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Role of Palatal Rugae in Human Identification and Sexual Dimorphism

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Abstract

Human identification is one of the most challenging tasks in forensic identification. In some cases it is necessary to apply different kind of techniques that also include rugoscopy. Objectives of our study are to investigate palatal rugae patterns in females and males and to evaluate the stability of these patterns in pre and post orthodontic casts. The association of rugae pattern (length, number, shape) and the gender was analyzed. The average length of the rugae was greater in males than in females. The average number of rugae was same in both males and females. When only primary rugae are observed wavy pattern is seen predominant in male and when total rugae are observed straight pattern is predominant in females. But statistically on doing chi-square analysis shows only significance in Primary rugae predominance on right side. Insignificant difference is found in the total number of primary rugae in males and females well as sidewise distribution of rugae pattern difference (p>.05) so gender determination is not possible only on basis of rugae pattern. Palatal patterns are unique to an individual and therefore it can be used for personal identification but without ante mortem data recording it is not possible.

Keywords: DNA, Rugoscopy, Predominant.

Introduction

Forensic science has played a key role in human identification 4.DNA, finger print and dental record comparisons are the most commonly used scientific methods of identification.[1-3] (Although DNA profiling is accurate, it is expensive and time consuming for using large population.[4] Limitations to the use of fingerprints occur in situations where the hands are charred or may be inaccurate or incomplete.[1,2] Forensic odontology is a specialty in dentistry which deals with appropriate handling and examination of dental evidence and proper

evaluation and presentation of dental findings in the interest of justice.[1] Identification using dental records maybe inaccurate or incomplete.[1,2] Use of human palatal rugae has been suggested as an alternative method for identification.

Palatal rugae are irregular, asymmetric ridges of mucous membranes extending lateral from the incisive papilla and anterior part of median palatal raphe. [2,6,7] Palatal rugoscopy is the study of palatal rugae in order to establish a person's identity.[3] Palatal rugae have been shown to be highly individual and consistent in shape, direction and unification throughout life except in length.[8] The anatomical position of the rugae inside the oral cavity also gives some protection in cases of trauma or incineration.[1,3] It can be of special interest in edentulous cases.

Thus the uniqueness, postmortem resistance overall stability and additionally low utilization cost makes palatal rugae an ideal forensic identification parameter. [9] The objective of the present study was to record the distribution of the predominant rugae pattern number, shape, length, unification and location) in Indian (central Gujarat population) and to compare the distribution of their parameters between males and females to know gender differentiation.

Materials And Method

The study was conducted at the Department of Oral Medicine and Radiology, Faculty of Dental Science, Dharamsinh Desai University, Nadiad, Gujarat, India. We studied patients who had undergone orthodontic treatment. Their pre and postoperative casts were visualized and compared to find closest match that is required to check the stability of rugae pattern. The study was conducted after obtaining ethical committee clearance .Subjects was briefed regarding the procedure and return consent was obtained.

Selection of Subjects

A total number of 150 patients, 75 males and 75 females between the age group of 15-25 years were taken.

Inclusion criteria: Healthy individuals free of congenital abnormalities, inflammation or trauma.

Exclusion criteria

- Subjects not willing to participate.
- Subjects allergic to impression materials.
- Subjects with congenital anomalies/malformations
- Subjects with previous orthognathic surgery
- Subjects with bony and soft tissue protuberances
- Subjects with active lesions
- Subjects with deformity or scars and trauma of the palate

Impressions

The subjects were made to sit upright on the dental chair. An irreversible hydrocolloid was used as an impression material on an appropriate perforated metal tray for the maxillary dental arch for all subjects. The impressions were then poured with Type III dental stone. All instructions by the manufacturer were followed such as water/powder ratio, vacuum mixing, and the use of a vibrator. All casts were free of air bubbles or voids.

Method of identification

A midline was drawn coinciding with that of the mid palatine raphe to the posterior most extent of the rugae on the palate. This divided the rugae into two halves and the rugae in each half were highlighted using a lead pencil under spotlight. The method of rugae recording used in this study was based on the classification of Thomas and Kotze. These classifications include number, length, shape, and unification of rugae. Classification of Kapali et al [7] was used for shape. The rugae were measured using a digital caliper. Those rugae, which have a length of more than 5mm, are referred to as primary rugae. Secondary rugae are those,

which have a length between 3-5 mm, whilst fragmentary rugae, are those which have a length between 2-3 mm. The shapes of individual rugae were classified into four major types: curved, wavy, straight, and circular. Straight types ran directly from their origin to termination. The curved type had a simple crescent shape which curved gently. Evidence of even the slightest bend at the termination or origin of rugae led to a classification as curved. The basic shape of the wavy rugae was serpentine. To be classified as circular, rugae needed to display a definite continuous ring formation. Unification occurs when two rugae are joined at their origin or termination. Unifications in which two rugae begin from the same origin medially but immediately diverged laterally were classified as diverging. Rugae with different origins medially which joined on their lateral portions were classified as converging.

To assess intraobserver variation in interpretation, double determinations were performed for all the subjects.

Results

Our study revels very minor change in numbers of rugae between males and females. (Table 1 and 2) Comparing both side right side shows more numbers of rugae in females and in left side in males (Table 3). Comparing both pre and post orthodontic casts revels that not a single cast shows significant change even after extraction, tooth movement or another orthodontic treatment.

Considering the shape when only primary rugae are observed wavy pattern is seen predominant in male and when total rugae are observed straight pattern is predominant in females. Followed by wavy pattern with again male predominance.

Our study data shows that sex determination only on base of length and shape is insignificant or bit difficult and further study is required with large data volume and more criteria in this subjects for further significant inference.

The study has revealed that no two palates are alike in their configuration & each presents an organized pattern of rugae specific to the individual. There was insignificant difference in the number of rugae between males and females. Our study has revealed that wavy, curved & straight patterns are predominant while circular & unified converging patterns are found less frequently. Wavy pattern was found more in males while curved pattern was found slightly more in the females than in males. There was no significant difference in the straight, circular, and unified patterns between males and females. (Table 4)

Considering the primary, secondary, and fragmentary rugae the most predominant pattern revealed is straight which in females has a percentage value of 22.55%, which is similar to males who have a mean value of 21.45%. Similarly, circular & unified patterns have insignificant gender differences. But the wavy pattern is found more in males while curvy pattern was found more in females. (Table 5)

In males, on the right side, straight pattern is predominant followed by wavy, curved, & unified diverging. While on the left side, wavy pattern is predominant followed by straight, curved, and unified diverging. In females, curved & unified diverging patterns are predominant of the left side while straight, wavy, & unified converging patterns are predominant on the right side. (Graph 1&2)

Table 1: Total number of subjects and the mean value of rugae in males and females

Sex	Total No of subjects	Total no rugae	Mean	SD
Male	75	688	9.09	1.37
Female	75	677	9.05	1.47

Table 2: Total number of different rugae patterns and percentage distributions

Gender	Patterns					
	Wavy	Curve	Straight	Circular	Converging	Diverging
Male	207(30.09%)	132(19.19%)	225(32.70%)	57(8.28%)	10(1.45%)	57(8.28%)
Female	169(24.96%)	149(22.01%)	229(33.83%)	57(8.42%)	15(2.22%)	58(8.57%)

Table 3: Total number of primary rugae

Gender	Number	Side	Total no of rugae	Mean	SD
Male	75	Right	188	2.51	0.96
		Left	198	2.64	0.90
Female	75	Right	204	2.72	0.83
		Left	177	2.36	0.78

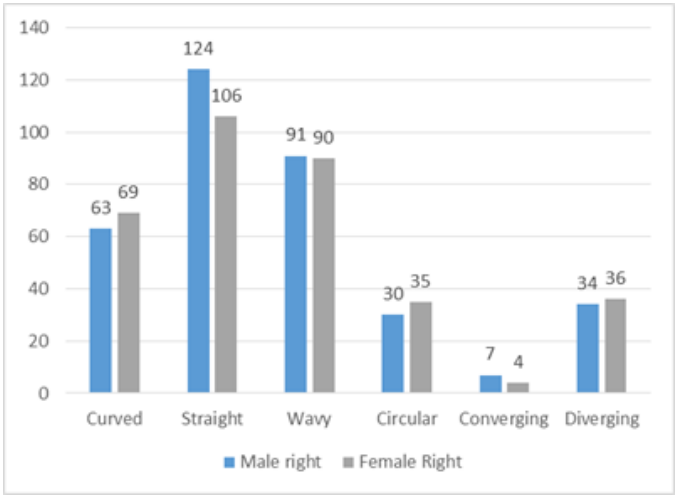
Table 4: Test of proportionality for the distribution of rugae pattern between male and female

		Observed Population	Total Population	Observed Proportion
Wavy	Male	207	688	0.301
	Female	169	677	0.250
Curve	Male	132	688	0.192
	Female	149	677	0.220
Circular	Male	57	688	0.083
	Female	57	677	0.084
Straight	Male	225	688	0.327
	Female	229	677	0.338
Converging	Male	10	688	0.015
	Female	15	677	0.022
Diverging	Male	57	688	0.083
	Female	58	677	0.086

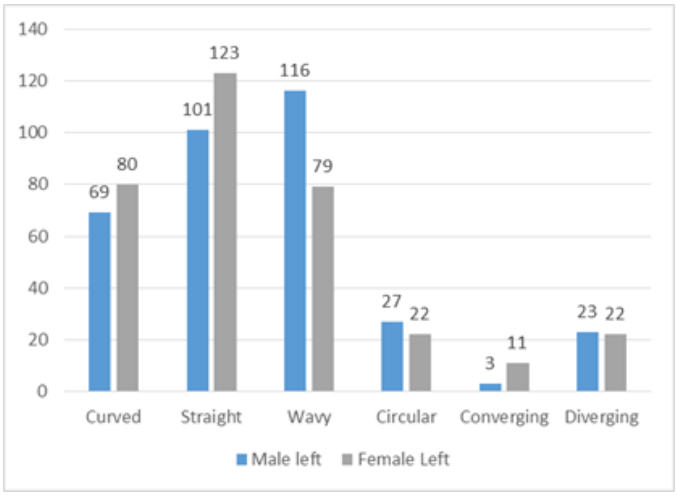
Table 5: Gender wise distribution of rugae pattern

Types of Rugae	Gender		Total N (%)
	Male n(%)	Female n(%)	
Primary			
Curved	77 (10.04)	80 (10.43)	157 (20.47)
Straight	81 (10.56)	89 (11.60)	170 (22.16)
Wavy	162 (21.12)	142 (18.51)	304 (39.63)
Circular	1 (0.13)	3 (0.39)	4 (0.52)
Converging	8 (1.04)	14 (1.83)	22 (2.87)
Diverging	57 (7.43)	53 (6.91)	110 (14.34)
Total	386 (50.33)	381 (49.67)	767 (100)
χ^2 (P Value)	4.49 (0.47)		
Secondary			
Curved	28 (8.67)	40 (12.38)	68 (21.05)
Straight	85 (26.32)	78 (24.15)	163 (50.46)
Wavy	44 (13.62)	27 (8.36)	71 (21.98)
Circular	9 (2.79)	4 (1.24)	13(4.02)
Converging	2 (0.62)	1 (0.31)	3 (0.93)
Diverging	0	5 (1.55)	5 (1.55)
Total	168 (52.01)	155 (47.99)	323 (100)
χ^2 (P Value)	13.24 (0.02)*		
Fragmentary			
Curved	26 (9.45)	29 (10.55)	56 (20.36)
Straight	59 (21.45)	62 (22.55)	121 (44)
Wavy	1 (0.36)	0	1 (0.36)
Circular	47 (17.09)	50 (18.18)	97 (35.27)
Converging	0	0	0
Diverging	0	0	0
Total	133 (48.36)	141 (51.27)	275 (100)
χ^2 (P Value)	1.09 (0.78)		

Graph 1: Right side distribution of rugae pattern in both gender



Graph 2: Left side distribution of rugae pattern in both gender



Discussion

Palatal rugae pattern shows uniqueness and stability that makes its role important in forensic investigation. [2] Application of palatal rugae pattern to personal identification was suggested by alen in 1889 [6] Since then various study have been done for palatal rugae and its use the present study investigated difference in number, shape, length, side distribution and sex determination in Indian sample in Gujarat .

Most of the previous study are focused on primary rugae our study indicates that along with primary rugae, secondary and fragmentary rugae are also important for

sex determination. Male have more number of primary rugae than females while females have more secondary rugae.

Our study revels very minor changes in the number of rugae between males and females ,several other studies shows similar results i.e Mahabalesh et al,[3] Kapali et al,[7] Paliwal et al,[9] Pooja bali,[5] Faizal et al,[10] Mohammed et al.[13] Our observation is in contrast that of Shetty et al,[3] Barath et al,[6] Surekha et al[8] who all have reported that number of rugae is more in females while the studies conducted by Indira at el,[11] Venegas et al,[12] and Herchandani et al[14] revels that number of rugae is more in male this gender base difference can be used as major aid in forensic odontology.[14]

Comparing both the sides the right side shows more no of rugae in females and left side in males this is in contrast to the study conducted by Mahabalesher et al,[3] Pooja bali et al,[5] Kapali et al[7] which shows insignificant side differences, however Indira at el[11] shows that total no of rugae is found more on right side while Surekha et al [8] shows more rugae on left side. Comparing both sides no bilateral symmetry was obtained in any individual.[11]

Considering the shape when only primary rugae are observed wavy pattern is predominant in males. Ibeachu P et al, [2] Kapali et al [3] also found same result. In contrast the study done by Chopra et al,[19] Mahabaleser et al [3] revels that curved pattern is predominant in males which is in accordance with Indira et al.[11]

When total rugae is observed straight pattern predominance is seen this is consistent with the result of Mohammed et al [13] and Balgi et al [5] in contrast curved is common in study of Mohammed et al. [13]

Our study also revels converging type predominance in females that is consistant with result of Saraf et al,[1] Faizal et al,[10] Herchandani et al,[14] Manickam et al [15] but the study conducted by Shetty et al[3] and Bharath et al [6] revel that converging pattern more in male .

Despite the controversy about the stability of different characteristics of rugae, the uniqueness of individuals has been recognized in forensic science as providing potential source of identification. [9]

Conclusion

After studying primary ,secondary as well as fragmentary rugae and reviewing all other studies rugae pattern is only an additional tool along with other establish method (DNA, Fingerprints, Teeth) of forensic dentistry for personal identification and gender determination . Our study results shows minor difference in number of rugae between males and females .Shape specification is not consistent in all studies so ante mortem data in terms of palatal impression and cast should be obtain of all individual as it is inexpensive and without radiation hazards as adjunct to fingerprints and this data can be useful in future in case of mass disasters or gender determination .Palatal rugae alone is not much reliable for gender determination and without ante mortem data is not useful for personal identification.

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