

Comparison of Topographic changes of Palatal rugae pattern in Dentate and Edentulous patients

Sajid Naeem¹, Afsheen Zakir², Muntaha Manzoor³, Asma Akram⁴, Mahira Khan⁵, Fareena Arshad⁶

ABSTRACT

Objective: To assess the topographic changes in palatal rugae in dentate and edentulous subjects and explore the topographic changes that has occurred due to aging and tooth loss.

Study Design: A cross sectional observational study.

Place and Duration: At Prosthodontic department of Lahore Medical and Dental College, Lahore from 5th January 2021 to 5th April 2021.

Methodology: A total of 40 participants, (20 dentate; age ranged 20-30 years, 20 edentulous; age ranged 50-70 years) were selected using non probability purposive sampling. Demographic data was collected and intra oral examination was done. Alginate impressions were taken and maxillary casts were fabricated. The casts were minutely analyzed for number, direction, shape, length and unification of rugae. Sharp graphite pencil was used for marking and Modified Thomas and Kotze classification was used to examine rugae characteristics.

Results: Topographic change was seen in rugae patterns and their distribution varies in both groups. The number of primary rugae was higher in dentate as compare to edentulous group (8.10 ± 0.788 ; $5.00 \pm SD 1.75$). The secondary rugae's count was also a bit higher in dentate group as compared to edentulous ($2.00 \pm SD 0.918$, $0.65 \pm SD 0.489$). The commonest pattern seen in dentate group is more complexed i.e., wavy (2.80 ± 0.616), whereas in edentulous group the commonest pattern observed was straight rugae ($2.78 \pm SD 1.6$). Dentate group had more frequent forward directed rugae ($2.80 \pm SD 1.196$; $1.62 \pm SD 0.885$) as compared to edentulous group where perpendicular directed ($2.50 \pm SD 1.39$) were more frequent. Significant difference was seen in convergent pattern of rugae of both groups (dentate $.90 \pm SD 1.02$, edentulous $1.00 \pm SD.001$). Significant statistical difference was found in both groups with respect to number, direction, shape unification and lengths; $p < 0.05$.

Conclusion: The aging process and tooth loss altered the topographical characteristics of palatal rugae and resulted in less number and complexity of characteristics in edentulous subjects as compared to dentate.

Keywords: Alginate impressions Age groups, Anatomic landmarks, Dentate, Edentulous, Palatal rugae.

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INTRODUCTION

Complete edentulism is a condition when a patient loss all of his teeth. The treatment planning of completely edentulous patients relies on the intra oral landmarks which act as positive guide for the restoration of an edentulous mouth.¹ One of the important landmarks in an edentulous patient is the palatal rugae that are asymmetrical folds present on the anterior part of palate and arranged between the palatine raphe and maxillary teeth.²

Prosthodontics rugae are secondary stress bearing area of a denture and efficiently used as support area of a complete denture.³ In removable partial denture in free end saddles rugae gives indirect retention and also serve as a guide in maxillary artificial teeth setup.³ Patients phonetics, i.e., the speech problems can be solved by duplicating rugae texture in palatal region.⁴ Many prosthodontists incorporate individual palatal rugae on the patients' dentures and recommend reproducing rugae pattern to improve phonetics.^{4,5}

Rugae are unique and different in every individual.⁶ They not only show difference in number and shape but also the width, height, and their location vary that is why, they are also used as

1. Professor of Prosthodontics
Lahore Medical and Dental College, Lahore
2. Associate Professor of Physiology
Faryal Dental College, Lahore
3. Dental Surgeon, THQ Hospital Qila Gujjar Sing,
Police Lines Hospital, Lahore.
4. PG Trainee of Prosthodontics
Lahore Medical and Dental College, Lahore.
5. Dental Surgeon of Prosthodontics
Lahore Medical and Dental College, Lahore.
6. House Officer of Prosthodontics
Lahore Medical and Dental College, Lahore

Correspondence:

Sajid Naeem
Professor of Prosthodontics
Lahore Medical and Dental College, Lahore
Email: drsajidnaeem@hotmail.com

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reliable tool in forensic identification and in process of medicolegal identification.⁷ In literature different studies have explained the variation of rugae patterns with respect to gender and racial difference.⁶⁻⁸

Events like excessive finger sucking in infantile stage, excessive pressure with orthodontic intervention, edentulism or denture wearing can contribute to change in rugae qualitative and quantitative characteristics.^{10,11} Many classification systems have been proposed to study the characteristics changes seen in rugae number, size, shape, direction and unification.⁴ Out of all these proposed classification systems, Thomas and Kotze classification system is said to be the simplest, easy and detailed classification system that tells us about the characteristics of palatal rugae.^{4,12} Less literature is available on the topographic changes occurring in rugae characteristics after tooth loss and the controversy still exist those dentate individuals and those who have lost their teeth due to extraction or edentulism process may have questionable stability of various characteristics of palatal rugae.¹³

Consideration should be given to the topographical changes in rugae pattern as they have clinical significance and can affect dentures' support, retention and can alter phonetics.³⁻⁵ By knowing the extent of topographical changes in old patients we can better plan the restorative procedures by incorporating additional features that can enhance the denture stability support and retention. The aim of the study was to compare rugae pattern in dentate and edentulous individuals and explore topographical changes that has occurred due to aging and tooth loss.

METHODOLOGY

This cross-sectional observational study consisted of 40 dentate and edentulous participants of both genders. The participants were divided in two groups. The dentate group comprised of the 20 subjects who were the students of Lahore Medical and Dental College, Lahore. The age ranged of dentate group was 20-30 years. We selected this age range because 15 to 30 years is the age range when growth has completed and after this time changes take place in dentition because of extensive restoration, aging other dental treatment. The edentulous group comprised of 20 patients who were selected from the outdoor of Prosthodontic department of Lahore Medical and Dental College, Lahore. The age of edentulous group ranged from 50-70 years. Data was collected in three months period, from 5th January 2021 to 5th April 2021. This was a cross sectional observational study. Non-probability purposive sampling technique was used and minimum sample size was estimated, based on the information obtained from previous study on rugae pattern evaluation.¹⁴

All the healthy individuals, within selected age range and having complete set of permanent teeth in dentate group were included. Participants with congenital abnormalities, malformations, surgery, orthodontic treatment, trauma and impression material allergies were excluded. All edentulous patients who had normal mouth conditions and free of all inflammations were included. Patients with suction disc

hyperplasia, papillary hyperplasia, palatal surgical resection, history of palatal fractures, asymmetries and impression material allergies were excluded. Informed consent was taken from all the participants. The ethical approval was obtained from ethical committee.

Alginate primary impressions were taken of all the individuals and were poured in hard plaster to fabricate dental casts. The casts were analyzed under good light and magnification lens was used to observe the rugae with the help of graphite pencil. All casts were inspected by two experienced prosthodontists separately. Their results were compared and the casts showing variation in interpretation were examined by a third examiner and common finding accepted. The sample comprised of 40 casts, the number of evaluated rugae was (240) as characteristics of 6 main primary rugae (3 on right and 3 on left side) on both sides were evaluated. The rugae were marked and highlighted on both sides, total number of all the rugae was counted and their lengths recorded. All the measurements were taken using digital vernier caliper to an accuracy of 0.01 mm.

Thomas and Kotze¹² classification was used to record the rugae characteristics. According to this classification rugae more than 5mm were primary and less than 5mm were considered as secondary rugae. The casts were minutely analyzed for number of total primary and secondary rugae and their characteristics i.e, direction, shape, length and unification was observed according to Thomas and Kortze¹² classification. According to the classification the shapes of rugae were classified as straight, curved, wavy and circular. Straight were line shaped, curved were crescent shaped, wavy were those who had more than single curves in their shape. Circular were in shape of definite ring. Concerning unification, the divergent rugae were those that arose from midline of maxillary arch and then bifurcate, whereas convergent had different origin but joined on their later portions. The direction of main primary rugae was studied. It was estimated by measuring angle between the line joining rugae origin and termination with the line drawn perpendicular to mid palatal raphe. Forwardly directed were associated with positive angles and backwardly directed with negative angles.

Data Analysis: Descriptive statistics were calculated for rugae number, shape, length, direction and unification. Independent sample t- test was used for comparison between dentate and edentulous groups. SPSS version 20 was used for statistical analysis. P vales <0.05 were considered statistically significant.

RESULTS

A total of 40 maxillary dental casts were made from 20 dentate and 20 edentulous individuals and rugae characteristics were evaluated using Thomas and Kotze¹² classification.

The number of total primary rugae found in both groups were (n=262; mean 6.55 $\pm$ SD 1.825) and total secondary rugae were (n=53; mean 1.33 $\pm$ SD .997). The number of primary rugae was higher in dentate as compare to edentulous group (8.10 $\pm$ 0.788; 5.00 $\pm$ SD 1.75) Table I.

Table – I: Comparison of shape and length of rugae in dentate and edentulous groups. (N=40)

Study Group	Shape				Length	
	Curve Mean $\pm$ SD	Wavy Mean $\pm$ SD	Straight Mean $\pm$ SD	Circular Mean $\pm$ SD	Primary rugae Mean $\pm$ SD	Secondary Rugae Mean $\pm$ SD
Dentate	2.00 $\pm$ 0.973	2.80 $\pm$ 0.616	0.35 $\pm$ 0.489	0.85 $\pm$ 0.813	8.10 $\pm$ 0.788	2.00 $\pm$ 0.918
Edentulous	1.87 $\pm$ 0.74	1.80 $\pm$ 0.789	2.78 $\pm$ 1.6	0.00 $\pm$ 0.000	5.00 $\pm$ 1.76	0.65 $\pm$ 0.489
t- value	-.460	-3.81	6.494	-4.67	-10.39	-5.85
p- value	>0.05	<0.001	<0.001	<0.001	<0.001	<0.001

Table – II: Comparison of direction and unification pattern in dentate and edentulous groups. (N=40)

Study Group	Direction			Unification	
	Forward Mean $\pm$ SD	Backward Mean $\pm$ SD	Perpendicular Mean $\pm$ SD	Divergent Mean $\pm$ SD	Convergent Mean, $\pm$ SD
Dentate	2.80 $\pm$ 1.197	2.70 $\pm$ 1.031	0.55 $\pm$ 0.605	1.35 $\pm$ 0.875	.90 $\pm$ 1.02
Edentulous	1.62 $\pm$ 0.885	2.00 $\pm$ 0.953	2.50 $\pm$ 1.39	1.83 $\pm$ 0.408	1.00 $\pm$ 0.001
t- value	-3.38	1.950	5.734	1.880	-4.59
p- value	<0.05	>0.05	<0.001	>0.05	<0.001

The secondary rugae's count was also a bit higher in dentate group as compared to edentulous (2.00 $\pm$ SD 0.918, 0.65 $\pm$ SD 0.489) Table- I. Regarding rugae shape the commonest pattern seen in dentate group is wavy (2.80 $\pm$ 0.616), whereas in edentulous group the commonest pattern observed was straight rugae (2.78 $\pm$ SD 1.6) Table I. According to direction the dentate group has more frequent forward directed rugae as compared to edentulous group (2.80 $\pm$ SD 1.196; 1.62 $\pm$ SD 0.885) whereas the more frequent direction of rugae seen in edentulous is perpendicular directed (2.50 $\pm$ SD 1.39) Table II. The unification pattern in both groups did not show any difference in mean values of divergent pattern (dentate 1.35 $\pm$ SD.875; edentulous 1.83 $\pm$ SD.408) however significant difference was seen in convergent pattern of rugae of both groups (dentate .90 $\pm$ SD 1.02, edentulous 1.00 $\pm$ SD.001) Table II. Significant statistical difference was found in both groups with respect to number, direction, shape unification and lengths; Table I and II.

DISCUSSION

The rugae of maxillary palate are important in complete denture fabrication.¹ The stability of rugae is a factor considered important when tooth loss occurs.⁴ The complete or partial denture fabrication requires the rugae duplication as they serve as indirect retainers, stress bearing areas and guide to artificial teeth set-up.^{3-5,15} The present study sought to find out the change in rugae number and characteristic in dentate and edentulous individuals. The study included dentate individuals within age ranged 20-30 years. This is the age range where the growth process ceases. Beyond this age dentition may change as a result of dental restorative treatment or tooth loss, whereas the edentulous group was selected after at least a year of complete loss so that we can evaluate the changes precisely.

Various methods have been proposed for rugoscopy.¹⁴ In current study we did cast analysis method for which dental casts were fabricated and they served as three dimensional records. They are excellent diagnostic and treatment planning aids in

Prosthodontics and are precise positive replica of patient's hard palate that gives accurate details and measurements.^{16,17} In our study digital vernier caliper was used for evaluating the dental casts, as it is the most economical, easy and precisely reproducible method. Inas¹⁷ also used digital Vernier caliper for purpose of recording the length of rugae. The rugae markings were easily carried out and minimum skills needed to accurately record the details with less error. Eye straining however was the problem faced and resting internals needed. Out of all classification system we used the classification proposed by Thomas and Kotze¹² as it is the most reliable, easy, detailed and practical classification.

The number of primary rugae (>5mm length) was counted and we found high number in dentate group and significant reduction was seen in edentulous group just like the study done by Inas.¹⁴ Garima¹⁸ conducted a study on edentulous population of Rajasthan state and reported the parallel results. The number of secondary rugae (<5mm length) were also found in lesser number in edentulous group as compare to the dentate. Similar findings were reported by Inas¹⁴, Garima¹⁸ and Kaur⁴ and Rogerio¹⁹ and co-workers. It can be concluded that the tooth loss, ageing and use of prosthodontic appliances in edentulous patients leads to the loss of primary and secondary number. rugae number details and their characteristics.

Rugae length evaluation is another key feature that is marked and recorded whenever rugoscopy is carried out. We reported a decrease in the length of rugae in edentulous group as compared to the dentate group. The current study's results are inconsistent with the study carried out by Kaur⁴ and co-workers, Garima,¹⁸ and Jawad¹⁴ who reported more laterally positioned rugae and reduced lengths. None of the studies reported an increase rugae length in edentulous patients. In light of these findings, we suggest that increasing age and the edentulous state results in diminishing and fading of the rugae which decreases their length.⁴

Determination of rugae shape is one of the main parameters of Kotze¹² classification system. The pattern seen in dentate group

was wavy followed by curved and circular. Straight rugae were the least. This shows that the dentate group in our study had the complex rugae shapes pattern. Grima¹⁸ found straight and curved shapes as the prominent ones followed by curved and wavy patterns in dentate group. The racial differences could be the reason of the variation in the shapes. The commonest pattern seen in edentulous group in our study was straight followed by curved and wavy, none had circular pattern just as Inas¹⁴ and Grima.¹⁸ These results depict that due to aging there is loss of complex shape patterns and edentulism state results in simpler shapes. The flattening of epithelium and its reduced thickening are the reasons for atrophy of rugae characteristics.⁴ Another important parameter that formed the base of the Kotze¹² classification system is the study of unification pattern. We observed the complexity in dentate as compare to edentulous group and results are in agreement with the studies of Preetinder⁴, Jawad¹⁷ however, Garima¹⁸ reported no difference of unification pattern. Regression in complex characteristics was also seen i.e., with unification pattern of divergence existed in edentulous group whereas converging was seen in dentate group. We believe that difference in the unification pattern in both groups is maybe due to the shape of palate. Due to increase in age a physiological process takes place as the adjacent teeth start migrating after tooth loss and rugae tend to straighten out in direction due to maxillary ridge resorption.⁴

The study of rugae direction is essential when rugae are being evaluated. Significant difference in forwardly directed rugae was found; dentate group having more forwardly directed, whereas perpendicular direction was found in edentulous group. Similar results were reported in the study done by Inas,¹⁴ Garima,¹⁸ and Preetinder⁴ but in contrast to Jawad.¹⁴ These shape differences we suggest maybe due to genetic and environmental expression.^{8,19-23} We suggest that significant changes had occurred in rugae positions at their lateral ends due to tooth loss and resulted in perpendicular pattern. Ohtani²⁴ and co-workers stated the same and proposed that this occurs due to the shape of edentulous palate resultant from the increase of age, teeth migration resultant more perpendicular pattern due to maxillary ridge resorption.²⁴

We found significant difference in different characteristics of rugae in dentate and edentulous groups and found that increasing age and the edentulous state results in fading of the rugae. Consideration should be given to the topographical changes as they have clinical significance and can affect dentures' support, retention and can alter phonetics.³⁻⁵ By knowing the extent of topographical changes in old patients we can better plan the restorative procedures by incorporating additional features that can enhance the denture stability support and retention.

The limitation of study was its small sample size and sampling technique. There is also degree of subjectivity in identification and classification; as wide range of classification systems has been proposed classifies rugae characteristics. However, we used length of rugae that is defining arbiter of primary and secondary rugae, dental casts for three dimensional assessments and with precise reproducibility. Further studies

needed to verify the findings in this study.

CONCLUSION

The aging process and tooth loss altered the topographical characteristics of palatal rugae and resulted in less number and complexity of characteristics in edentulous subjects as compared to dentate.

AUTHOR'S CONTRIBUTION

Naeem S: Conceived idea, Designed research, Proof reading

Zakir A: Statistical analysis

Manzoor M: Manuscript writing

Akram A: Data collection

Khan M: Literature review

Arshad F: Data collection

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