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Role of palatal rugae pattern in forensic identification of individuals

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Abstract

Introduction: Forensic odontology is the proper handling, examination and evaluation of dental evidence in order to identify an individual, which can then be presented in the interest of justice. The objective of this study was to analyze any possible difference between the rugae pattern among males and females, which can be used for forensic evaluation as an adjuvant to other methods.

Material and Methods: The study was carried out at Armed Forces Institute of Dentistry (AFID), Rawalpindi. The duration of this study was from December 2016 – February 2017. A total of 100 maxillary dental casts were analyzed. The results were then analyzed using SPSS Statistics 21.0.

Results: There were no significant differences in the length of the rugae amongst different genders, however differences in the shape, direction and unification existed.

Conclusions: Within the limitations of the present study it may be concluded that the rugae pattern may be used as an additional method of differentiation between the male and female for forensic evaluation.

Keywords: Rugae; forensic evaluation; dental casts

Introduction

Forensic odontology is the proper handling, examination and evaluation of dental evidence in order to identify an individual, which can then be presented in the interest of justice. Finger prints and DNA analysis have long been used for identification of individuals but dental evidence is also gaining popularity.[1] Forensic odontology is of importance for legal and criminal cases. Forensic dentists may assist in determining age, race, previous dental history, occupation and socioeconomic status of an individual.[2]

Finger print identification has always been amongst the most commonly used means of identifying an individual but in instances like burn injuries and decomposition of the cadaver, one has to identify with the help of hard tissues. Teeth have been used for forensic identification since a long time, but they may also be lost due to trauma.[2,3] Soft tissue examination is what needs to be done next. Soft tissues that can possibly serve as identification tools include rugae on the anterior palate (rugoscopy), lip prints (cheiloscopy), bite marks and use of molecular techniques such as Polymerase Chain Reaction (PCR) to identify DNA in dental pulp tissue.[7]

"Palatal rugoscopy" is the study of the palatal rugae in order to identify an individual.[3] Palatal rugae are asymmetric, irregular ridges on the mucous membrane of the palate that extends behind the incisive papilla and lateral

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to the mid palatal raphe. Histologically, they consist of layers of fibroblasts and collagen fibers distributed in the connective tissue, covered by thick epithelium. Palatal rugae are formed by 12th to 14th week of intrauterine life and remain stable throughout life, except in individuals who have under gone orthodontic treatment.[4] The pattern changes in length owing to growth of the tissues over time but does not change in shape. It has been suggested by Van der Linden that anterior rugae do not increase in length after 10 years of age.[5] Even disease, chemicals or trauma do not affect the shape of the rugae. Rugae due to their internal position are protected by the lips, cheeks, buccal fat pad, tongue, teeth and bone. The rugae pattern is unique to each individual thus can be helpful in identification.[3,4] Rugoscopy includes analysis of rugae size, shape and merging pattern of rugosities. Palatal rugoscopy offers some advantages over other methods such as uniqueness, simplicity, reliability and low utilization cost.[5,7]

In a previous study conducted by Rani S Thabitha, most prevalent rugae pattern was found to be wavy and curved in both males and females, with no significant difference. On observing the left side of the palate, primary rugae were found to be more prevalent in females and secondary rugae in males as compared to their counterparts. When rugae unification was observed, diverging pattern was significantly more in males than in females. Parabolic arch form and medium length of mid palatal raphae was observed in majority of the subjects.[6,8,9]

The aim of this study was to investigate the role of rugae pattern in an individual's identification and to determine the uniqueness of palatal rugae pattern in our population. This study also aims to identify different patterns of rugae prevalent amongst males and females.

Material and Methods

This was a cross-sectional study conducted in the department of Prosthodontics, AFID. The study involved 100 subjects, divided into 2 groups (50 males and 50 females) between the age range of 20-40 years. The subjects in the age range of 20-40 years, free of congenital abnormalities, without history of orthodontic treatment and trauma to anterior maxilla were included in the study. Patients with abnormalities of palate such as cleft palate, wearing maxillary removable partial dentures, with bony and soft tissue protuberances in the palate, with active lesions on the palate and with scars on the palate were excluded from the sample.

After appropriate selection of the subjects, informed consent was obtained from the patient and maxillary impressions were recorded using Alginate (irreversible hydrocolloid) impression material in a perforated metal stock tray. These impressions were then poured using dental stone. All instructions by the manufacturer were followed such as the water/powder ratio and the use of a vibrator. The selected casts were free of air bubbles or voids, especially in the anterior third of the palate. The rugae pattern on the study models was traced with a black marker in order to enhance the clarity of the rugae pattern on the cast.

The assessment of the palatal rugae pattern was done using Thomas and Kotze classification.[10] The classification was based on the length of rugae with primary rugae greater than 5mm, secondary rugae between 3-5mm and fragmentary rugae less then 3mm in size. The length of the rugae were determined by measuring its greatest dimension regardless of its shape, using a divider. The measurement on the divider was then translated into millimeters using a scale. Based on these predominant shapes were curved (crescent shaped), wavy (slight curve at the origin or termination of a curved rugae), straight (run directly from origin to termination in a straight path) and circular (rugae that form a definite continuous ring).

The direction was determined by measuring the angle formed by the line joining the origin and termination of the rugae and the line perpendicular to the mid palatal raphe. These were forward directed i.e. associated with positive angles and backward directed, associated with negative angles.

Unification was said to have occurred when two rugae were joined at their origin or termination. Diverging, when two rugae had the same origin and immediately branched. Converging when rugae with different origins from the midline, joined laterally.

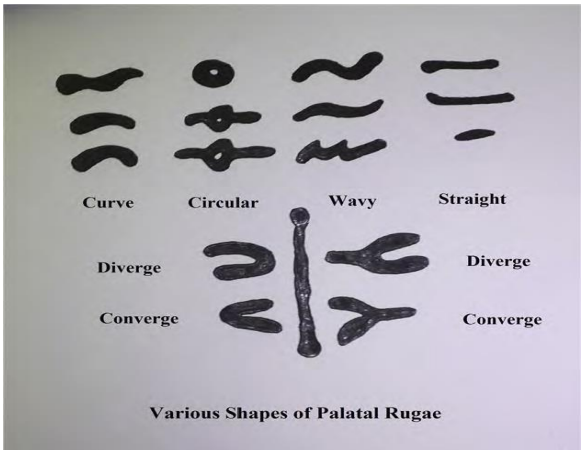

Figure 1: Thomas and Kotze classification of rugae pattern[10]

Results

The total number of rugae and the mean values for both genders are illustrated in Table I. The results were further analyzed for the comparison of rugae pattern in males and females on the basis of differences between length, shape, direction and unification pattern (Table II, III, IV and V). It was analyzed that males had greater number of rugae with majority being secondary length pattern while females had primary rugae more prevalent. There was a marked difference in the shape of the rugae, with the wavy pattern being prevalent amongst males and straight amongst females.

Table I: Sample size along with the total number of rugae and its mean.

Gender	Sample Size	Total Number Of Rugae	Mean
MALE	50	426	8.52
FEMALE	50	415	8.3

Table II: Difference in lengths of rugae amongst males and females

Gender * Length Cross tabulation					
		Length			Total
		Primary	secondary	fragmentary	
Gender	male	22	24	4	50
	female	44	4	2	50
Total		66	28	6	100

Table III: Difference in shapes of rugae amongst males and females

Gender * Shape Cross tabulation					
		Shape			Total
		wavy	straight	Circular	
Gender	Male	34	5	11	50
	female	6	43	1	50
Total		40	48	12	100

Table IV: Illustrates the difference in pattern of direction of rugae amongst males and females

Gender / Direction Cross tabulation				
		Direction		Total
		Forward directed	Backward directed	
Gender	Male	37	13	50
	Female	44	6	50
Total		81	19	100

Table V: Difference in pattern of unification amongst males and females

Gender * Unification Cross tabulation				
		Unification		Total
		Diverging	Converging	
Gender	Male	15	35	50
	Female	43	7	50
Total		58	42	100

Discussion

It is widely acknowledged that there are limitations in forensic identification by methods other than rugae pattern identification. This field along with other methods can prove to be extremely beneficial for forensic studies. This study highlights the importance of rugae pattern identification in our sub-population and also helps differentiate the patterns between males and female.

The present study was cross-sectional in nature and included recording of the rugae pattern of a sample of narrow age frame of 20- 40 years. Hence further studies should be carried out on a sample of wider age frame, larger sample size and with a longitudinal approach may be performed amongst the Pakistani population to corroborate these results.

Kapali et al[11] in their study did not reveal any significant differences in the number of primary rugae between Aboriginal males and females. The present study also did not show any significant difference in the number of rugae between the males and females. In another study, presented by Dohke and Osato[12] it was concluded that females had fewer rugae than males in the Japanese population.

Majority of the studies performed previously did not take fragmentary rugae into consideration and only researched on primary and secondary rugae.[2,4,5,8] While this study aims to compare all the three rugae designs, primary, secondary and fragmentary and helps analyze their prevalence in both the genders. It can be concluded from the present study that primary and secondary rugae, both were prevalent in males without any significant difference. While primary rugae were seen more prevalent in females of our population. Both the genders showed few fragmentary rugae. The shapes of the rugae have been assessed in previous studies and was concluded by Fahmi FM et al, that the presence of the circular type of rugae was found to be statistically higher in males than in females. According to Fahmi FM et al, palatal rugae of a male could be differentiated from that of a female by the circular pattern that was commonly seen in the Saudi population.[13] On the other hand, this study showed that males had a huge number of wavy rugae when classified according to shape. Circular rugae pattern was also seen prevalent in males but to a lesser extent. While straight rugae pattern was seen in a huge number amongst females. When analyzing the unification of the palatal rugae, it was found that diverging and converging both patterns exist in males. While in females, majority of the rugae were diverging type. In this study intra-observer error was assessed by repeat observations and was found to be negligible. Also, the errors in length were small as the measurements were not analyzed quantitatively and were rather categorized. However, this error rate may be reduced further or completely eliminated by development of an intraoral scanning device to capture palatal rugae pattern, with image transfer directly to a computer, with appropriate software, as is presently available for fingerprints. This would help eliminate the manual errors and would also help reduce the time involved in the process of categorization of rugae pattern samples.

Conclusions

Within the limitations of the present study it may be concluded that the rugae pattern may be used as an additional method of

differentiation between the male and female for forensic evaluation.

Using rugae pattern may narrow the field for identification and give results in conjunction with the other methods such as visual, fingerprints, and dental characteristics in forensic sciences. Further research may be indicated with a larger sample size and with a wider age range in order to substantiate the findings of the present study. In addition, examining the rugae patterns in other Pakistani populations may further corroborate the findings of this study.

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