

Evaluation of palatal rugae pattern in establishing identification and sex determination in Nalgonda children

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Abstract

Background: Establishing individual identification of a decedent only by dental means is a mammoth task in forensic odontology. Palatal rugae's uniqueness, its resistance to heat, and stability throughout life have been proved by its use as an alternative aid in individual identification where comparison of fingerprints and other records is difficult. **Aims and Objectives:** The aim of the present study was to analyze the role of palatal rugoscopy in personal identification and sex determination of Nalgonda pediatric population. **Materials and Methods:** The study group consisted of 100 children having mixed dentition within the age range of 8–11 years, residing in Nalgonda district. Palatal rugae pattern, shape of the incisive papillae, length of the median palatal raphae, and shape of the dental arches were analyzed using Chi-square and Mann-Whitney tests between males and females. **Results:** Wavy and curved patterns appeared to be most prevalent in both males and females but with no significant difference. The number of primary rugae in females and secondary rugae in males, on left side of the palate, was significantly more than their counterparts ($P < 0.05$). When rugae unification was observed, diverging type was significantly more in males than in females. Parabolic dental arch form, elliptical type of incisive papilla, and medium length of median palatal raphae was observed in majority of the subjects. **Conclusion:** The present study hypothesizes the uniqueness of the rugae in personal identification as no two palates showed similar type of rugae in either of the genders. The rugae pattern also contributes minimally towards sex determination as there was no significant difference observed between the two variables.


Key words: Human identification, palatal rugoscopy, pediatric population, sex determination

Introduction

Human identification in postmortem scenarios is fundamental and achieving it by dental or any

other means is one of the most challenging task. Forensic odontology is a unique discipline dealing with evidence related to dental and oral structures. Although the literature is replete with the use of teeth in forensic investigations, use of other methods such as palatal rugae patterns, lip prints, and bite marks were also reported. Palatal rugae are considered to be equipotent with fingerprints and bite marks, for individual identification in medico-legal investigations.

Palatal rugae or transverse palatine folds are asymmetrical and irregular elevations of the mucosa located in the anterior third of the palate, arranged in transverse direction

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from palatine raphae located in midsagittal plane. Rugae are protected from trauma by their internal position in the head, and they are insulated from heat by the tongue and the buccal fat pads.^[1] Palatal rugoscopy, the study of palatal rugae, can be used with expediency in cases like decomposed and burned bodies where fingerprints are unavailable.^[2]

Sassouni stated that no two palates are alike and are constant even during growth.^[3] The abiding nature of palatal rugae and its uniqueness^[1,4,5] has led us to undertake the following study with the principal objective of evaluating its role in establishing individual identity and sex determination among Nalgonda pediatric population, since such studies have seldom been carried out in children.

Materials and Methods

A total of 100 children (50 males and 50 females), within the age-group of 8–11 years were randomly selected and included in the present study after complete oral examination in the Department of Pedodontics and Preventive Dentistry, Kamineni Institute of Dental Sciences, Narketpally, Nalgonda. Children having mixed dentition and absence of proximal carious lesions on teeth were included. Subjects with congenital abnormalities, bony and soft tissue protuberances, active lesions, scars, trauma to the palate, and those undergoing interceptive orthodontic procedures were excluded.

This study was conducted after obtaining the institutional ethical committee clearance and informed written consent from the subjects or parents of the selected sample. Alginate impressions of maxillary arches were made using appropriate perforated metal trays and the casts were prepared using dental stone devoid of air bubbles especially in the anterior third of the palate. The individual palatal rugae were then delineated using sharp graphite pencil on dental casts, under adequate light [Figure 1].

Variables studied were:

Palatal rugae

The palatal rugae pattern was recorded according to the classification given by Lysell, 1955;^[4] Thomas and Kotze, 1983;^[6] and Kapali, 1997.^[7] These classifications include length, unification, and shape of rugae, respectively.

Incisive papilla

The shape of the incisive papilla was evaluated as elliptical, triangular, or thin (thin and narrow shape).^[8]



Figure 1: Delineation of palatal rugae pattern on dental casts

Median palatal raphae

The median palatal raphae was recorded as short (S), medium (M), or long (L) according to Filho IEM *et al.* (2009).^[8]

Dental arch shape

The dental arch was assessed and classified according to Testut, 1944,^[9] which include:

Hyperbolic

When the dental arch segments are divergent throughout their perimeter.

Parabolic

When the dental arch segments are divergent, yet in a less marked manner.

Epsilon

When the dental arch segments are parallel to each other.

Elliptical

When the dental arch segments are convergent.

Comparison of the number, shape, and length of palatal rugae on either sides of the palate along with the shape of incisive papilla, length of the median palatal raphae, and dental arch form were analyzed between males and females using Chi-square and Mann-Whitney U tests.

Results

The total number of rugae was more on the right side of the palate in both males and females than on the left side with numbers greater in males than in females, but with no significant difference [Table 1]. The predominant rugae shape in both males and females were wavy patterns followed by curved, then straight, and circular. More number of wavy and curved types of rugae was observed in females than in males [Figure 2]. When unification of the rugae was analyzed, diverging type was higher in number than converging type, in both males and females on both sides of the palate. However, the total number of diverging rugae was more in males than in females with statistical significance ($P < 0.05$) [Table 2].

On observing the length of the rugae, primary rugae appeared to be most prevalent than secondary and fragmentary types in either of the genders. The number of primary rugae in females and secondary rugae in males was significantly more than their counterparts. ($P < 0.05$) [Table 3 and Figure 3].

The most common dental arch form was found to be parabolic type followed by hyperbolic and epsilon types. None of the sample had elliptical type of dental arch form [Figure 4].

Elliptical type of incisive papilla was found to be most pronounced followed by triangular and thin or narrow types [Figure 5]. On evaluating the length of the median palatal raphae, medium type was observed in most of the subjects followed by long and short types [Figure 6]. None of the variables showed statistically significant difference between males and females except for the number of primary, secondary, and diverging types of rugae.

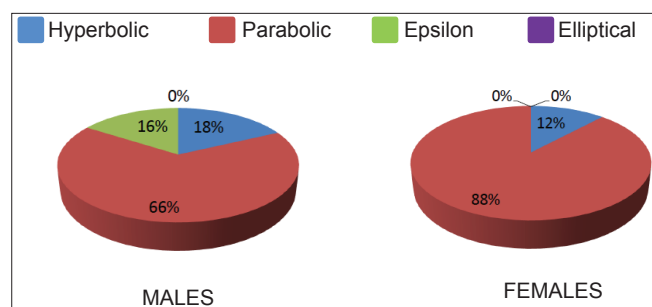


Figure 2: Distribution of various shapes of palatal rugae

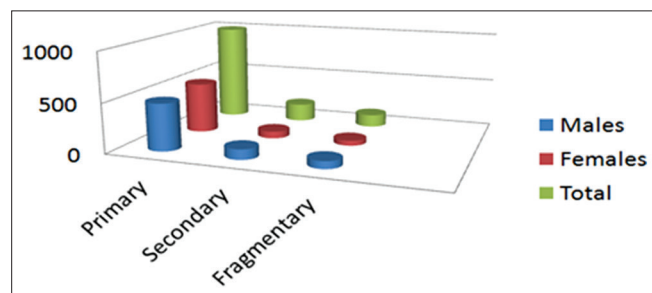


Figure 4: Percentage distribution of dental arch forms

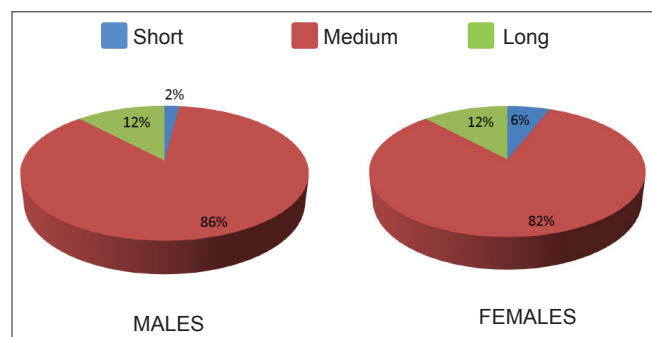


Figure 6: Percentage of extent of the median palatal raphae in males and females

Discussion

The traditional methods for human identification include anthropometry, fingerprints, dental records, gender determination, age estimation, weighing, identifying by specific characteristics, and blood-group differentiation.^[8] Among these, the most accurate means of identification are fingerprints followed by dental records, which is the second most reliable method. In Forensic odontology, teeth restorations, bony protuberances, and palatal rugae present a vast majority of individual details.

Palatoscopy was first suggested by Harrison Allen (1889)^[10] as an alternate method of identification. Palatal rugae was first described by Winslow (1753),^[11] and the earliest illustration of them was given by Santorini (1775).^[12] The anatomical position of the rugae inside the mouth, surrounded by cheeks, lips, tongue, buccal pad of fat, teeth, and bone keeps them well protected from trauma and high temperatures. Thus, they can be used as a reference landmark in forensic identification.^[13]

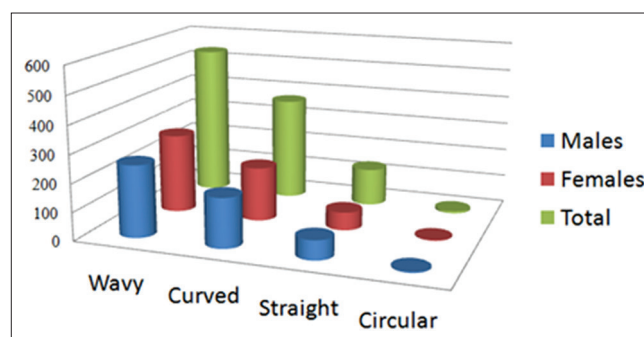


Figure 3: Distribution of various lengths of rugae

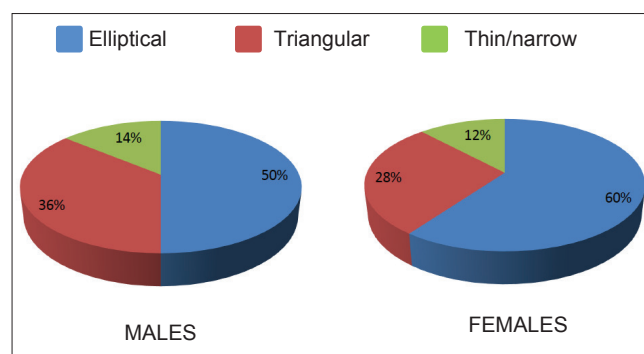


Figure 5: Percentage distribution of types of incisive papillae

Table 1: Distribution of total number of rugae pattern in both the genders

Number of rugae	Male			Female			Z
	Total	Mean	S. D	Total	Mean	S. D	
Right	308	6.16	1.653	293	5.86	1.511	0.84
Left	295	5.90	1.359	291	5.82	1.438	0.12

S. D: Standard deviation

Table 2: Distribution of different types of rugae in males and females

Type	Male					Female					Z	
	R	L	Total	Mean	S. D	R	L	Total	Mean	S. D	R	L
Shapes of rugae												
Wavy	128	128	256	5.12	3.29	130	152	282	5.64	2.33	0.78	1.35
Curved	99	77	176	3.52	1.65	98	94	192	3.84	1.86	0.01	0.88
Straight	33	36	69	1.38	1.29	38	26	64	1.28	1.29	0.65	1.42
Circular	0	4	4	0.08	0.27	2	1	03	0.06	0.23	1.42	1.37
Unification of rugae												
Converging	7	7	14	0.28	0.53	6	8	14	0.28	0.57	0.29	0.27
Diverging	26	23	49	0.98	0.84	12	11	23	0.46	0.71	2.19*	2.20*

*Statistically significant at *P* value <0.05 level. S. D: Standard deviation, R: Right, L: Left

Table 3: Distribution of rugae length in males and females

Length of rugae	Male					Female					Z	
	R	L	Total	Mean of total	S. D	R	L	Total	Mean of total	S. D	R	L
Primary	250	231	481	9.62	2.11	253	260	513	10.26	2.01	0.11	2.38*
Secondary	51	54	105	2.10	1.38	40	32	72	1.44	1.12	0.87	2.77*
Fragmentary	33	43	76	1.52	1.83	26	26	52	1.04	1.70	0.66	1.85

*Statistically significant at *P* value <0.05 level. S. D: Standard deviation, R: Right, L: Left

The first system of classification was developed by Gorla (1911)^[14] and was rudimentary. In 1955, Lysell classified rugae comprehensively including incisive papilla, later it was modified by Thomas and Kotze in 1983 and Kapali *et al.* (1997), which included unification and cross-linking and shape of the rugae.

Sognnaes^[15] advocated the use of dental casts from jaws rather than from dentures for a more reliable result. Jacob and Shaila^[16] reported 100% accuracy from the tracings of entire cast and 79% accuracy with palatine rugae. Limson and Julian^[17] evaluated the photographs of delineated rugae patterns of the cast using a computer software program and reported digitized rugae patterns matched the patterns in the stored records with highest sensitivity and specificity. In our study, we have used dental stone casts for recording the rugae pattern, incisive papilla, and median palatal raphae as it provides three-dimensional view in delineating all the selected variables.

In the present study, the number of rugae was slightly more in males than in females with no significant difference observed on both sides of the palate. These results were in accordance with the findings of Shetty M *et al.* (2011);^[18] Bharat ST *et al.*, (2011);^[19] and Indira AP *et al.* (2012).^[20] However, the right side of the palate had higher number of rugae than on the left side without any statistical significance. These observations were in agreement with the reports given by Indira AP *et al.* (2012). In contrast, Dhoke and Usato (1994);^[21] and Surekha R *et al.* (2012)^[22] reported that the right side of the palate had fewer rugae than the left side.

On observing the shape of the rugae, the present study revealed that the wavy pattern appears to be the most

predominant pattern in both males and females followed by curved, straight, and circular pattern. Our results were similar with the findings reported by Abdellatif AM *et al.* (2011),^[23] which was conducted in Egyptians and Saudi pediatric population groups. In Indian population, similar results were reported by Nayak P *et al.* (2007);^[24] Kotrashetti *et al.* (2011);^[25] Satish KN *et al.* (2012);^[26] Surekha R *et al.* (2012), and in Australian Aborigines and Caucasian population by Kapali *et al.* (1997). In contrast, Shetty SK *et al.* (2005)^[27] revealed that Indian males had more curved pattern and Tibetan females had wavier pattern than their counterparts.

When unification of rugae was analyzed in both males and females, diverging type was more common than converging type with more number seen in males than in females, with no significant difference. In contrast, Fahmi FM *et al.* (2001),^[28] observed that Saudi females had more converging rugae than males. Whereas, Shetty SK *et al.* (2005); Shetty M (2011); and Surekha R (2012) reported that unification of rugae did not show any specific trend.

On analyzing the length of the palatal rugae, females had significantly higher number of primary rugae than males, whereas secondary rugae were significantly more in males. Similarly, Shetty SK *et al.* (2005) reported that Mysorean males and Tibetan females had more number of primary rugae than their respective counterparts. In contrast, Shetty M and Premalatha K (2011) reported that the number of primary rugae did not show any significant difference among the genders.

The present study revealed that most dental arches were parabolic followed by hyperbolic and elliptical

shapes, which differs with the findings of Filho IME *et al.* (2009) who reported highest distribution of hyperbolic dental arches followed by parabolic and elliptical shapes.

Variation of rugae pattern, number, and orientation exist not only among people but also to a lesser extent—in the right and left sides of the same person. In general, no bilateral symmetry exists in the rugae pattern,^[29] which is similar with the results of our study.

In this study, significant difference was observed in two variables between males and females. Based on this, palatal rugoscopy can be documented as an adjunctive investigatory aid in sex determination. Similarly, Saraf A *et al.* (2011)^[30] reported palatoscopy as a useful tool in sex determination. In contrary, Kumar S *et al.* (2012) suggested it as an inefficient tool for sex determination.

The results of the present study conducted in Nalgonda children were discussed with references of all age-groups as literatures on pediatric population is limited.

Conclusion

Palatal rugoscopy is one of the pragmatic methods of human identification in the decree of justice. Rugae pattern, incisive papilla, median palatal raphae, as well as dental arch form was found to be unique to each individual as neither two sides of the palate nor two palates were alike. Thus, palatoscopy might be a useful fact-finding aid in forensic odontology. Wavy shape of the rugae, elliptical incisive papilla, medium length of the median palatal raphae, and parabolic dental arch form were found to be most predominant in Nalgonda pediatric population. Based on the significant differences observed in two variables between males and females, palatoscopy may be useful as an adjunctive aid in sex determination. Within the limitations of the present study, the authors consider the above interpretations to be taken as preliminary data as it was carried out in a small sample. We, thus presume that examination of large samples in detail would be beneficial to further substantiate our present findings and to reach an unambiguous conclusion.

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