Variable		Mean	S.D.	Sig
Primary right side	Male	4.51	1.12	0.64
	Female	4.44	1.35	
Primary left side	Male	4.39	0.86	0.01*
	Female	4.42	1.17	

**Table no. 5: Shape of the maxillary arch and incisive papilla, length of mid-palatine raphe and canine-papilla-canine relation**

Shape of arch	Total N=200	%
Parabolic	157	78.5
Elliptical	15	7.5
Hyperbolic	28	14.0
Shape of Incisive Papilla		
Elliptical	69	34.5
Thin	45	22.5
Triangular	86	43.0
Length of Mid-Palatine raphe		
Long	155	77.5
Medium	45	22.5
Canine Papilla canine Relation		
Middle	72	36.0
Posterior	85	42.5
Anterior	43	21.5

**REFERENCES:**

- Bajracharya D, Vaidya A, Thapa S and Shrestha S (2013). Palatal Rugae Pattern in Nepalese Subjects, *Orthodontic Journal of Nepal*; 3(2): 36-9.
- Filho IEM, de Carvalho Sales-Peres SH, Sales-Peres A and Carvalho SPM (2009). Palatal rugae patterns as bioindicators of identification in Forensic Dentistry. *RFO*; 14(3): 227-33.
- Hermosilla VV, San Pedro VJ, Cantin LM and Suazo GIC (2009). Palatal rugae: systematic analysis of its shape and dimensions for use in human identification. *Int. J. Morphol*, 27(3):819-25.
- Indira AP, Gupta M and David MP (2012). Palatal rugae patterns for establishing individuality. *J Forensic Dent Sci*; 4: 2-5.
- Kapali S, Townsend G, Richards L and Parish T (1997). Palatal rugae patterns in Australian Aborigines and Caucasians. *Australian Dental Journal*; 42: (2): 129-33.
- Madhankumar S, Natarajan S, Maheswari U, Kumar VA, Veeravalli PT and Fathima Banu (2013). Palatal Rugae Pattern for Gender Identification among Selected Student Population in Chennai, India, *Journal of Scientific Research & Reports*; 2(2): 491-96.
- Mohammed RB, Rao TH, Rani SG, Chowdary MS (2014). Analysis of Various Rugae Patterns among Coastal Andhra (South Indian) Population: Digitized Method. *Oral and maxillofacial pathology journal*; 5(1): 418-22.
- Nayak P, Acharya A. B. , Padmini A. T. , Kaveri H (2011). "Differences in the palatal rugae shape in two populations of India" *Archives of Oral Biology*; 52: 977-82
- Poppa MF, Stefanescu C and Corici PD(2013). Forensic identification elements with the help of rugoscopy in children. *Rom J Leg Med*; 21: 95-100.
- Sekhon HK, Sircar K, Singh S, Jawa D and Sharma P (2014). Determination of the biometric characteristics of palatine rugae patterns in Uttar Pradesh population: A cross-sectional study. *Indian J Dent Res*; 25: 331-35.
- Shetty M and Premalatha K (2011). Study of Palatal Rugae Pattern among the Student Population in Mangalore. *J Indian Acad Forensic Med*;33(2): 112-15.
- Shrestha RB (2013). Polynomial analysis of dental arch form of Nepalese subjects. *Orthodontic journal of Nepal*; 3(1): 7-12.
- Shubha C, Sujatha GP, Ashok L and Santhosh CS (2013). A Study of Palatal Rugae Pattern among North and South Indian Population of Davanagere City. *J Indian Acad Forensic Med*; 35(3): 219-22.
- Shukla D, Chowdhry A, Bablani D, Jain P and Thapar R (2011). Establishing the reliability of palatal rugae pattern in individual identification (following orthodontic treatment). *J Forensic Odontostomatol*; 29(1): 20-9.
- Subramanian P, Jagannathan N (2015). Palatal rugoscopy as a method of sex determination in forensic science. *Asian J Pharm Clin Res*, 8(2): 136-38.