

“Study of Palatal Rugae Pattern for Establishing Individuality”

Dr. Mohamadzowharsajid¹, Dr. Prachi Singh², Dr. Shailesh Kumar³, Dr. Kamini Kiran⁴, Dr. Shakti Agrawal⁵, Dr. Rameshwar Singh⁶, Dr. Nitesh Kumar⁷, Dr. Gourab Das⁸, Dr. Sumit Verma⁹, Dr. Abhisekh Singh¹⁰

¹MDS, Rama Dental College, Kanpur, U.P., India, Department Of Oral Medicine and Radiology

²Lecturer, MRA Medical College Ambedkar Nagar, U.P, India. Department Of Conservative Dentistry and Endodontics

³MDS, Sardar Patel Post Graduate Institute of Dental and Medical Sciences, Lucknow, Uttar Pradesh Lucknow, India, Department Of Oral and Maxillofacial Surgery.

⁴MDS, Sardar Patel Post Graduate Institute of Dental and Medical Sciences, Lucknow, Uttar Pradesh Lucknow, India, Department Oral Pathology and Microbiology.

⁵MDS, Sardar Patel Post Graduate Institute Dental and Medical Sciences, Lucknow, Uttar Pradesh Lucknow, India, Department Oral Medicine and Radiology.

⁶Professor, Dental College Azamgarh, Uttar Pradesh, India, Department Prosthodontics Crown Bridge and Implantology.

⁷PG Student, Sardar Patel Post Graduate Institute Dental and Medical Sciences, Lucknow, Uttar Pradesh Lucknow, India, Department Prosthodontics Crown Bridge and Implantology.

⁸PG Student, Sardar Patel Post Graduate Institute Dental and Medical Sciences, Lucknow, Uttar Pradesh Lucknow, India, Department Oral and Maxillofacial Surgery.

⁹MDS, Sardar Patel Post Graduate Institute Dental and Medical Sciences, Lucknow, Uttar Pradesh Lucknow, India, Department Oral and Maxillofacial Surgery.

¹⁰MDS, Sardar Patel Post Graduate Institute Dental and Medical Sciences, Lucknow, Uttar Pradesh Lucknow, India, Department Oral and Maxillofacial Surgery.

Corresponding author, Dr. Kamini Kiran, deptt of Oral Pathology & Microbiology, Sardar Patel Post Graduate Institute Dental and Medical Sciences, Raibareillyroad, Lucknow. Uttar Pradesh, India, 226025.

Abstract: Forensic dentistry is the examination and evaluation dental evidence which will be then presented in the interest justice. The palatal rugae are generally transverse ridges situated in the anterior part the palatine mucosa. Palatal rugae are resistant to chemical aggression, thermal effects and decomposition changes because internal position in the head. They are widely used in edentulous patients where dental identification is not possible and in patients where other body parts are burnt and decomposed.

Aim the study is to analyze and identify the differences in the palatal rugae patterns in males, females, families & identical twins.

Methods & material: study included a total 180 palatal casts 75 males, 75 females, 5 families (father, mother & two childrens) & 5 pairs identical twins. **Statistical Analysis:** Two-sample t-test and Chi-Square tests were used for comparison means and relationship between the attributes. **Conclusion:** variations in palatal rugae in gender wise, or various geographically different races can be used as identifying tool in forensic dentistry.

Keywords: Forensic dentistry, Palatoscopy, rugae patterns, identical twins.

I. Introduction

Forensic science refers to areas endeavour that can be used in a judicial setting as accepted by the court and the general scientific community to separate truth from untruth. Forensic is derived from the Latin word forum, which means “court law”. Odontology refers to study teeth. Forensic odontology, therefore, has been defined by the Federation Dentaire International (FDI) as that branch dentistry which, in the interest justice, deals with proper handling and examination dental evidence, and with the proper evaluation and preservation dental findings. The entity forensic dentistry comprises four major areas interest: Dental identification the unknown body; by far, this area the field represents practically the entire body dental case material bite mark comparison leads to the analysis bite mark evidence which comprises a very small but very significant aspect the field the forensic dentistry. Trauma and the oral tissues involve in the interpretation oral injury and its applications to legal matters. Dental malpractice and negligence is the option the dentist who is expert witness pertaining to such matters represents another segment forensic dentistry.

Other currently evaluated ancillary methods identification include cheiloscopy (study lip prints) and rugoscopy (study palatal rugae patterns). Genomic and mitochondrial DNA from pulp, dentin or cementum teeth or desquamated cells in saliva are vital to the forensic process identification. In the human embryo they are

relatively prominent; occupying much the length the palatal shelves at the time their elevation⁵, but become less prominent during fetal growth and from the newborn stage onwards, are confined to the anterior part the secondary palate.⁶

Palatoscopy or rugoscopy refers to the study palatalrugae patterns in order to establish a persons individual identity⁷. The uniqueness palatalrugae can provide reliable source identification. The human palatal rugae are protected from trauma by their internal position in the head and are insulated from heat by the tongue and buccal pad fat. Furthermore the palatal rugae are resistant to chemical aggression, thermal effects and decomposition changes.⁷

So, the present study was carried out to know the uniqueness palatalrugae for establishing individuality.

Materials and Method.

This study included a total 180 palatal casts 75 males, 75 females, 5 families (father, mother & two childrens) & 5 pairs identical twins. The age group selected was 14 yrs & above. Informed consent was obtained from all the patients participating in the study. The casts were taken from those individuals, who were healthy and free congenital abnormalities, inflammation, trauma related to palate, were included in our study.

Methodology:

Examination the patient:

The patients were made to sit comfortably on the illuminated electrically operated dental chair. Complete oral examination the patient was carried out.

Procedure for impression making:

The backrest the dental chair was raised to an angle 45° for the maxillary impression. The dental chair was raised so that the operating area was at the level elbow the operator. Maxillary impression trays were selected according to the shape and size the patient's arches and tested by checking the extensions the trays in the patient's mouth. For maxillary examination, the maxilla the patient was made parallel to the floor.

The container the alginate impression material was shaken vigorously each time before use to ensure complete mixing the contents. The powder scoop (provided by the manufacturer) was filled lightly without tapping. Only level scoops were employed for mixing. Two levels the impression material were taken in the scoop and mixed with 40 ml water (using a measuring jar provided by the manufacturer), in a water / powder (W/P) ratio 40 ml: 15 g, in a flexible rubber bowl with a mixing spatula. A vigorous figure-eight motion was used with the mix being swiped or stropped against the sides the rubber mixing bowl with intermittent rotations (180 degrees) the spatula to press out air bubbles. The contents were mixed for 45 seconds to 1 minute (mixing time alginate material) till a smooth creamy mixture was obtained that did not drip f the spatula when it was raised from the bowl. The mix was immediately transferred to the impression tray for insertion into the patient's mouth. The tray was held passively and motionless during the setting impression material. After about 2 minutes (setting time Alginate), the tray was separated quickly from the teeth to avoid rocking and possible deformation the fine areas the impression. Excess material at the periphery was trimmed.

Preparation study casts:

Dental stone was mixed with water in a W/P ratio 28 ml: 100g. The alginate impression was kept on the mechanical vibrator and the mixed dental stone was added to the impression in small increments to avoid air entrapment. The cast was separated from the impression after 60 minutes. Base for the study casts was made using the base former and dental stone. Each cast was numbered for easy identification.

Measurements on the study casts:

All the measurements were taken by a single observer. The observations were made in a quiet, well illuminated room. The study casts were placed on a horizontal base. The rugae were highlighted by a sharp graphite pencil on the cast and a magnification lens was used for identification. Measurement was done using a plastic ruler (Kenson) in millimeters. The method rugae identification was based on the classification Thomas et al (1983) and Kapli et al. The classifications include number, length, shape and unification rugae. The shapes are classified into curved, wavy, straight and circular. Fragmented rugae are those which have length less than 5 mm. The data thus obtained was recorded in a printed prorma, A written informed consent was obtained from the subjects participants in the study and photographs were also taken. The data was analyzed regarding the number, shape, length the palatal rugae in both the study population and also among the male and female population.

Statistical Analysis

Two-sample t-test and Chi-Square tests were used for comparison means and relationship between the attributes.

Comparison in Total Number Rugae In Males And Females

A total 1980 palatal rugae were observed in 180 subjects, almost equally divided on the left and the right side the median palatine raphe. Average number rugae found in each individual was 11 which 4 to 7 rugae were present on each side the palate. In 91 females, a total number 1011 rugae were identified with a mean value 11.11 ± 2.438 (mean \pm SD), while in 89 males, a total number 969 rugae were observed with a mean value 10.89 ± 2.129 (mean \pm SD). Statistically, no significant differences were observed in the number rugae among males and females ($p=0.516$). Hence, no significant differences were found on the left and right side the palate or among males and females (Table1) (Graph1&2).

Comparison In Different Shapes Rugae In Males And Females

Regarding shape the palatal rugae, out the total 1980 rugae found in 180 individuals, 321 were curve type rugae, i.e. 16.2% which were less in number in comparison with wave type rugae found to be 1052 in number, i.e. 53.1%, then straight type rugae were 566 in number making 28.6% the total rugae shapes followed by circular type rugae found to be 41 in number, i.e 2.1% which is minimum in number in comparison all shapes palatal rugae.

In males as well as in females, the mean proportion wave type rugae was observed to be maximum (mean value in males 5.72%, while in females 5.97%) followed by straight type (mean value in males 3.22% and in females 3.7%) followed by curve type (mean value in males 1.76% and in females 1.78%), and circular type rugae (mean value in males 0.168% and in females 0.820%).

Hence, males had higher mean proportion all shapes rugae as compared with females. (Total p - value = 0.516 which is constituent curve = 0.944, wave = 0.403, straight = 0.606, circular = 0.246, total p = 0.516). (Table 2).(Graph 3,4 & 5).

Comparison In Size Rugae (Length In Mm) In Males And Females

Primary palatal rugae were more on the right side in females than in males i.e. 95% in females & 93.4% in males, secondary rugae on the right side were more in males than females i.e. 5.4% in males & 4.4% in females and fragmentary rugae on the right side were more in males than females i.e.1.2% in males & 0.6% in females.

On the left side primary rugae were more in males than in females i.e. 96.2% in males & 95.3% in females, secondary rugae were more in males than in females i.e. 3.6% in males & 3.3% in females, while fragmentary rugae were more in females than in males i.e. 0.2% in males & 1.4% in females.(Table 3) (Graph 6 & 7).

Comparison Different Shapes Rugae At Left & Right Side Palate In Males & Females

Shape rugae on the left and right side the median palatine raphe : At right side median palatine raphe, the proportion circular rugae was found to be higher in females than males (16,i.e. 3.1%) and (09,i.e .1.8%) . Hence, the proportion circular rugae was higher among females as compared with males ($p = 0.37$) on the right side the median palatine raphe. (Table 4)

At the same side (right side), the proportions curve, wavy & straight rugae were almost similar among males & females; curve rugae among males (91, i.e.17.2%) as compared with females (90, i.e.18.3%) ($p=0.392$), wavy rugae males (254, i.e.51%) as compared with females (271, i.e.51.9%) ($p=0.071$) and the straight rugae same side in males (144, i.e.28.9%) as compared with females (145, i.e.27.8%) ($p=0.804$). (Table 4)

On the opposite side (left side) median palatine raphe, the proportion curve rugae was higher among females (67, i.e.14.2%) as compared with males (73, i.e.14.9%) ($p=0.061$).

At the same side (left side), the proportion wave type rugae was higher among males (255,i.e.54.1%) as compared to females (272,i.e.55.6%) leading to a difference ($p =0.692$), while circular rugae on the same side were more in females (10,i.e.2.1%) as compared to males (6,i.e.1.3%) ($p = 0.345$). The proportion straight rugae was more in males (30.4%) than in females (27.4%).

Regarding shapes rugae like curve, wavy, straight and circular , there was no statistically significant difference at the left and right sides the median palatine raphe (Table 4) (Graph 8).

Age Wise Comparison The Rugae Patterns

Comparison in Number Rugae in Different Age Groups

When the number rugae was compared in different age groups the study population, it was observed that total number rugae were maximum in age groups 14 to 24 years ($n = 1558$) with mean value 11.13 ± 1.20 , while the number rugae was minimum in age group 35 years & above ($n = 91$) with mean value 10.11 ± 1.35 . It was noted that the mean number rugae showed a slight decreasing trend with increasing age ($P = 0.0292$). (Table 5) (Graph 9)

Comparison the shape palatal rugae in various age groups lead to a conclusion that wave, straight & curve rugae were grossly maximum in all the four age groups, followed by circular rugae. Hence, shape palatalrugae does not change with age (Table 6) (Graph 10).

Comparison in Size Rugae in Various Age Groups Primary secondary and fragmentary rugae were maximum in the age group 14-24 years. Size rugae slightly increased up till the middle age group, i.e. 14 to 24 years thereafter remaining constant as growth ceases thereafter. Statistically, no significant intergroup differences were observed in the average length rugae among various age groups individuals ($p=0.883$). Thus, length neither increases nor decreases with age, once the rugae are completely formed. (Table7) (Graph 11).

Comparison Rugae Patterns In Families

Comparison rugae patterns in siblings with their parents and in identical twins revealed no similarity rugae patterns suggesting that heredity may not play a role in determining the rugae pattern an individual. This result is inconclusive since the number families studied is limited.

II. Discussion

The present study was aimed to determine the differences in rugae pattern among males, females, sibling families and twin families in an Indian population thereby highlighting the importance palatalrugae in establishing individual identity.

Studies have demonstrated that no two individual's rugae patterns are alike in their configuration and that the characteristic rugae pattern the pallet does not change as a result growth.²⁰ In the present study the rugae pattern did not comprise one form alone but appeared as a combination varying forms. The palatal rugae patterns in all 180 subjects were distinct and unique. None the patterns were identical and also no bilateral symmetry was observed in any individual. These findings are in congruity with the results obtained in similar studies conducted before.⁸

Anatomically the rugae consist around 37 ridge and oblique ridges that radiate out tangentially from the incisive papilla.

In the present study, females showed slightly more total number rugae than males but this finding was statistically insignificant. On comparison the right and left sides, both males and females showed more number rugae on the right side the palate but the difference was not statistically significant. Similar results were obtained by Kamala. R et al (2011), Mahabalesh Shetty et al(2011), S. Manjunath et al (2012), Faisal M et al(2001) and A Saraf et al (2011).

They concluded that there was no significant difference in the number rugae between males and females.^{9,10,11,12,13}

Nayak P, Acharya AB investigated the differences in the shape palatal rugae in two populations India and concluded that wavy and curved were the most prevalent rugae shape in both groups followed by straight rugae.¹⁴

According to A Saraf (2011) the wavy and curved pattern rugae were more common in both males and females.¹⁵

Our observations conform with the results the aforementioned studies.

Conclusion

The study showed that no significant differences were found on the right and left sides the palate or among males and females regarding the number rugae.

In males and females wave type rugae were seen predominantly followed by straight curved and circular types. Statistically significant differences were not seen on the right and left sides, in the shape rugae.

From our study, it can be concluded that rugae patterns can be used for ante mortem and postmortem identification. Further research is required to substantiate the results our study with a larger sample size.

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Table – 1 Total Number Rugae In Males And Females And Also Right And Left Side Palate

Age ranged from 14 to 54 years (Mean age = 23.61±8.705)

Variables	Total individuals	Total no. rugae	Mean no. rugae	SD
GENDER				
Males	89	969	10.89	2.129
Females	91	1011	11.11	2.438
SIDE				
Right	89	1020	5.67	1.366
Left	91	960	5.33	1.341
Total	180	1980	11.00	2.287

t=-.651; p=0.516 (Not Significant)

Table – 2 Descriptive Statistics Different Shapes Rugae (N=1980) In 180 Individuals (Males And Females)

Rugae shapes (n=1980)	Total individuals (n=180)	Males (n=89)	Mean	SD	Females (n=91)	Mean	SD	t-value	p-value
Curve	321 (16.2)	181 (17.7)	1.76	1.493	140 (14.6)	1.78	1.569	-0.071	0.944
Wave	1052 (53.1)	525 (51.5)	5.72	1.859	527 (54.9)	5.97	2.100	-0.838	0.403
Straight	566 (28.6)	289 (28.3)	3.22	1.987	277 (28.8)	3.07	2.133	0.516	0.606
Circular	41 (2.1)	25 (2.5)	0.168	0.482	16 (1.7)	0.285	0.820	-1.165	0.246
Total	1980	1020 (51.5)	10.89	2.129	960 (48.5)	11.11	2.438	-0.651	0.516

Table- 3 Statistical Comparison Size Rugae At Left And Right Side The Palate In Males And Females

Size Rugae	Males (n=89)		Females (n=91)	
	No. rugae	%	No. rugae	%
RIGHT SIDE (N=1020)	N=498		N=522	
Primary	465	93.4	496	95
Secondary	27	5.4	23	4.4
Fragmentary	6	1.2	3	0.6
LEFT SIDE (N=960)	N=471		N=489	
Primary	453	96.2	466	95.3
Secondary	17	3.6	16	3.3
Fragmentary	1	0.2	7	1.4
TOTAL (N=1980)	969	100	1011	100

Table – 4 Statistical Comparison Different Shapes Rugae At Left And Right Side The Palate In Males And Females

Rugae shapes (n=1980)	Males		Females		Statistical significance	
	N	%	n	%	X-value	p-value
RIGHT SIDE (N=1020)	N=498		N=522			
Curve (n=181)	91	18.3	90	17.2	4.102	0.392
Wave (n=525)	254	51	271	51.9	11.634	0.071
Straight (n=289)	144	28.9	145	27.8	2.313	0.804
Circular (25)	9	1.8	16	3.1	0.603	0.307
LEFT SIDE (N=960)	N=471		N=489			
Curve (n=140)	67	14.2	73	14.9	7.384	0.061
Wave (n=527)	255	54.1	272	55.6	3.890	0.692
Straight (n=277)	143	30.4	134	27.4	4.221	0.377
Circular (n=16)	6	1.3	10	2.1	2.126	0.345

Test used – Chi square and Fischer’s Exact Test
P<0.05 is considered for statistical significance

Table – 5 Number Rugae In Different Age Groups Individuals

Age (years)	Total number individuals (n=180)	%	Total number rugae (n=1980)	Mean	SD
14-24	140	77.8	1558	11.13	1.20
25-34	19	10.6	210	11.05	1.26
35-44	9	5	91	10.11	1.35
45-54	12	6.7	121	10.08	1.39

F=1.252 (ANOVA); p=0.292

Table- 6 Descriptive Statistics Comparison Shapes Rugae In Different Age Groups Individuals.

Shapes rugae	14-24 years	25-34 years	35-44 years	45-54 years	f-value	P-value
Curve	1.65±1.424	1.95±2.068	2.44±1.740	2.33±1.557	1.694	0.170
Wave	5.88±1.980	5.74±2.513	5.89±1.764	5.58±1.311	0.102	0.959
Straight	3.35±2.088	3.00±1.972	1.78±1.394	2.00±1.595	3.167	0.026
Circular	0.24±0.718	0.32±0.671	0.00±0.000	0.08±0.289	0.651	0.583

Table – 7 Descriptive Statistics Difference In Size Rugae In Different Age Groups Individuals

Size rugae	14-24 years	25-34 years	35-44 years	45-54 years
Primary	1499 (96.2)	202 (96.2)	83 (91.2)	96 (79.3)
Secondary	51 (3.3)	8 (3.8)	5 (5.5)	19 (15.7)
Fragmentary	8 (0.5)	0 (0)	3 (3.3)	6 (5)
Total	1558	210	91	121
Mean	11.12	11.05	10.11	10.08

Chi square value = 23.694; p=0.883



Fig. 1 – Armamentarium used for examination of patients.



Fig. 2 – Armamentarium used for making impression



Fig. 3 – Armamentarium used for obtaining study cast



Fig. 4 – Armamentarium used for marking rugae on Maxillary cast



Fig.5 –Cast identical twins



Fig. 6 – Cast identical twins



Fig. 7–Cast family (Mother, Father, Child A, & Child B)