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The Relationship between Palatoscopy and Face Shape among the Ibolo Ethnic Group in Nigeria

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ABSTRACT

Palatoscopy is the study of palatal rugae patterns in order to utilize its uniqueness to establish the identities of individuals. Face shape refers to the geometric form of an individual's face. The aim of this study is to determine the relationship between palatal rugae patterns and face shapes among the Ibolo ethnic group in Osun and Kwara states, Nigeria, in individuals aged 18-65. The study was conducted on 500 subjects (250 male, 250 female) of the Ibolo ethnic group in Osun and Kwara, Nigeria. The palatal rugae of each individual was captured intraorally using a Sony digital camera and a picture was taken of the subject's face, also. The Statistical Package for Social Sciences (IBM. version 23, Armonk, New York, USA) was used to determine group differences. Using Chi-square Automatic Interaction Detector (CHAID), a model of the relationship between the predominant rugae types and face shape were described. Differences were declared significant and correlation exist when $P \leq 0.05$. The results showed that rugae types E and D were predominant in males and females respectively and the oval face shape was the most common in both sexes. The test of association between the left anterior segment and sex was significant. The analysis showed no relationship between palatal rugae patterns and face shapes. This study shows that the face shape of an individual from the Ibolo ethnic group cannot be determined using his or her palatal rugae pattern.

Key Words: Palatoscopy, Face shape, Rugae pattern, Sex, Ibolo ethnic group

INTRODUCTION

Dactiloscopy and palatoscopy are united as similar methods based on the same scientific principles and sometimes are complementary, for instance, palatoscopy can be of special interest in those cases where are no fingers to be studied (burned bodies or bodies in severe decomposition) 1 . Palatal rugae are protected from trauma and high temperature by lips, cheek, tongue and buccal pad of fat due to their internal position, and do not change with age. They are equal to fingerprints in level of uniqueness to an individual and patterns are specific to racial groups, facilitating population identification². Inter-individual variations in face shapes are one of the most important phenotypes in humans, and uniquely identify each individual. The bony structure of the face (skull), complex soft tissue variations and skin color all influence the shape of the face and it's perception by others ³. The face provides our identities as humans. The face plays an important role in communication as it is the interface for interaction because it houses the eyes, ears and mouth 4.

Palatoscopy, otherwise known as palatal rugoscopy, is the study of the palatal rugae and it's uniqueness in every human being. It is a forensic odontology tool in identifying human beings. The palatal rugae are anatomical folds on the anterior third of the palate behind the incisive papillae ⁵.

Kuppler in 1897 was the first person to study palatal anatomy to identify racial anatomic features. Palatal rugoscopy was first proposed in 1932, by a Spanish investigator called Trobo Hermosa. In 1937, Carrea developed a detailed study and established a way to classify palatal rugae. One year later, Da Silva proposed another classification. In 1946, Martin dos Santos presented a practical classification based on rugae location. In 1983, Brinon, following the studies of Carrea, divided palatal rugae into two groups in a similar way to that done with fingerprints ¹.

Palatal rugae first appear toward the third month of intrauterine development, from the covering connective tissue in the palatine the maxillary process of bone. It's development and growth are mutually controlled by epithelial - mesenchymal interactions. The first rugae is visible next to the incisive papilla. They are very prominent in the prenatal stage and are well organized at birth with a typical orientation pattern and acquire their final feature shape in adolescence ⁶.

The face is the anterior aspect of the skull, from the forehead to the chin and from ear to ear. The face shape is determined by the underlying bones, tissues and muscles ⁴.

In 2018, Rahmat classified face shapes into 6 categories: oval, round, square, oblong, triangle, and diamond ⁷. The golden ratio technique uses famous Egyptian ratio 1:1.6, it states that the facial index of a normal face should be 1.6 - 1.69. Golden Ratio (1.6-1.699 = Normal, < 1.6 = Short, > 1.699= Long). The precise value of the golden ratio is the irrational number phi ($\Phi = a/b =$ (a+b)/a = 1.61803399...) named by the sculptor of the Parthenon Phidias. The golden ratio is also referred to as the Fibonacci ratio or the 'divine proportion⁸. Prosprioc index divides face length by face width. and has 5 categories Hypereuriprosopic "very short broad face type", Europrosopic "short broad face type", Mesoprosopic "medium or intermediate face type", Leptoprosopic "Long narrow face type", Hyper Leptoprosopic "Very long narrow face type"⁹.

Recognisable features of the face develop around the 4th week and are closely related to the neural crest cells. 5 facial processes are formed initially -frontonasal, medial nasal, lateral nasal, maxillary and mandibular. They fuse at different times, notably in the 6th, 8th and 12th weeks. Fusion of the facial processes depends on events involving cell growth, migration, adhesion, differentiation and apoptosis ¹⁰.

There are no previous works done on this particular study. The aim of this study is to know the relationship between the palatal rugae patterns and face shape among adults of the Ibolo ethnic group in Kwara State and Osun State.

MATERIALS AND METHODS

The study was conducted in two different states, Osun and Kwara states. Osun state is located in south western, Nigeria. According to 2006 national population census, Osun state population had been projected to be 4, 009, 837 by 2011. Kwara state is located in north central, Nigeria. According to 2006 national population census, Kwara state population had been projected to be 2,649,784 by 2011.

Sample Size: Calculating the Sample Size, using FISCHER'S FORMULA for large populations (>10,000)

 D^2 Where S=Sample size Z=1.96(constant) D=Tolerance level=0.05 O=1-P CONSIDERED POPULATION=562,670 P=AGE GROUP X CONSIDERED POPULATION =54.4X562,670=306,092.48 100 100 P=306,092.48=0.62 562.670 P=0.544 Therefore; Q=1-P=1-0.544 =0.46Substituting values into the Fischer's formula; Sample Size = (1.96)²X0.544X0.46 $(0.05)^2$ =3.8416X0.544X0.46 0.0025 =0.961321984=384.52879 0.0025 Attrition Rate = 384.52879 + 10% of 384.52879 = 384.52879 + 38.453= 422.98 ≈ 423. Approximately 500 Sample size is 500.

Inclusion Criteria: The following participants were included in the study;

- 1. Participants who volunteered to take part in the study with prior informed consent.
- 2. Participants who are of the Ibolo ethnic group by both parents traced to the second generation.
- 3. Participants who were free from any diagnosed congenital abnormalities.

Ethical Approval: Ethical clearance was sort and obtained from the Department of Anatomy Ethical Review Committee of the University of Ilorin, Ilorin. The ethical approval number was 17/46KA068/07/2020.

Sampling Technique: Informed consent was obtained from volunteers who met the inclusion criteria, after which a structured questionnaire was given to them. Literate subjects were asked to fill the required information while subjects who could not write were assisted. The following procedures were then followed to obtain their palatal rugae patterns and face shapes:

Palatoscopy: Subjects were made to sit in a relaxed position and tilt the head upwards with their mouth wide open and an intraoral photograph of the hard palate of the mouth was taken using digital camera (SONY) Focal length: 26-130mm to standardize all the photographs.

Face Shape: Pictures of the subjects' straight faces were taken using digital camera (SONY) Focal length: 26-130mm to standardize all the photographs,12 inches from the face.



Figure 1: A: Picture of a Subject's Palate being taken



Figure 2: A Picture of a Subject's Face being taken.

Data Analysis: Analysis commenced by dividing the palates into compartments as follows, Right Anterior Quadrant (RAQ), Left Anterior Quadrant (LAQ), Right Posterior Quadrant (RPQ), and Left Posterior Quadrant (LPQ).

The rugae patterns were then classified according to Trobo's classification ¹¹, which divided them into:

a. Type A- Point

- b. Type B- Line
- c. Type C- Curve
- d. Type D- Angle
- e. Type E- Sinuous
- f. Type F- Circle
- g. Type X Compound

Subsequently, the craniometric points for identification of the face shape are marked and analyzed, using Rahmat's classification⁷ which divided them into:

- 1. Round
- 2. Oval
- 3. Triangle
- 4. Square
- 5. Oblong
- 6. Diamond

Statistical Analysis: Descriptive statistics were used to categorize demographic frequency and distribution patterns. Palatal rugae patterns and face shapes were expressed as frequency and proportion for each quadrant or shape. Correlations between male and female palatal rugae patterns and their face shapes was done using Chi-square test. The confidence level was set as 95% while statistical significance was set at <0.05. Pearson correlation and Chi-square statistical methods were used.

RESULTS

In Table 1, the right anterior segment shows a predominance of Type E patterns in the male volunteers (30.4%), and a predominance of Type D patterns in the female volunteers (27.6%). The test of association between right-anterior segment and sex was significant ($X^2 = 32.44$, P = <0.001).

The right posterior segment shows a predominance of Type E patterns in male volunteers (52.4%), and a predominance of Type E patterns in female volunteers (51.6%). There in an absence of Type F patterns in the male volunteers while there is a 0.4% exhibition in female volunteers. The test of association between the right posterior segment and sex was significant ($X^2 = 15.952$, P = 0.014).

In Table 2, the left anterior segment shows a predominance of the Type E patterns in the male volunteers (34.0%), and a predominance of the Type D in the female volunteers (32.0%). The test of association between the left anterior segment and sex was significant ($X^2 = 74.413$, P = <0.001).

The left posterior segment shows a predominance of Type E in both male and female volunteers with 62.0% and 53.6% respectively. There is no occurrence of the Type C patterns in the male volunteers but there is a 0.4% occurrence in the female volunteers. The test of association between the left posterior segment and sex was significant ($X^2 = 13.506$, P = 0.019).

Table 3 shows both the male and female volunteers have predominance of the oval face shape with 43.2% and 44.4% respectively. The test of association between the face shapes and sex showed no significance ($X^2 = 28.602$, P = <0.005).

Table 1:Distribution of rugae patterns at the right side of the palate and test of sex-
associated differences

	Rugae Pa	attern (righ								
Sex	Type A	Type B	Type C	Type D	Type E	Type F	Type X	Df	Chi-square	P-value
Male	5	62	3	53	76	16	35	6	32.44	< 0.001
	2.0%	24.8%	1.2%	21.2%	30.4%	6.4%	14.0%			
Female	3	79	6	69	26	23	44			
	1.2%	31.6%	2.4%	27.6%	10.4%	9.2%	17.6%			
Total	8	141	9	122	102	39	79			
	1.6%	28.2%	1.8%	24.4%	20.4%	7.8%	15.8%			

	Rugae Pa	attern (righ								
Sex	Type A	Type B	Type C	Type D	Type E	Type F	Type X	Df	Chi-square	P-value
Male	2	90	2	9	131	0	16	6	15.952	0.014
	0.8%	36.0%	0.8%	3.6%	52.4%	0.0%	6.4%			
Female	2	65	5	9	129	1	39			
	0.8%	26.0%	2.0%	3.6%	51.6%	0.4%	15.6%			
Total	4	155	7	18	260	1	55			
	0.8%	31.0%	1.4%	3.6%	52.0%	0.2%	11.0%			

 X^2 =Chi square, df=degree of freedom

	Rugae P	attern								
Sex	Туре	Туре	Туре	Туре	Туре	Туре	Туре	D	Chi-	Р-
	А	В	С	D	Е	F	Х	f	square	value
Male	7	58	4	33	85	17	46	6	74.413	< 0.001
	2.8%	23.2%	1.6%	13.2%	34.0%	6.8%	18.4%			
Femal	2	45	4	80	19	30	70			
e										
	0.8%	18.0%	1.6%	32.0%	7.6%	12.0%	28.0%			
Total	9	103	8	113	104	47	116			
	1.8%	20.6%	1.6%	22.6%	20.8%	9.4%	23.2%			

Table 2:Distribution of rugae patterns at the left side of palate and test of sex-
associated differences

	Rugae Pa	attern	Pearso	h's Chi-square Analysis Chi-square P-value					
Sex	Type A	Type B	Type C	Type D	Type E	Type X	df	Chi-square	P-value
Male	4	73	0	9	155	9	5	13.506	0.019
	1.6%	29.2%	0.0%	3.6%	62.0%	3.6%			
Female	3	76	1	7	134	29			
	1.2%	30.4%	0.4%	2.8%	53.6%	11.6%			
Total	7	149	1	16	289	38			
	1.4%	29.8%	0.2%	3.2%	57.8%	7.6%			

 X^2 =Chi square, df=degree of freedom

Table 3: Distribution of face shapes and test of sex-associated difference

	Face Shap	e							
Sex	Diamond	Oblong	Oval	Round	Square	Triangular	Df	Chi-square	P-value
Male	59	45	108	6	10	22	5	28.602	< 0.001
	23.6%	18.0%	43.2%	2.4%	4.0%	8.8%			
Female	86	14	111	13	15	11			
	34.4%	5.6%	44.4%	5.2%	6.0%	4.4%			
Total	145	59	219	19	25	33			
	29.0%	11.8%	43.8%	3.8%	5.0%	6.6%			

 X^2 =Chi square, df=degree of freedom



Figure 3: Decision tree for explaining the relationship between the right rugae pattern and face shapes

In fig. 3, no additional node was created except the initial grouping and thus, it can be concluded that the distribution of rugae pattern at the right anterior (R-ant) and right posterior (R-post) sides do not explain face shapes.



Figure 4: Decision tree for explaining the relationship between the left anterior (L-Ant) rugae pattern and face shapes

In fig. 4, test of association shows that at the left anterior (L-Ant) palate, the palatal rugae patterns had significant association with face shapes ($X^2 = 35.879$, P = 0.027); such that Type X and B appear to be more associated with diamond face shape (36.1%), while Type D, A, and C on node 2 were associated with distribution of the oval face shape (53.8%)., and Type E and F on node 3 were associated with oval shape (44.4%).

No additional node was created except the initial grouping and thus, it can be concluded that the distribution of rugae pattern at the and left posterior (L-post) side do not explain face shapes.

In this present study, a predominance of the Type E patterns in the male volunteers was found, and a predominance of the Type D in the female volunteers.

DISCUSSION

Palatal Rugae Pattern in Relation to other Ethnic Groups: In this present study, a predominance of the Type E patterns in the male volunteers was found, and a predominance of the Type D in the female volunteers.

A study carried out in the College of Health Sciences, Delta State University, Abraka, Nigeria, showed a predominance of the Type A, C, and D patterns in the male volunteers, and a predominance of the Types B, E, and F in the female volunteers ¹².

A study carried out among the Ikwerre and Igbo people shows a dominance of Type D rugae in both ethnic groups and both sexes ¹³.

In a study conducted in Ibadan, Nigeria, the sample studied comprised 100 dental stone models representing 50 Yoruba (group A) and 50 Igbo (group B) participants. There were 25 males and 25 females in each group. Group A had more of wavy and straight patterns while there were more of curve and circular in group B 14 .

A study of the frequencies of major rugae forms, including unifications, in Australian Aborigines and Caucasians. Straight forms were more common in Caucasians than Aborigines (15.2 per cent compared with 3.6 per cent), while wavy forms were more common in Aborigines (55.8 per cent compared with 40.6 percent)¹⁵.

Palatal Rugae Pattern in Relation to Sex: identification deals Human with the recognition of the physical characteristics that are unique to an individual. In case of violent crimes, child or elder abuse, missing and mass disasters, forensic persons anthropologists are usually asked to assist in providing information that can determine the identity (ies) of the individual(s). Sex determination is usually the first step involved in an identification process in forensics ¹⁶.

In this present study, the test of association between the left anterior segment and sex was significant.

A study carried out in the College of Health Sciences, Delta State University, Abraka, Delta State, Nigeria, comparing the relative occurrence of palatal rugae between sexes in this study, it was observed that males had higher mean values of palatal rugae types A, C and D, while females had higher mean values of types B, E, F and X¹².

In a study conducted in Ibadan, Nigeria, the sample studied comprised 100 dental stone models representing 50 Yoruba (group A) and 50 Igbo (group B) participants. There were 25 males and 25 females in each group. Females had more of wavy, circular and curve shapes while males had more of straight shape ¹⁴.

Palatal rugae pattern study in the Saudi population showed that the sinuous and

curve patterns had the highest frequency in both genders; the sinuous pattern had a higher incidence in males, 31.5%, while the curve pattern showed higher incidence in females, 34% ¹⁷.

However, in a study conducted on males and females of an average age of 35 in Sarajevo, Bosnia and Herzogovina, there was no significance difference between males and females in any type of the rugae pattern ¹⁸.

Face Shapes in Relation to other Ethnicities: The current study showed a predominant oval face shape in both male and female.

In a study conducted on craniofacial forms among the three most dominant ethnic groups in Gombe state, Nigeria, On the bases of face shapes, Fulani males and females are hyperleptoprosopic (long narrow face) ; Tangale males and females are both leptoprosopic (long narrow face) ; Tera males are leptoprosopic while their females are hyperleptoprosopic (long narrow face) ¹⁹.

A study conducted among the Idoma people of Benue state, Nigeria, also revealed that the predominant face type of Idoma people is hyperleptoprosopic (long narrow face)²⁰.

An evaluation of head and face shapes in the North Eastern population of Nigeria indicates the hyperleptoprosopic type (long narrow face) as the dominant face shape among people in that region ²¹.

Face Shapes in Relation to Sex: In this present study, there was no significant relationship between face shapes and sex.

In a study conducted on craniofacial forms among the three most dominant ethnic groups in Gombe state, Nigeria, Fulani, Tangale males and females are of same face shape. However, Tera males are leptoprosopic while their females are hyperleptoprosopic¹⁹.

An evaluation of head and face shapes in the North Eastern population of Nigeria indicates the same face shape for both males and females ²¹.

Ashok & Ganapathy conducted a test in 2019 to ascertain a geometric method to determine face forms and gender in 200 subjects using the face form indicator and photographic method. It was seen that a majority of subjects (males and females) had ovoid face forms ²² similar to the findings of this research.

Palatal Rugae Pattern in Relation to Face Shapes: In this present study, there was no significant relationship between palatal rugae patterns and face shapes.However, there is paucity of data relating palatal rugae patterns to face shapes.

CONCLUSION

It has been further established from this study that different tribes have different types of palatal rugae patterns as a result of variation in genetic composition. The results of this study also reiterated that rugae patterns are sexually dimorphic. It also showed that there is no relationship between face shape and sex. Furthermore, this study also established that palatal rugae patterns have no significant relationship with the face shape among the study population.

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COMPETING INTERESTS

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