PALATAL RUGAE PATTERN IN GENDER IDENTIFICATION - A FORENSIC STUDY

Dr. Gutta Mounika[1], Dr. Bonthagarla Krishna Sahi[2], Dr. A.D.N Deepika[2], Dr. Naidu Harika[1], Dr. Avuluri Malyadri[3],

[1]Department of Oral Medicine and Radiology, Lenora Institute of Dental Sciences.

[2]Department of Oral Medicine and Radiology, GSL Dental College and Hospital.

[3]Department of Hospital Administration, Narayana Medical College and Hospital.

ABSTRACT

Background: Palatal rugae pattern is reasonably unique to an individual and remain stable throughout lifetime. It can serve as an important tool in forensic identification particularly when other regular methods of identification become difficult.

Aim: To evaluate the palatal rugae pattern between both gender in terms of Number, Shapes and Length on right and left sides among different age groups.

Materials and methods: Cross-sectional study comprising of 60 patients which were divided into four groups according to their age. Each of the four groups consisted of 15 participants of whom 30 were males and 30 were females. All the patients meeting the inclusion and exclusion criteria were randomly selected and alginate impressions of the hard palate were taken and casted by dental stone. The data were assessed based on the Thomas and Kotze classification (1983) and the rugae patterns were delineated using sharp graphite pencil under adequate light and were analysed macroscopically.

Statistical analysis: The obtained values were analysed using Student's t- test for evaluation of gender difference in rugae patterns and ANOVA was applied for determination of age groups using SPSS version 20.0 software.

Results: Palatal rugae of right side showed higher prevalence and curved rugae in females than in males and the finding is statistically significant. The mean number of rugae showed a slight decreasing trend with increasing age with more curved rugae and size of the palatal rugae is slightly increased up till the middle age group, as growth ceases thereafter.

Conclusion: The present study reveals significant gender and age difference in palatal rugae pattern. Thus, palatal rugae appear to possess features of an ideal forensic identification parameters such as uniqueness, postmortem resistance and stability, provided antemortem record exists.

Key words: Forensic Odontology, Palatal rugae, Rugoscopy.

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INTRODUCTION

Forensic Science helps in scientific examination of the crime in the legal justice system. Forensic odontology is that division of

Address for Correspondence
Dr. Gutta Mounika
Post Graduate Student, Lenora Institute of Dental Sciences, Rajahmundry.
Email : dr.mounikamalyadri@gmail.com.

forensic science which deals with the identification of the person from dental evidences such as teeth, bite marks which

can be found in the cases of child abuse, dead remains that involve the human dentition and bite impressions.[1]

Personal identification forms an integral part of forensic science that is based on scientific principles, mainly involving dental records, fingerprints and DNA comparisons. Sometimes, it becomes necessary to apply a lesser known and unusual technique like palatoscopy. Palatoscopy or palatal rugoscopy is the study of palatal rugae in order to establish a persons identity.[2] Palatal rugae is defined as an anatomical fold or wrinkle usually made in the plural sense; the irregular fibrous connective tissue ridges located in the anterior third of the hard palate. It is also known as Plica Palatinae. Palatal rugae appear in the 3rd month of intra-uterine life. Due to its anatomic position, rugae are protected from thermal insults by the tongue and buccal pad of fat. In the previous literature there is consensus opinion that palatal rugae remains fairly stable in number and do not undergo any change due to growth, ageing, tooth extraction and disease.[3]

The palatal rugae appear towards the third month of intrauterine life. Palatal rugoscopy was first proposed by Trobo Hermosa in 1932.The analysis of palatal rugae was first proposed by Allen in 1889. Rugoscopy is useful in mass disasters where conventional methods are not feasible.[4]

As there are few studies in the literature regarding evaluation of the palatal rugae, the present study was undertaken to evaluate the palatal rugae pattern between the Genders in terms of Number, Shapes and Length on right and left sides among different age groups.

MATERIALS AND METHODS

The present study was conducted in the Department of Oral Medicine and Radiology, Lenora Institute of Dental Sciences, Rajanagaram, Rajahmundry, East Godavari district, Andhra Pradesh, India after getting approval from the Institutional Ethical Committee and informed consent was taken from all the participants. A total of 60 patients were randomly selected from the outpatient department. These patients were divided into four groups according to their age.

i) Age group I: 3 to 5 years i.e deciduous dentition

ii) Age group II: 6 to12 years i.e Mixed dentition

iii) Age group III: 13 to 30 years i.e Young adults

iv) Age group IV: 31 to 60 years i.e Middle and elderly age.

Each of the four groups consisted of 15 participants of whom 30 were males and 30 were females, thus the groups were matched gender wise too.

INCLUSION CRITERIA: Patients without removable and fixed partial dentures and without braces.

EXCLUSION CRITERIA: Patients with cleft lip, cleft palate, injured hard palates and infectious diseases. All the patients who participated in the study were explained about the study in their known language and consent was taken. Patients were made comfortably seated on a dental chair and the detailed history along with the demographic data was recorded. A thorough clinical examination was carried out under artificial illumination and the alginate impressions of the maxillary arch was made using a perforated impression tray.

METHODOLOGY: Alginate impressions was washed under running tap water and casts were poured using high strength plaster. The models were free of voids or discrepancy especially in the anterior two-third of hard palate. The casts were sterilized and base of the stone model was trimmed parallel to the occlusal plane and were dried up. The rugae patterns were delineated using sharp graphite pencil under adequate light and were analysed macroscopically (Figure 1).

IDENTIFICATION METHOD: A midline was drawn coinciding with that of the mid palatine raphae extending from the incisive papillae to the posterior most extent of the rugae on the palate. This divided the rugae in two halves. Number of palatal rugae on left as well as right side of the mid palatine raphae was recorded. Size of each rugae was measured and recorded in the study table using a point divider and a scale by measuring the length from end to other end of the rugae. Rugae <2mm were ignored when the mean value of the total number rugae was calculated. Shapes of the rugae present on right and left sides of the median raphae were analysed according to the classification given by Thomas and Kotze (Figure 2). It classifies the rugae pattern into straight, wavy, circular, curved, and unification. Length of the rugae was evaluate as primary (>5mm), secondary (3-4mm) and fragmentary (<3mm). Shape of the rugae was recorded as straight, wavy, circular and curved. The direction of the rugae was evaluated by measuring the angle formed by the line joining its origin and termination and the line perpendicular to the median raphae and classified as forwardly directed rugae, backwardly directed rugae and perpendicular rugae. Unification of rugae in the samples was recorded as diverging or converging rugae.

STATISTICAL ANALYSIS

The statistical analysis was performed using SPSS ((Statistical package for social sciences) software version 20.0. Student's t- test was

applied for evaluation of gender difference in rugae patterns and ANOVA was applied for determination of age groups. A *P* value of <0.05 was considered to be statistically significant.

RESULTS

The current study performed on 60 healthy patients with ages ranging from 3-60 years, among which 30 (50%) were males and 30 (50%) were females. All the dental casts were thoroughly examined and statistically analysed. The total number of Rugae on right side of the hard palate was higher in females than in males and the observed difference was found to be statistically significant. (Table:1)

Table 1: Distribution of Number of Rugae among Gender on Right Side.

Gender	Number	Mean ± SD	t - value	P - value	Remarks
Male	30	3.01± 0.419	2.042	<0.05	Significant
Female	30	3.40±0.676			

Table 2: Distribution of Number of Rugae among Gender on Left Side.

Gender	Number	Mean ± SD	t - value	P - value	Remarks
Male	30	3.01± 0.988	0.532	>0.05	Not Significant
Female	30	3.09±0.836			

On the contrary, the difference in the values of total number of rugae on left side of hard palate was not significant. (Table:2) While analysing the shape of the palatal rugae, it was observed that the predominant shape of the rugae among gender was curved followed by wavy, straight ad circular shapes. When the number of rugae was compared in different age groups of the study population, it was observed that total number of rugae were maximum in age groups 3 to 5 years while the number of rugae was minimum in age group above 51 years.

Also, females exhibit a higher mean value of curved rugae when compared to males and the difference was found to statistically significant. (Table:3)

There was no statistically significant difference in the number of unifications of palatal rugae among male and female samples. (Table:4)

Table 3: Distribution of various shapes of Rugae among Gender.

	Curved		**Wavy**		**Straight**		**Circular**	
Gender	Male	Female	Male	Female	Male	Female	Male	Female
Mean ± SD	1.58 ± 1.04	2.47 ± 0.992	1.41 ± 1.258	1.70 ± 1.088	1.23 ± 0.955	1.11 ± 1.095	0.23 ± 0.431	0.11 ± 0.239
t- value	3.463		1.032		0.47		1.376	
P - value	<0.05		>0.05		>0.05		>0.05	
Remarks	Significant		Not Significant		Not Significant		Not Significant	

Table 4: Distribution of number of unifications of Rugae among Gender.

	Converging		Diverging	
Gender	Male	Female	Male	Female
Mean ± SD	0.76 ± 0.654	1 ± 0.603	0.41 ± 0.499	0.353 ± 0.597
t- value	1.536		0.444	
P - value	>0.05		>0.05	
Remarks	Not Significant		Not Significant	

Comparing the shape of the palatal rugae in various age groups lead to a conclusion that curved, wavy and straight curve were grossly maximum in all the four age groups followed by unification converging and then unification diverging type of rugae.

The average length of the palatal rugae was higher in males when compared to females and the observed difference was found to be statistically significant. (Table:5) It was noted that the mean number of rugae showed a slight decreasing trend with increasing age. (Table:6)

Table 5: Distribution of Length of Rugae among Gender.

Gender	Number	Mean ± SD	t - value	P - value	Remarks
Male	30	13.63 ± 2.413	1.965	<0.05	Significant
Female	30	11.69 ± 2.207			

Table 6: Distribution of Number of Rugae among different age groups.

Age groups	Age (years)	Total no: of individuals	Mean ± SD
I	3-5	15	9.30 ± 1.57
II	6-12	15	9.00 ± 1.59
III	13-30	15	8.80 ± 1.75
IV	31-60	15	8.76 ± 1.86

Circular shape of palatal rugae were found to be negligible among all four age groups. Hence, the shape of the palatal rugae does not change with age. (Table:7) Size of the palatal rugae is slightly increased up till the middle age group i.e 13-30 years thereafter remaining

constant as growth ceases thereafter. There was no statistically significant difference in the average length of the rugae among various age groups of individuals. Thus, length neither increase nor decrease with age once the rugae are formed to its full growth. (Table:8)

DISCUSSION

Forensic human identification requires the determination of various requirements for both living and deceased such as age, sex, ethnicity or geographical region.

Table 7: Comparison of Shapes of Rugae among different age group

Shape	**3-5 years**	**6-12 years**	**13-30 years**	**31-60 years**	**P value**
Converging	7.63 ± 9.16	7.65 ± 8.14	4.91 ± 7.76	5.80 ± 8.49	0.001
Diverging	4.53 ± 6.85	4.30 ± 6.57	4.94 ± 8.63	4.68 ± 7.85	0.945
Straight	24.40 ± 16.16	27.69 ± 16.34	22.21 ± 16.39	29.31 ± 16.39	<0.001
Wave	26.42 ± 13.37	31.80 ± 16.51	33.14 ± 19.79	23.56 ± 13.35	<0.001
Curved	33.43 ± 16.57	24.82 ± 14.80	30.70 ± 18.42	31.32 ± 18.30	<0.001
Circular	2.78 ± 5.49	1.68 ± 4.41	2.09 ± 4.71	3.33 ± 7.47	0.055

Palatal rugoscopy is one such method which is successfully used to identify an individual on the basis of the analysis of the rugal pattern, as it has been shown to be significantly unique in type, length, width, prominence, number & orientation among individuals. There is also a disparity on the right & left sides of the same individual, i.e. there is no bilateral symmetry in the pattern of rugae.[5] Many studies have been carried out in past on rugae patterns and it is an established fact that no two palates are alike in their configuration. The palatal rugae are unique. In the present study, it is observed that the total number of rugae on the right side of palate shows a statistically significant difference among sexes in the study population. However, the total number of rugae on the left side did not show any

statistically significant differences among the sexes. The predominant number of the rugae among gender showed a higher mean value among females when compared to males and the difference was found to statistically significant. This was in accordance with the study conducted by Panda S et al[6] which showed higher significance in females.

palatal rugae. This observation is unlike the study conducted by Kamala R et al[10], Gadicherla P et al.[11] which stated that females had significantly higher mean proportion of unification converging rugae as compared with males.

Table 8: Difference in the Size of the Rugae among different age groups

Size	**3-5 years**	**6-12 years**	**13-30 years**	**31-60 years**
>5 mm	6.6%	6.2%	6.0%	5.7%
3-4 mm	52.8%	52.2%	49.1%	49.4%
<3 mm	40.6%	41.6%	44.9%	45.0%
Mean	9.20	9.27	9.44	9.47

According to studies conducted by Oberoi IS et al[7], Dwivedi N et al[8], and Nayak P et al[9], the palatal rugae were found more in number among males when compared to females and also they exhibited that straight type of rugae were more prevalent whereas the present study showed curved type of rugae followed by wavy, straight and circular shapes. This can be compared to a study conducted by Kamala R et al., which stated that 33.1% of total rugae shapes were curved in both sexes followed by wave and straight type comprising 27.9% and 25 % respectively.[10] In present study it was observed that there is no sexual dimorphism in unification pattern of. The average length of the palatal rugae was higher in males when compared to females and the observed difference was found to be statistically significant in the present study. This study was in accordance with the study conducted on population sample from Upper Egypt revealed that the length was higher in males and the

difference was statistically significant. The Egyptian study also reported that the length of rugae and its number did not differ in relation to either age or gender. Another component of the present study was age related where the number of rugae was compared in different age groups of the study population and it was noted that the mean number of rugae showed a slight decreasing trend with increasing age. Also, when comparing the shape of the palatal rugae curved, wavy and straight curve were grossly maximum in all the four age groups followed by unification converging and then unification diverging type of rugae by stating that the shape of the palatal rugae does not change with age. Size of the palatal rugae is slightly increased up till the middle age group i.e 13-30 years thereafter remaining constant as growth ceases thereafter. Thus, length neither increase nor decrease with age once the rugae are formed to its full growth. By taking all above-mentioned points into consideration, the present study was in correlation with the studies conducted by Kapali et al[12], Peavy et al[13], Bailey et al[14] which showed statistically significant difference in the number, shape and size of the palatal rugae among different age groups.

The present study has echoed the findings of earlier studies in establishing the potential of palatal rugae pattern in gender and age determination and serves as a reliable tool for identification purpose owing to its uniqueness and stability. Finally, such identification depends largely on the availability of antemortem records of rugae pattern in various forms.

LIMITATIONS

1) Unfortunately, the data base in India is scanty and improper and thus limits the potential of this tool in forensic study.

2) As this study had a limited sample size of 60 subjects, it will be beneficial to conduct similar studies with larger samples. Creation of a data bank comprising antemortem data on palatal rugae pattern will overcome the limitation of using the method in human identification.

CONCLUSION

The present study on palatal rugae pattern in gender identification establishes the potential of rugae pattern as important tool in identification of humans. The results of the present study showed a unique pattern in the population where the total number of rugae in right side of palate showed a statistically significant difference among gender. The incidence of curved rugae was more in females. However, no significant gender difference in the number of unifications of rugae could be found. This study also reported that the mean number of rugae showed a slight decreasing trend with increasing age with more curved rugae and size of the palatal rugae is slightly increased up till the middle age

group, as growth ceases thereafter. However, no two palates are alike in their configuration and once formed, they do not undergo any changes except in their length due to normal growth, remaining in the same position throughout a person's entire life.

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