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A Study on Gender Identification Using Palatal Rugoscopy

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Abstract

Palatal rugae are distinct to every single person, and no two patterns are alike concerning traits, encompassing orientation, length, form, and location. The current study was conducted to identify and determine the association between gender and characteristics of palatal rugae in Kerala and Karnataka population. Analysis of palatal rugae might offer a significant contribution to forensic dentistry, given their unwavering maintenance of shape, arrangement, orientation, and unity throughout an individual's lifespan, except for alterations in size as the palate grows. Sixty maxillary casts (30 from each group including males and females) in Kerala and Karnataka Population were taken and examined in the age group ranging from 18 to 30 years. Palatal rugae pattern were analysed on the right and left sides of the palate for total number, length, shape, direction, and unification according to the Thomas and Kotze's Classification. Using Graphite pencil the rugae were drawn and compared. Vernier Caliper was used for measuring the length of the Rugae. Total 60 maxillary casts were taken and compared. The total number of rugae was found to be more among females than males. Forward rugae was more in male while backward and perpendicular were more among females. Another significant difference seen would be straight shaped rugae was seen higher in male and curved shape rugae was more among females. And in the unification convergent rugae was seen higher in females and divergent in males. No two palates were seen to be having similar patterns. Palatal rugoscopy can be a better aspect for identification. It can be applied in forensic identification . More researches on palatal rugae would help for a better perspective and to use it in practice.

Keywords: Palatal Rugae, Rugoscopy, Dental Cast, Forensic Dentistry

1. Introduction

Human recognition is extremely important and is certainly difficult given that each person possesses unique traits. This mandates a fusion of distinct procedures to personalize an individual or an object.

1.1 1Personal Identification:

"Identity" entails a collection of physical attributes, functional or psychological, typical or pathological, that defines an individual [1] . In forensic practice, the primary techniques of identification employed are the DNA examination, retinal scans, fingerprints, and dental features. DNA analysis stands as the benchmark in forensic science, yet it incurs significant expenses and cannot be executed universally. In numerous cases, one or all of these approaches might not be entirely efficacious or definitive. Numerous criminal inquiries and instances of aviation accidents have utilized dental characteristics for identification. Presently, dental recognition embodies the most valuable among scientific techniques in mass calamities, with its effectiveness rate escalating to roughly 75%[2]. The question of ascertaining a population has

importance specifically in mass disasters when fatalities take place simultaneously involving person/persons of various races/nationalities/ethnicities and so on[3].

1.2 Palatal Rugoscopy:

Palatal rugae are structural creases situated on the foremost third of the palate following the incisive papillae. They are also recognized as "Plica palatine," and the analysis of these configurations for recognizing an individual's identity is termed palatoscopy or palatal rugoscopy [4]. The steadiness of palatal rugae, similar to fingerprints, renders it a pertinent source of human identification. Palatal rugae are distinct to every single person, and no two patterns are alike concerning traits, encompassing orientation, length, form, and location. Rugae can endure decomposition alterations for seven days subsequent to demise and seldom transform in structure as time advances. They reemerge following trauma or surgery and find safeguarding behind the lips, cheeks, tongue, buccal fat pad, and teeth in situations of fire or forceful injury. The layout and composition of palatal rugae remain unaltered by chemicals, heat, ailments, or injury, and if obliterated, they are precisely replicated at their original position. The configuration of palatal rugae might alter due to certain incidents, like finger sucking during childhood, orthodontic therapy, removal of neighboring teeth, and surgical mending of the palate. According to a recent organized assessment, the visual matching precision was >90% despite substantial modifications in the proportions of the palatal rugae before and after treatment, implying that form might have played a crucial role in the visual correspondence. Palatal rugae can be used as a reliable guide to the forensic identification.

2. Research Methodology

2.1 Nature and Source of Data:

This study compiles the Mixed-method Nature of Data which combines both Quantitative and Qualitative data to gain a comprehensive understanding of a research problem. The study is based on Primary Data collection directly by the researcher to the human individual. The collected samples were Maxillary Dental Casts from the Human individual.

2.2 Sample Design:

For This research Healthy human subjects were selected for the samples. This study comprises of total 60 samples which includes 30 males and 30 females in the age group 18 – 30 years of population belonging to Kerala and Karnataka. The materials used were: Alginate powder, perforated metal maxillary impression tray, Mixing bowl, Spatula, Dental Stone and Water. Later the patterns were drawn with the help of a Graphite pencil and the patterns were studied and classified according to their number, length, shape, direction and unification.

Inclusion criteria: The subjects were those without braces, removable and fixed partial dentures.

Exclusion criteria: The subjects were those with abnormalities in palate and lips and subjects wearing partial dentures and braces.

2.3 Sampling Technique: the sampling technique used is stratified sampling technique which divides the population into subgroups or strata based on certain characteristics such as age and Gender.

2.4 Data Collection Method: Dental cast method was used to get the maxillary impressions of the individuals. Dental casting, also known as dental impressions or dental molds, is a common technique used in dentistry to create a replica of a patient's teeth and oral tissues. These replicas are essential for various dental procedures, including the fabrication of crowns, bridges, dentures, orthodontic appliances, and mouthguards. For the rugae impressions we need maxillary dental cast to examine

2.5 Data Analysis : For the Analysis, first the rugae were drawn with the help of graphite pencil. Later the data was recorded according to the Thomas and Kotze classification of palatal rugae, on the basis of their number, direction, length, shape and their unification. For the measurement of the length of the rugae Vernier Caliper was used and rest of the characteristics were recorded by using magnifying lens. As the study is based on sex determination it mainly focused on the differences among the male and female and the specifications were analysed and recorded.

3. Result and Discussion:

TABLE 3.1 COMPARISON BETWEEN GENDER AND THE TOTAL NUMBER OF RUGAE IN THE LEFT AND RIGHT PALATE OF MALES AND FEMALES.

Gender		Number of Rugae						Total
		Left Palate			Right Palate			
		1 - 2	3 - 4	5 - 6	1 - 2	3 - 4	5 - 6	
Male	Count	07	11	0	06	12	0	36
	%	19.44%	31%	0%	17%	33%	0%	46.15%
Female	Count	07	13	01	05	16	0	42
	%	16.66%	30.95%	2.38%	11.90%	38.09%	0%	53.84%
Total	Count	14	24	01	11	28	0	78
	%	17.94%	30.76%	1.28%	14.10%	35.89%	0%	100%

Male:

1. Among the total 30 male samples the total number of rugae observed is 46.15% . In which he highest number of rugae found in left palate is 31% under the range of 3-4, 19.44% under the range of 1-2 and No rugae was observed under the range of 5-6.
2. The highest number of rugae found in right palate is 33% under the range of 3-4, 17% under the range of 1-2 and none was observed under 5-6.

Female:

1. Among the total 30 samples of female the total number of rugae observed is 53.84%. In which the highest number of rugae found in the left palate is 30.95% under the range of 3-4, 16.66% under the range of 1-2 and 2.38% under the range of 5-6.
2. The Highest number of rugae found in the right palate is 38.09% under the range of 3-4, 11.90% under the range of 1-2 and none was observed under 5-6.

TABLE 3.2 COMPARISON BETWEEN GENDER AND THE TOTAL NUMBER OF PRIMARY RUGAE IN THE LEFT AND RIGHT PALATE OF MALES AND FEMALES.

Gender		Primary Length of Rugae						Total
		Left Palate			Right Palate			
		1 - 2	3 - 4	5 - 6	1 - 2	3 - 4	5 – 6	
Male	Count	11	18	01	12	18	0	60
	%	18.33%	30%	1.66%	20%	30%	0%	54.05%
Female	Count	05	14	02	09	21	0	51
	%	9.80%	27.45%	3.92%	17.65%	41.18%	0%	45.95%
Total	Count	16	32	03	21	39	0	111

	%	14.41%	28.82%	2.70%	18.19%	35.13%	0%	100%

Male:

1. Among the total 30 male samples the total number of Primary rugae observed is 54.05% . In which he highest number of rugae found in left palate is 30% under the range of 3-4, 18.33% under the range of 1-2 and 1.66% under the range of 5-6.
2. The highest number of Primary rugae found in right palate is 30% under the range of 3-4, 20% under the range of 1-2 and none was observed under 5-6.

Female:

1. Among the total 30 samples of female the total number of Primary rugae observed is 45.95%. In which the highest number of Primary rugae found in the left palate is 27.45% under the range of 3-4, 9.80% under the range of 1-2 and 3.92% under the range of 5-6.
2. The Highest number of Primary rugae found in the right palate is 41.18% under the range of 3-4, 17.65% under the range of 1-2 and none was observed under 5-6.

TABLE 3.3 COMPARISON BETWEEN GENDER AND THE TOTAL NUMBER OF FORWARDLY DIRECTED RUGAE IN THE LEFT AND RIGHT PALATE OF MALES AND FEMALES.

Gender		**Forward Direction of Rugae**				**Total**
		Left Palate		**Right Palate**		
		1 - 2	**3 - 4**	**1 - 2**	**3 - 4**	
Male	**Count**	19	10	24	06	59
	%	32.20%	17%	41%	10%	53.63%
Female	**Count**	19	06	18	08	51
	%	37.25%	11.76%	35.29%	15.68%	46.36%
Total	**Count**	38	16	42	14	110
	%	34.54%	14.54%	38.18%	12.72%	100%

Male:

1. Among the total 30 male samples the total number of forwardly directed rugae observed is 53.63% . In which he highest number of forwardly directed rugae found in left palate is 32.20% under the range of 1-2, 17% under the range of 3-4 and No rugae was observed under the range of 5-6.
2. The highest number of forwardly directed rugae found in right palate is 41% under the range of 1-2, 10% under the range of 3-4 and none was observed under 5-6.

Female:

1. Among the total 30 samples of female the total number of forwardly directed rugae observed is 51%. In which the highest number of forwardly directed rugae found in the left palate is 78 37.25% under the range of 1-2, 11.76% under the range of 1-2 and none under the range of 5- 6.
2. The Highest number of rugae found in the right palate is 35.29% under the range of 1-2, 15.68% under the range of 3-4 and none was observed under 5-6.

TABLE 3.4 COMPARISON BETWEEN GENDER AND THE TOTAL NUMBER OF BACKWARDLY DIRECTED RUGAE IN THE LEFT AND RIGHT PALATE OF MALES AND FEMALES.

Gender		Backward Direction of Rugae				Total
		Left palate		Right Palate		
		1 - 2	3 - 4	1 - 2	3 - 4	
Male	Count	16	01	13	03	33
	%	48.48%	3%	39%	9%	50.76%
Female	Count	17	01	11	03	32
	%	53.13%	3.13%	34.38%	9.38%	49.23%
Total	Count	33	02	24	06	65
	%	50.76%	3.08%	36.92%	9.23%	100%

Male:

1. Among the total 30 male samples the total number of Backwardly directed rugae observed is 50.76% . In which he highest number of forwardly directed rugae found in left palate is 48.48% under the range of 1-2, 3% under the range of 3-4 and No rugae was observed under the range of 5-6.
2. The highest number of Backwardly directed rugae found in right palate is 39% under the range of 1-2, 9% under the range of 3-4 and none was observed under 5-6.

Female:

1. Among the total 30 samples of female the total number of forwardly directed rugae observed is 51%. In which the highest number of forwardly directed rugae found in the left palate is 37.25% under the range of 1-2, 11.76% under the range of 1-2 and none under the range of 5- 6.
2. The Highest number of rugae found in the right palate is 35.29% under the range of 1-2, 15.68% under the range of 3-4 and none was observed under 5-6.

TABLE 3.5: COMPARISON BETWEEN GENDER AND THE TOTAL NUMBER OF PERPENDICULARLY DIRECTED RUGAE IN THE LEFT AND RIGHT PALATE OF MALES AND FEMALES.

Gender		Perpendicular Direction of Rugae				Total
		Left Palate		Right Palate		
		1 - 2	3 - 4	1 - 2	3 - 4	
Male	Count	03	01	0	02	06
	%	50.00%	17%	0%	33%	75.00%
Female	Count	01	0	01	0	02
	%	50.00%	0.00%	50.00%	0.00%	25.00%
Total	Count	04	01	01	02	08
	%	50.00%	12.50%	12.50%	25.00%	100%

Male:

Among the total 30 male samples the total number of Perpendicularly directed rugae observed is 75% . In which he highest number of Perpendicularly directed rugae found in left palate is 50% under the range of 1-2, 17% under the range of 3-4 and No rugae was observed under the range of 5-6.

The highest number of Perpendicularly directed rugae found in right palate is 33% under the range of 3-4 and none was observed under both ranges 1-2 and 5-6.

Female:

Among the total 30 samples of female the total number of Perpendicularly directed rugae observed is 25%. In which the highest number of perpendicularly directed rugae found in the left palate is 50% under the range of 1-2 and none under the range of 3-4 and 5-6.

The Highest number of rugae found in the right palate is 50% under the range of 1-2 and none under the range of 3-4 and 5-6.

TABLE 3.6 COMPARISON BETWEEN GENDER AND THE TOTAL NUMBER OF STRAIGHT SHAPED RUGAE IN THE LEFT AND RIGHT PALATE OF MALES AND FEMALES.

Gender		Straight shape Rugae				Total
		Left Palate		Right Palate		
		1 - 2	3 - 4	1 - 2	3 - 4	
Male	Count	12	01	13	0	26
	%	46.16%	4%	50%	0%	55.31%
Female	Count	07	02	11	01	21
	%	33.33%	9.52%	52.38%	4.76%	44.68%
Total	Count	19	03	24	01	47
	%	40.42%	6.38%	51.06%	2.12%	100%

Male:

Among the total 30 male samples the total number of Straight shaped rugae observed is 55.31% . In which the highest number straight shaped rugae found in left palate is 46.16% under the range of 1-2, 4% under the range of 3-4 and No straight rugae was observed under the range of 5-6.

The highest number of Straight shaped rugae found in right palate is 50% under the range of 1-2 and none was observed under both ranges 3-4 and 5-6.

Female:

Among the total 30 samples of female the total number of Straight shaped rugae observed is 44.68%. In which the highest number of straight shaped rugae found in the left palate is 33.33% under the range of 1-2, 9.52% under the range of 3-4 and none under the range of 5 - 6.

The Highest number of rugae found in the right palate is 52.38% under the range of 1-2, 4.76% under the range of 3-4 and none under the range of 5-6.

TABLE 3.7: COMPARISON BETWEEN GENDER AND THE TOTAL NUMBER OF CURVED SHAPED RUGAE IN THE LEFT AND RIGHT PALATE OF MALES AND FEMALES.

Gender		Curved shape Rugae				Total
		Left Palate		Right Palate		
		1 - 2	3 - 4	1 - 2	3 - 4	
Male	Count	13	01	14	0	27
	%	48.15%	4%	52%	0%	40.90%
Female	Count	17	02	19	01	39

	%	43.58%	5.12%	48.71%	2.56%	59.09%
Total	**Count**	30	03	33	01	66
	%	45.45%	4.54%	50.00%	1.51%	100%

Male:

1. Among the total 30 male samples the total number of Curved shaped rugae observed is 40.90% . In which the highest number Curved shaped rugae found in left palate is 48.15% under the range of 1-2, 4% under the range of 3-4 and No Curved rugae was observed under the range of 5-6.
2. The highest number of Curved shaped rugae found in right palate is 52% under the range of 1-2 and none was observed under both ranges 3-4 and 5-6.

Female:

1. Among the total 30 samples of female the total number of Curved shaped rugae observed is 59.09%. In which the highest number of Curved shaped rugae found in the left palate is 43.58% under the range of 1-2, 5.12% under the range of 3-4 and none under the range of 5 - 6.
2. The Highest number of rugae found in the right palate is 48.71% under the range of 1-2, 2.56% under the range of 3-4 and none under the range of 5-6.

3.8: COMPARISON BETWEEN GENDER AND THE TOTAL NUMBER OF WAVY SHAPED RUGAE IN THE LEFT AND RIGHT PALATE OF MALES AND FEMALES.

Gender		**wavy shape Rugae**				**Total**
		Left Palate		**Right Palate**		
		1 - 2	**3 - 4**	**1 - 2**	**3 - 4**	
Male	**Count**	22	01	18	01	42
	%	52.38%	2%	43%	2%	50.00%
Female	**Count**	18	02	21	01	42
	%	43.00%	4.76%	50.00%	2.38%	50.00%
Total	**Count**	40	03	39	02	84
	%	47.61%	3.57%	46.42%	2.38%	100%

Male:

Among the total 30 male samples the total number of Wavy shaped rugae observed is 50% . In which the highest number Wavy shaped rugae found in left palate is 52.38% under the range of 1-2, 2% under the range of 3-4 and No wavy shaped rugae was observed under the range of 5-6.

The highest number of Wavy shaped rugae found in right palate is 43% under the range of 1- 2, 2% under the range of 3-4 none was observed under the range of 5-6.

Female:

Among the total 30 samples of female the total number of Wavy shaped rugae observed is 50%. In which the highest number of Wavy shaped rugae found in the left palate is 43% under the range of 1-2, 4.76% under the range of 3-4 and none under the range of 5 -6.

The Highest number of rugae found in the right palate is 50% under the range of 1-2, 2.38% under the range of 3-4 and none under the range of 5-6.

TABLE 4.9: COMPARISON BETWEEN GENDER AND THE TOTAL NUMBER OF CONVERGENT RUGAE IN THE LEFT AND RIGHT PALATE OF MALES AND FEMALES.

Gender		Convergent Rugae		Total
		Left Palate	Right Palate	
		1 - 2	1 - 2	
Male	Count	02	0	02
	%	100.00%	0%	28.57%
Female	Count	04	01	05
	%	80.00%	20.00%	71.42%
Total	Count	06	01	07
	%	85.71%	14.28%	100%

Male:

1. Among the total 30 male samples the total number of Convergent rugae observed is 28.57% . In which the highest number of convergent rugae found in left palate is 100% under the range of 1-2 and none was observed under both the range 3-4 and 5-6. No.
2. Convergent rugae was observed under the right palate of the males.

Female:

1. Among the total 30 samples of female the total number of Convergent rugae observed is 71.42%. In which the highest number of convergent rugae found in the left palate is 80% under the range of 1-2 and none under both the ranges 3-4 and 5-6.
2. The Highest number of rugae found in the right palate is 20% under the range of 1-2 and none under both the ranges 3-4 and 5-6.

3.10 COMPARISON BETWEEN GENDER AND THE TOTAL NUMBER OF DIVERGENT RUGAE IN THE LEFT AND RIGHT PALATE OFMALES AND FEMALES.

Gender		Divergent Rugae		Total
		Left Palate	Right Palate	
		1 - 2	1 - 2	
Male	Count	08	15	23
	%	34.78%	65%	53.48%
Female	Count	12	08	20
	%	60.00%	40.00%	46.50%
Total	Count	20	23	43
	%	46.50%	53.48%	100%

Male:

i. Among the total 30 male samples the total number of Divergent rugae observed is 53.48% . In which the highest number of Divergent rugae found in left palate is 34.78% under the range of 1-2 and none was observed under both the range 3-4 and 5-6.

ii. The highest number of Divergent rugae found in the right Palate is 65% under the range of 1- 2 and none under the range of 3-4 and 5-6.

Female:

1. Among the total 30 samples of female the total number of Divergent rugae observed is 46.50%. In

2. which the highest number of Divergent rugae found in the left palate is 60% under the range of 1-2 and none under both the ranges 3-4 and 5-6. 83
3. The Highest number of rugae found in the right palate is 40% under the range of 1-2 and none under both the ranges 3-4 and 5-6.

4. Conclusion

When the Rugae in both left and right palate was compared with Gender, the total number of rugae was found to be higher in female than that of male. The Rugae were found more in the left palate when compared to the right palate. Only Primary rugae was observed, while secondary and fragmented were absent. Forwardly Directed rugae were more in male than female, only a slight difference was observed among the Backwardly directed rugae and the perpendicularly directed rugae was very high in male than females. Straight shaped rugae was observed more in male while the curves shape rugae was higher in females. The wavy shaped rugae was found to be equal among both males and females while the circular rugae was absent among both. Within the Unification of Rugae the Convergent Rugae was found very high in females than males and Divergent Rugae was found more in male than Females.

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