

ORIGINAL RESEARCH

Rugae Patterns in Dentulous and Edentulous Models -A Comparative Study

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ABSTRACT:

INTRODUCTION: Palatal rugae are asymmetrical irregular elevations of dense connective tissues located on the anterior third of the palate extending on either side of the mid palatine raphe, behind the incisive papilla. Palatal rugoscopy is defined as the study of palatal rugae patterns. The uniqueness of the palatal rugae suggests their important role in personal identification and they are well protected by the lips, buccal pad of fat and teeth. They are considered to be stable throughout life even after the completion of growth and hence are suggested for use in forensics.

AIM AND OBJECTIVE: This study aims to analyse rugae patterns in dentulous and edentulous models of both genders.

METHODOLOGY: The study group consisted of 100 study models of which 50 were dentulous and 50 were edentulous. Thomas and Kotze classification was followed based on form and position to assess the edentulous and dentulous rugae pattern.

RESULTS: The present study concludes that there are variations in rugae pattern between the dentulous and edentulous models. However, the most predominant patterns were straight, wavy, and circular.

KEY WORDS: Palatal rugae, Rugoscopy, Dentulous, Edentulous

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INTRODUCTION:

The Federation Dentaire Internationale (FDI) defines forensic odontology as that branch of dentistry which, in the interest of justice, deals with the proper handling and examination of dental evidence, with proper evaluation and presentation of dental findings.¹ Palatal rugoscopy is defined as the study of palatal rugae patterns. The rugae located intraorally, are stable in nature and their design and structure are not altered during growth and are well protected from external trauma.² Palatal rugae appears during the third month of intrauterine life and its development and growth is controlled by epithelial- mesenchymal interactions.³ The first rugae are distinguished in human embryo when it is in 3 month of intrauterine life of about 32 mm located next to the incisive papilla.⁴ Once they are formed, there may be changes in their size due to growth of the palate, but their shape remains unaltered.⁵ The palatal rugae pattern like fingerprints, do not change

during the life of an individual . They are well protected from trauma and high temperatures owing to its intraoral position, being protected by the lips, cheeks, tongue, teeth, bone, and prosthetic devices. Once formed, there will be change only in length, due to normal growth and are stable in the same position throughout the life of an individual.⁶ Even disease, trauma or chemical attack does not change the shape of the rugae.⁷ The use of teeth in postmortem identification has gained many advantages for the past few years. Postmortem dental identification is, however, not possible in the edentulous jaws and therefore palatal rugae can be used as a supplement .⁸ Thomas and Van Wyk had successfully identified a severely burnt edentulous body by comparing the rugae pattern with the victim's old denture ,there by indicating that rugae patterns are stable in adult life.⁹ Thus, the palatal rugae pattern appears to possess the features of an ideal forensic identification parameter with uniqueness

of postmortem resistance and stability. Hence, it can be used in post-mortem identification when an ante-mortem record exists.

MATERIALS AND METHODS:

Our study sample consisted of 100 diagnostic study models of which 50 were dentulous and 50 were edentulous. The models obtained were free from palatal defects so that they could be used to determine the number and predominant rugae pattern between the dentulous and edentulous models. The materials used to assess the rugae pattern were magnifying glass, marking pencil, divider and metal scale.

Inclusion criteria were dentulous models of age 17 to 30 years and edentulous models of age 50 to 75 years. Palatal defects due to any cause were considered to be exclusion criteria.

The method of identification was based on Thomas and Kotze classification in 1983

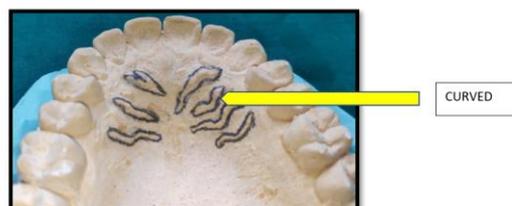
The rugae were classified based on their length as:

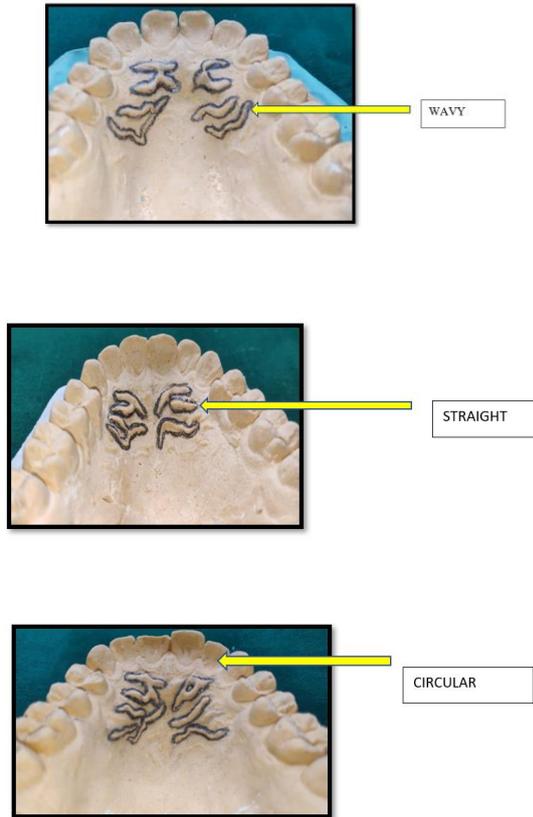
- Primary: > 5 mm
- Secondary: 3.5 mm
- Fragmentary: < 3 mm

rugae less than 2 mm were ignored

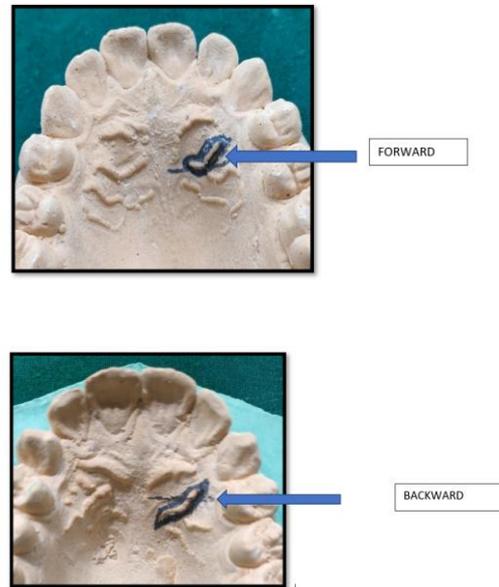
The rugae are divided into 4 types based on their shape.

- Curved: They are crescent shape and gently curved
- Wavy: Curved rugae with the slight curve either at the origin or terminal end.
- Straight: They run directly from their origin to termination.
- Circular: Rugae that form a definite continuous ring.





3. Perpendicular rugae: Associated with zero angles



The direction of the rugae was determined by measuring the angle formed by the line joining its origin and termination and the line perpendicular to the median raphe.

Based on the direction rugae were classified as:

1. Forwardly directed rugae: Associated with positive angles
2. Backwardly directed rugae: Associated with negative angles.



Unification was said to have occurred when two rugae joined at their origin or termination:

- Diverging: If two rugae had the same origin from the midline but immediately branched

•Converging: Rugae with different origins from midline, but which joined on their lateral portions.

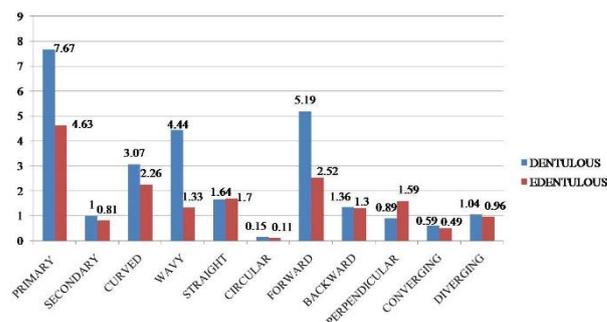
RESULTS:

The study was conducted at the Department of Oral and maxillofacial pathology, APDCH, Melmaruvathur. A total of 50 dentulous models and 50 edentulous models were examined for the palatal rugae patterns using the classification proposed by Thomas and Kotze as per the number, length, shape, direction and unification patterns. All details from each dental model were documented. The data obtained were subjected to statistical analysis using Statistical Package for the Social Sciences (SPSS) software version 20.0.

A significant difference was noted for forward and perpendicular directions for both dentulous and edentulous models.

There was no significant difference noted for backward direction.

Table 1, 2, 3, 4 explains the results.



Discussion:

The field of forensic sciences primarily involves identification of deceased individuals. Various methods such as DNA analysis, finger printing and dental comparisons are used for human identification. Forensic odontology is a branch of forensic science that involves the skill of a dentist in personal identification especially during mass calamities.¹⁰ Since teeth are resistant to various external and internal factors, they play a pivotal role in human identification. In recent, oral soft tissues also have been employed in human investigations, of which, identification of palatine rugae, has gained a lot of importance.

Palatal rugae also referred to as plicae palatine transversae or rugae palatine are asymmetrical irregular elevations of the

mucosa located in the anterior third of the palate and arranged in transverse direction from the palatine raphe.¹¹ Historically rugae were first described in 1732 by Winslow. The first suggestion of using palatal rugae as a method for personal identification was by Harrison Allen in 1889.⁹ The basic assumption for its use is that the rugae patterns are unique to every individual just like fingerprints and do not change during the course of life and also are well protected from the various environmental factors.. The study of palatal rugae called Rugoscopy was first proposed by a Spanish investigator Troban Hermaso, in 1932.

Classification of rugae patterns based on their length as well as shape forms the basis for use of palatal rugae in personal identification. Various classification systems have been proposed to categorise palatal rugae based on their number, shape, direction and unification. One of the commonly used methods of classification is the one given by Thomas

and Kotze. Palatal rugae as an aid in forensic investigations are primarily used for population differentiation and personal identification with minimal contribution towards sexual dimorphisms. It can be of great interest in human identification as it is possible to maintain ante-mortem data in the form of dental casts, maxillary prosthetic devices and intra-oral radiographs.¹² With this background, the present study was undertaken with an aim of examining and comparing various palatal rugae patterns between dentulous and edentulous models. We used the classification system proposed by Thomas and Kotze.

The present study showed significant reduction in total rugae number and number of primary rugae in edentulous group which was consistent with the results obtained by Kamala et al noted that mean number of rugae showed a small decreasing trend with increasing age.¹³ Similar results were also obtained by Jawad in Iraqi population.¹⁴ In contrast,

Hauser et al had suggested that the mean rugae count changes moderately in adolescence and then increases significantly from the age of 35 to 40 years.¹⁵ It has been suggested that changes in the length of rugae with age result from underlying palatal growth. Furthermore, Bailey et al concluded that movement of teeth may change the position of the rugae points.¹⁶ Jawad in his comparative study evaluated that the space between the medial rugae points and incisive papilla appear to be reduced within the edentulous group. Also, the distances between medial rugae ends and median palatine raphe increase in edentulous palates, suggesting that the palatal rugae begin to degenerate and shorten in length from their medial ends.¹⁷ Bhatt et al, Kaur et al was in concordance with the results of the present study which showed that there was decrease in the length of the palatal rugae and positioned more laterally and anteriorly in comparison to those in dentulous group.^{18,19} In contrast, Kapali et

al, Almasudi et al in their study concluded that the length of rugae increased significantly till 10 years of age thereby remaining stable throughout life.^{20,21}

In our study, the most common rugae shapes were wavy and curved, whereas straight and circular types were least common regardless of age. The edentulous group showed the highest mean of curved pattern and total absence of circular pattern suggesting the presence of simpler form of rugae pattern. This study coincidence with Kaur et al and in contrast with Bhatt et al

Forward is more common in dentulous group, perpendicular direction is more common in edentulous group and there is no significant difference in backward direction. This study was in coincidence with Bhatt et al whereas it was in contrast to Almasudi et al as the perpendicular direction is more in dentulous.

Another complex figure of rugae pattern is that the unification. It was clear that this

perplexity of rugae pattern in dentate individuals tend to regress in edentulous group. The above results were consistent with the studies of Jawad , Rajguru et al and Kaur et al ^{17,19,22}

Ohtani et al stated that in edentulous patients, features like poorly demarcated eminence of rugae and non-complex rugae pattern are mainly due to the shape of the edentulous palate itself and infrequently thanks to the dentures and will cause difficulties find unique points for private identification. The continuous mechanical stimulation can result in much morphological degeneration in the palatal mucosa involving rugae.²³

Recording the points were easily performed. Minimum training was needed to achieve results with low errors. The uses of palatal rugae in forensic identification have advantages because of their low expense, simplicity and reliability. It is sufficiently characteristic to discriminate between individuals

because no two palatal rugae configurations are alike. Kashima et al., compared the palatine rugae and shape of the surface among Japanese and Indians children and reported that Japanese children had more primary rugae than Indian children and the palatal raphe of Japanese children were wider than those of the Indian children. Comparisons were drawn among Indians, straight and wavy patterns were prominent in our study in contrast to the curved pattern which predominated in the Mysoreans evaluated in the study of Shetty et al. Fahmi et al reported that between twins the patterns are not identical.² Variability between populations can be attributed to inheritable and environmental factors. Still, some authors have indicated easily that environmental factors play a minimum part in affecting the conformation of rugae and that the main determinant factor in the conformation is the inheritable background.²⁴

Conclusion:

Identification of living or dead people is frequently a delicate, gruelling and time consuming process. Palatal rugae have been shown to be largely individualistic and harmonious in shape throughout the life. It is a well-established fact that the palatal rugae pattern are unique to mortal being like fingerprints, therefore its use in forensic identification is fairly justified. Rugoscopy is rather veritably simple without complex instrumentation. In the present study curved, wavy, circular pattern, forward and backward direction are more common in dentulous while straight pattern and perpendicular direction is more in edentulous . Therefore, palatal rugae are an implicit as a supplementary tool, along with the dentition, to establish the identity of individuals. To conclude, larger samples can be studied to further validate the findings of this study for definitive conclusions.

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Conflicts of interest

There are no conflicts of interest

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Table:1

	Dentulous	MEAN	±SE	Edentulous	MEAN	±SE	t-test	P value	RESULT
Total.No.Rugae	50	8.63	0.1927	50	5.44	0.1377	13.44	0.0000	**
PRIMARY	50	7.67	0.1840	50	4.63	0.1761	11.93	0.0000	**
SECONDARY	50	1.00	0.1710	50	0.81	0.1040	0.93	0.3571	NS
FRAGMENTARY	50	0	0.00	50	0	0.00	0	NA	NA

** - $p < 0.01$. STATISTICALLY SIGNIFICANT

NS – $p > 0.05$. STATISTICALLY NOT SIGNIFICANT

The total number of rugae were more in dentulous models(mean-8.63) when compared to edentulous models(mean-5.44)

Table:2

	Dentulous	MEAN	±SE	Edentulous	MEAN	±SE	t-test	P value	RESULT
CURVED	50	3.07	0.2110	50	2.26	0.1598	3.08	0.0027	**
WAVY	50	4.44	0.2582	50	1.33	0.1109	11.07	0.0000	**
STRAIGHT	50	1.64	0.1386	50	1.70	0.1165	0.35	0.7256	NS
CIRCULAR	50	0.15	0.0645	50	0.11	0.0453	0.47	0.6394	NS

** - $p < 0.01$. STATISTICALLY SIGNIFICANT

NS – $p > 0.05$. STATISTICALLY NOT SIGNIFICANT

The incidence of wavy (mean - 4.44) and curved (mean-3.07) rugae patterns were found to be more in dentulous models whereas in edentulous models, curved (mean-2.26) and straight(mean- 1.70) were seen predominantly.

Table:3

	Dentulous	MEAN	±SE	Edentulous	MEAN	±SE	t-test	P value	RESULT
FORWARD	50	5.19	0.2513	50	2.52	0.1263	9.48	0.0000	**
BACKWARD	50	1.36	1.495	50	1.30	1.31	0.213	0.5234	NS
PERPENDICULAR	50	0.89	0.1320	50	1.59	0.1127	4.05	0.0001	**

** - $p < 0.01$. STATISTICALLY SIGNIFICANT

NS – $p > 0.05$. STATISTICALLY NOT SIGNIFICANT

A significant difference was noted for forward and perpendicular directions for both dentulous and edentulous models. There was no significant difference noted for backward direction.

Table:4

	Dentulous	MEAN	±SE	Edentulous	MEAN	±SE	t- test	P value	RESULT
CONVERGING	50	0.59	0.1721	50	0.49	0.0000	0.60	0.5525	NS
DIVERGING	50	1.04	0.2270	50	0.96	0.0000	0.34	0.7350	NS

** - $p < 0.01$. STATISTICALLY SIGNIFICANT

NS – $p > 0.05$. STATISTICALLY NOT SIGNIFICANT

Both converging and diverging patterns did not show any significant difference.

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