Biometric Analysis of Palatal Rugae in Northern Region of Saudi Arabia

[1]Dr. FarahnazMuddebihal, [2]Dr. MuhammedSartaj Khan, [3]Dr. Mohammed Anwar ulhaque Chand, [4]Dr. Salman Alsharari,
[5]Dr. Abdullah Almajhad, [6]Dr. MetabAlbalawe
[1](Department of Preventive Dentistry, College of Dentistry, Al Jouf University, Sakaka – KSA)
[2] (Department of Prosthetic Dental Sciences, College of Dentistry, Al Jouf University, Sakaka KSA)
[3] (Dental Surgeon, Gulbarga, Karnataka- INDIA)
[4] (Dental Student, College of Dentistry, Al Jouf University, Sakaka – KSA)
[5] (Dental Student, College of Dentistry, Al Jouf University, Sakaka – KSA)
[6] (Dental Student, College of Dentistry, Al Jouf University, Sakaka – KSA)

Abstract:- The main purpose of forensic science is to establish a persons identity which is a complicated process. The examination of teeth, fingerprints & DNA comparison are the most used methods which gives quick& reliable recognition processes. But however these techniques cannot always be appealed for few cases. Thus, in this study biometric analysis of palatal rugae (PR) was performed. We analyzed sample of 120 adult subjects residing in northern kingdom of saudiarabia. Dentulous maxillary plaster casts were selected from age ranging 25 to 70 years & calcorrugoscopy was performed to establish the number, length, shape & position of palatal rugae. The average number of PR wereexcess on right half as compared to left half of maxillary cast. Majority of the rugae were more than 5mm in length. The most prevalent PR shape was straight (frequency : 85% on right side, 88% on left side) followed by wavy (frequency : 90% on right side, 84& on left side) and then curved (frequency : 99% on right side, 72% on left side). With 33% of frequency the PR were noted in zone E quadrant pursued by 21% in zone D quadrant. Thus, based on biometric analysis, and their features PR can be utilized as a reliable marker for detection of human which is an immerging development in forensic dental sciences.

Keywords:- Rugae, Calcorrugoscopy, human identification, forensic dentistry.

I.   INTRODUCTION

Forensic dentistry has been in use since very long. For this purpose teeth have been used as a tool for identification of dead bodies, however, this can be difficult in case of edentulous patients. Transverse palatine folds or Palatal rugae(PR), having a unique pattern for individual persons can be helpful in postmortem identification. These rugae are prominent, stable and well protected by surrounding structures in case of accident, burns, incinerations, mutilated bodies or trauma.(1) Apart from these palatal rugae's can be specific to some racial groups or gender. (2,3) Morphologically these rugae are present on palatal aspect of maxillary arch having different shapes and spreading pattern. Besides performing an essential role for maxillary dentures as secondary stress bearing areas, these rugae's also have an equal and important role for supplementing food and taste receptors and swallowing. Numerous studies have agreed that there is also relevance of palatal rugae to the sex determination, describing the numbers of rugae to be more in females than males and vice versa. (4)

Although studies on the different aspects of PR are more and comprehensive but there is little data available locally. The present study will focus on the different biometric patterns including the number, length, shapes and position of PR in local population of northern Kingdom of Saudi Arabia.

II.   MATERIALS & METHOD

The current college work was conducted in outpatient division of College of Dentistry, Al Jouf University KSA from December 2017 to March 2018, after seeking approval from the college ethical committee. A random sample of 120 maxillary plaster casts was selected from different patients seeking treatment for various prosthodontics problems including fixed and removable partial dentures. All those patients were included who had an intact maxillary arch and palate with an age ranging from 25 to 70 years. Patients seeking orthodontic treatment and those with maxillary deformities were excluded from the study. Impression of maxillary arch was obtained using alginate impression material and simultaneously plaster casts were prepared. The casts were numbered accordingly on which calcorrugoscopy was performed. Consequently, the data obtained was recorded a rugoscopy including: shape, number, size and position of the palatal rugae and applying the SPSS statistical descriptors were acknowledged for each of the constraints.

Number examination: All the PR that were totally bounded within calcorrugoscopy were documented.

Length examination: By means of a digital caliper extent of PR was recorded according in the direction of the cataloging given viaLysell (5) which include as,

- Primary PR (more than 5mm)

- Secondary PR (3-5mm)
- Fragmentary PR (2 or less than 3mm)

Shape examination: The shape of the PR was listed according to the customizedcategorization of Thomas and Kotze (1983) (6) and Hauser et al (1989) (7). Then a palatoscopy was performed, from the right half and then the left half, starting with the main rugae (neares to the palatal raphe), which was categorized with a principal letter from A to J as shown beneath in the classification.

Individual rugae characteristics used in the study	Denoted as
Straight	A
Curved	B
Wavy	C
Annular ring	D
Papillary	E
Cross Linked	F
Branch	G
Breaks	H
Converging	I

Diverging	J

Position of Rugae (8): To study the position of the PR, palate was divided by handinto quadrant, with the plan of obtaining the coordinate position of palatal rugae; for the, six horizontal lines mentioned below:

I. Slanting line passing through the palatal cervical 3rd of the central incisors.
II. Slanting line that goes from the mesial half of the right lateral incisor to the mesial half of the left lateral incisor.
III. Slanting line through the mesial half of the right canine and reaches to the mesial half of the left canine.
IV. Slanting line through the mesial half of the right first premolar and reaching to the mesial half of the left first premolar.
V. Slanting line through the mesial half of the right second premolar and reaching to the mesial half of the left second premolar.
VI. Slanting line through the distal half of the second premolar and reaching to the right half of the distal left second premolar.

Depending upon these lines following category was mentioned:

A. Connecting lines I and II.
B. Connecting lines II and III.
C. Connecting lines III and IV.
D. Connecting lines IV and V.
E. Connecting lines V and VI.

III. OUTCOMES

Number: Total number of PR be 1431, with left side being more with a number of 731 rugae as compared to right side with a number of 700 rugae. (Table I)

Length: The resulting larger palatal rugae were more than 5mm in length, with a mean of 6.158(SD 1.045), minutiae of the extent in the different types of palatal rugae are found in Table II.

Shape: A good numberestablishedfor the shape of PR was straight with a frequency of 85% on right side & 88 % on left side, followed by the wavy with a frequency of 90% on right side & 84 % on left side then curved with a frequency of 99% on right side & 72% on left side. There were no cross linked shaped rugae on left side of palate. The particulars of division of shape for other rugae are enlisted into Table III & Graph 1.

Position: Thirty three percentageof PR were instituted in the E quadrant, pursued by the D quadrant into

which we noted 21% of rugae. The residual percentage wascirculated in the other regions where the palate had been divided. The specified position of the PR analyzed manually is in Table IV.

Total Number of Sample	Numeral of PR on right half	Numeral of PR on left half	Total number of rugae
120	700	731	1431

Table 1. Number of Palatal Rugae:

Type of rugae by Lysell	n	Mean	SD	Maximum	Minimum	Frequency
Primary (more than 5mm)	120	6.158	1.045	8	2	56
Secondary (3-5mm)	120	2.041	1.056	5	1	48
Fragmentary (2 or less than 3mm)	120	0.158	0.366	1	0	15.8

Table 2. Length: Classification by Lysell

Characteristics	N	Right side					Left side				
		Mean	SD	Max	Min	Frequency	Mean	SD	Max	Min	Frequency
Straight	120	1.033	0.564	3	0	85	1.13	0.549	3	0	88
Curved	120	0.875	0.400	2	0	99	0.633	0.517	2	0	72
Wavy	120	1.075	0.521	3	0	90	0.916	0.54	2	0	84
Annular Ring	120	0.05	0.21	1	0	6	0.033	0.18	1	0	4
Papillary	120	0.275	0.466	2	0	31	0.225	0.419	1	0	27
Cross Linked	120	0.016	0.128	1	0	2	0	0	0	0	0
Branch	120	0.058	0.235	1	0	7	0.05	0.218	1	0	6
Breaks	120	0.033	0.180	1	0	4	0.041	0.200	1	0	5
Converging	120	0.025	0.156	1	0	3	0.041	0.200	1	0	5
Diverging	120	0.266	0.444	1	0	32	0.291	0.508	2	0	29

Table 3:- Shape of Rugae

Position of Rugae	N	Mean	SD	Max	Min	Frequency
Zone A	120	0.141	0.350	1	0	17
Zone B	120	0.208	0.465	2	0	19
Zone C	120	0.091	0.289	1	0	11
Zone D	120	0.358	0.645	2	0	21
Zone E	120	0.433	0.657	3	0	33

Table 4:- Position of Rugae
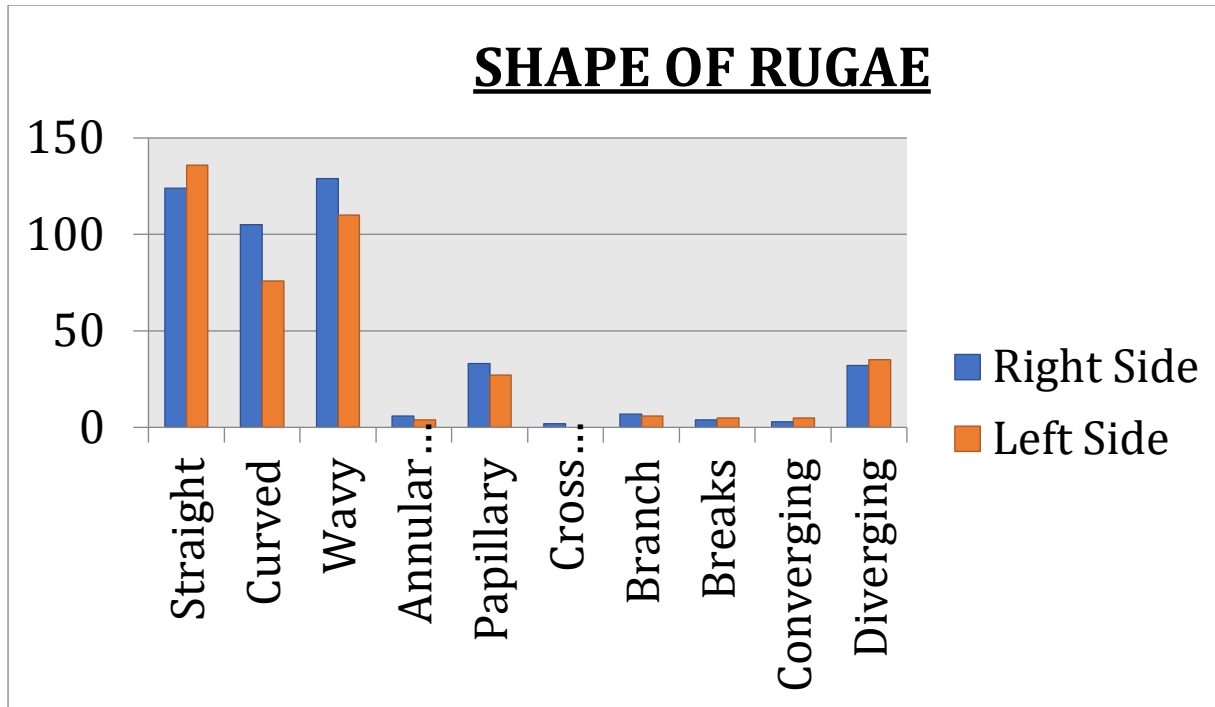
Graph 1: Shows distribution of shape of palatal rugae

IV. DISCUSSION

Development of palatal rugae is through localized epithelial proliferation and thickening. Beneath the thickened epithelium fibroblast along with collagen fibres in the connective tissue get accumulated, plus assume distinct orientation. Fibres run anteroposteriorly surrounded by the core and in concentric curves diagonallyto the base of each rugae which determines the orientation. (9)

Unlike fingerprints PRcannot change throughout the life of the human being as they are being surrounded and sheltered by lips, cheeks, tongue, teeth and bone, also prosthetic devices which prevents them from disturbance and soaringtemperature for its innerlocation in the oral cavity,. They merelyvary in length, owing to standard growth, staying in similar position right through the death of a person. (8)

Because of this it is able to be effectively handed in forensic sciences for person identification. The nearly all common method used for detection are visual, fingerprints and dental characteristics. Visual system is the best means to recognize a person however in case of mass disaster it becomes difficult. Although fingerprints are considered to be a standard method but in the vein of fire, decomposition, massive trauma, they are often unavailable which poses difficulty in persons identification.Familiar, dental records might also pose troubles like missing teeth in urn of disaster, which leads near difficulty in identification (2). Thus an ideal ,

persons identification can only be obtained by structures which are there in all fatalities and resist toward any transformation. Thus single method is platal rugae designed for human identification. Thomas and Van wyk victoriously analyzed a harshly burnt edentulous remains by comparing the rugae to folks of victims older denture and thus indicated that rugae remain constant in the mature life even after any disaster. (10)

Different ways are used to examine to PR, like intraoral check up which is likely the mainly used and cheap process. If an upcomingproportional study is essential this could pose difficulty in comparing the data. Utsuno et al (2005), suggested that use of photographs or impressions could be used a analyzing tool which would give a more detail and accurate, evidence for identification.(11) To observe shape of the rugae, which is an one-sided process but it is somewhat easy to record and do not call forintricate instrumentation.Thus the present cram was carried out to identify the biometric characteristics of palatal rugae in subjects residing in northern kingdom of Saudi Arabia.

Within this study, the overall number of palatal rugae were 1431 and were more on right side of maxillary cast as compared to left side in a sample of 120 casts which coincides with that observed by Sadatullah Syed et al (2016) in a sample of 256 casts residing in southwestern kingdom of Saudi Arabia (12) . Many comparative studies were done, where numbers of rugae were more in males as in contrast to females and vice versa. While Muhasilovic et al (2006) analyzed citizens

residing in Sarajevo Canton, and recommended that number of rugae to be more in left side as weigh against to right side in males which was in contrast to our findings.(13)

Majority of rugae in our study were measuring more than 5mm in length which was coinciding through study done by Muhasilovic et al (2006) and Gondivikar et al (2011) in Sarajevo Canton & western Indian populations with former more in males than compared to females and later vice versa suggesting the racial difference (13,14). The rugae dimensions may perhaps diverge with growth, extraction of teeth or teeth movement and may be construed as continuous variables while rugae shape relics stable and are distinct variables (15).

We noted that on average straight rugae were more followed by wavy and then curved which were into contrast to findings observed withNayak et al (2007) &Hermosilla et al (2009) (8,15). Also Abeer et al (2011) identified wavy form of rugae to be more in Saudi children as compared to the Egyptian children. (16). This suggest that inspection of rugae pattern or shape is a prejudiced process and it may not portray some of more intricate rugaepattern although conceivably complex patterns bring on observer errors.(15)Thus in our study intraobserver variability was not carried out which could be one of the limitation for the shape of rugae pattern.

To know the position of rugae many authors have followed different directions like forward or backward. In our study we manually analyzed the position of rugae based on six horizontal lines by dividing the quadrant. This suggested that 33% of rugaewere in Zone E quadrant go behind by 21% in Zone D quadrant which coincide with study done by Hermosilla et al (2009) using Photoshop software. (8)

Thus the results from the study suggest the efficacy and effortless way towards the reproducibility of palatal rugae for person identification in dentate folks residing in northern kingdom of Saudi atabia. But it is stillvital to make aappropriate selection of cases, captivating the diversity of forms that may arise, deliberately where the population-specific, can be an increase in the rate of accuracy of detection with this method, loom 100% of cases. (17).

Some authors propose the occurrence of sexual dimorphism in the biometric features of the palatal rugae, which wedisagree with our end result. With the partialjournalism of the subject matter, it is clear that there is lack of standardization in taxonomy which poses difficulty in comparing the results. Greater parts of technique are developed independently and no validated inorder is reported. Due to the magnitude of relating the rugoscopy characteristics in dental-forensic expertise, wesuggest budding a standard method for valuation of palatal rugae.

Thus palatoscopy is a procedure that can be of immenseconcern in human identification. In fact, opposing to the visual, fingerprints and lip prints, it is possible to acquire ante-mortem data that are steadymore thana period of time, in dental practice which are in a choice of forms like dental casts, intraoral photographs and dental prostheses.For investigation of crime scenes and involving suspects to faultscene cannot be done by palatoscopy as such findings are not found in such circumstances. In toothless cases, it is also possible to consider falsification of the rugae pattern. Gitto et al. (1999) describe a method that PR are addedto the maxillary complete dentures to get better patterns of verbal expression and phonetics in various patients. This practice can lead to the bogus identity of omission due to ante-mortem data misleading. (18)

Normal growth of palate can be altered by continuation of atypical patterns and shapes on palatal rugae. Ikemi et al (2001) recommended that these anomalous patterns can be used as an supplementary feature or mark in the analysis of cleft palate in humanand Park et al (1994) used this as a benchmarkin pre-and postsurgical cleft palate surgery (19,20).

V. CONCLUSION

Like forsenic sciences, forensic dentistry is also a emerging field where palatoscopycan be capable for using as a tool for human identification. It is matchless and stable for individuals. In the present study it was found that numbers of rugae were more on right half of palate, with majority belonging to 5mm in length. We even noticed that straight rugae were more followed by wavy & curved for subjects residing in northern kingdom of Saudi Arabia. Furthermore we conclude that, since no study is carried out in northern kingdom of Saudi Arabia and to facilitate the sample size should be larger and additional number of Arabian population of both sexes should be measured to conclude the accurateness of palatal rugae in residents identification. This is a first round study where possibility still exist for further study to establish gender and population identification. As a final point we deem that in forsenic dentistry palatal rugae can be used as a trustworthymarker or tool in favor of human identification.

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