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TOPOGRAPHIC VARIATION OF PALATAL RUGAE AMONG THREE DIFFERENT ARCH FORMS

Dental Science

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ABSTRACT

Aim: To determine the association of arch form with the number, direction, unification and shape of palatal rugae.
Materials and methods: The total sample consisted of 90 edentulous subjects comprising of 30 U-shaped, 30 V-shaped and 30 ovoid shaped arch forms of the age ranging from 45-65 years. Their maxillary casts were examined for the palatal rugae number, direction, unification and shape.
Results: After analyzing the rugae patterns in three arch forms, some differences were observed.
Conclusions: Palatal rugae revealed a specific pattern in direction and unification among three different arch forms, but rugae number and shape did not give significant results.

KEYWORDS

Palatal Rugae, Arch form, Edentulous subjects.

INTRODUCTION

Palatal rugae or rugae palatinae or pilca palatinae transversae, are asymmetric ridges of dense connective tissues extending laterally, on both sides, from the incisive papilla and the anterior part of the median palatine raphae and are supplied by the greater palatine and nasopalatine branches.[1-3] These are widely distributed in mammals. They do not cross the midline but are easily seen and palpated, and can be felt with tongue. Histologically these are folds of epithelium that contain dense connective tissue with fine interwoven fibres. These fibres directly pass into the underlying bone. These are termed traction bands and make the rugae immovable structures. The purpose of palatal rugae is to aid in oral swallowing; improve the relationship between food and taste receptors in the dorsal surface of the tongue. Due to the presence of gustatory and tactile receptors they contribute to the perception of taste, texture of food qualities and tongue position during speech.[4]These important rugae functions encouraged many researchers to reproduce the individual palatal rugae on the dentures palatal surfaces.[5-7]

In Prosthodontics, rugae area plays an effective role:
It is a secondary stress bearing area that resists anterior displacement of the denture. It is considered as a part of the primary denture supporting area because it is not affected by resorption. Sometimes, rugae area is covered to provide indirect retention for free extended denture base, and there were efforts to use palatal rugae as a guide in positioning the artificial maxillary anterior teeth.[8-10]

In orthodontic treatment Palatine rugae can be used as internal dental-cast reference points for quantification of tooth migration.[11]

Palatal rugae first appear in 3rd month of intrauterine life and its growth is mutually controlled by epithelial mesenchymal interactions.[12] Once formed they experience changes in their size due to growth of the palate, but its shape is maintained.[13] Vander Linden proved that the anterior rugae do not increase in length after 10 years of age.[14] Significantly they are unique patterns in each individual and remain stable from the time of development until death[15]. Rugae patterns can contribute reliable details to forensic odontology in identification of the deceased as their anatomic position is less disturbed and remains protected even in extreme cases of trauma or incineration. They are well protected from heat as the lips, tongue and the buccal fat pads act as insulators.[2] Hence it can be useful as an identification method. If palatal rugae are destroyed, are reproduced exactly on the same site that had.[16]sometimes palatal rugae adjacent to the alveolar arch slightly change their position after tooth extraction.[17]

Arch form describes the position and relationship of the teeth to one another in all three dimensions. It can be considered as a result of the underlying skeletal morphology, the surrounding soft tissues, and any additional environmental effects. They are classified as square, tapering and ovoid.

Knowledge of arch form is essential
a. As an anatomical parameter in positioning and selection of anterior teeth for artificial prosthesis,
b. Number and stress distribution pattern of dental implants and stability of any prosthesis in Prosthodontics.

The purpose of this study is to describe the variation of the palatal rugae pattern among three different arch forms.

MATERIALS AND METHODS

The study population included 90 edentulous subjects aged between 45-65yrs who were devoid of congenital abnormalities, inflammation and trauma. The subjects were divided into three groups comprising of 30 patients each as Group 1- Subjects with thumb sucking habit, Group 2- Subjects with tongue thrusting habit & Group 3- Subjects without any history of habit The present study has utilised cast models to study the rugae pattern. The study population were explained about the objectives, study methodology and an informed consent was procured. Clearance for the study was obtained from the institutional ethical board. The patients were made to sit comfortably in the illuminated electrically operated dental chair. The backrest of the dental chair was raised to an angle of 45° for the maxillary impression. The dental chair was raised so that the operating area was at the level of elbow of the operator.

Maxillary impressions were recorded using irreversible hydrocolloid material and perforated edentulous stock trays of suitable dimension. The impression was poured with type III gypsum product & cast was separated from the impression after 60 minutes. The positive replicas of palatal rugae obtained on the cast were highlighted using0.3mm graphite pencil and were observed under adequate light and magnification.

Number analysis-Using brass wire and digital callipers (0.01mm) found the maximum length of all palatal rugae accounted and were classified depending on its length into
Primary rugae: 5mms or more
Secondary rugae: 3 to 5mm
Fragmentary rugae: 2 to 3 mm

Rugae smaller than 2mm were disregarded

Direction analysis- The direction of each main primary rugae was determined by measuring the angle between the line joining its origin and termination and a line perpendicular to the mid palatine raphae. Forward directed rugae were associated with positive angles, backward directed rugae with negative angles, and perpendicular rugae with angles of zero.

Unification analysis- Unification occurs when two rugae are joined at their origin or termination.

Diverging: if two rugae had the same origin from the midline but immediately branched.

Converging: rugae with different from midline, but which joined on their lateral portions.

Shape analysis. The shape of the palatine rugae was registered according to the classification of Trobo. Classification divides rugae into two groups: simple rugae, classified from A to F and composed rugae, classified with the letter X. Composed rugae result from two or more simple rugae unions. The rugogram is made from right to left, beginning with the principal rugae (the one closest to the raphae), which is classified with a capital letter. The following rugae are classified with small letters. Finally, the left side of the palate is described using the same criteria.[12]

All the details from each dental model were documented. Association between rugae pattern and arch form were tested by unpaired t- test.

RESULTS: All the 90 working casts showed different rugae patterns and each individual had a different set of rugae pattern.

Number vs Arch forms
A total of 765 palatal rugae were observed in 90 subjects. Average number of rugae found in each individual was 8.5 of which 4 to 5 rugae on each side of the palate. On comparing three arch forms Primary rugae were more in number in U-shaped arch and least in ovoid arch form but no statistically significant difference was found in Primary rugae between the three arch forms. Secondary rugae & fragmentary rugae were more in number in ovoid arch but it was not statistically significant (Table 1 & graph 1).

Table 1: Association between arch forms and mean number of palatal rugae

Rugae	U-Shaped Arch		V-Shaped Arch		Ovoid-Shaped arch		t-Value	P-Value
	Mean	S.D	Mean	S.D	Mean	S.D		
Primary	3.85	0.89	3.6	0.47	3.1	2.9	0.11	0.5
Secondary	0.20	0.49	0.18	0.51	0.63	0.55	0.47	0.4
Fragmentary	0.04	0.20	0.06	0.13	0.19	0.17	0.14	0.4
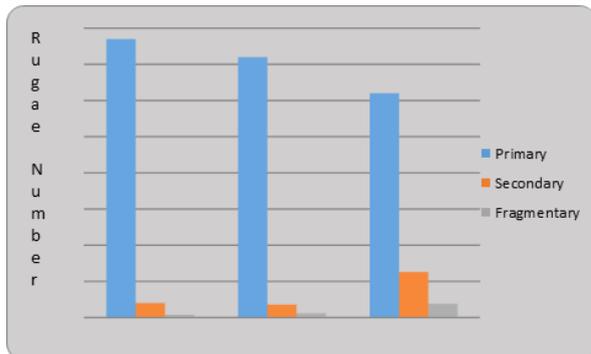
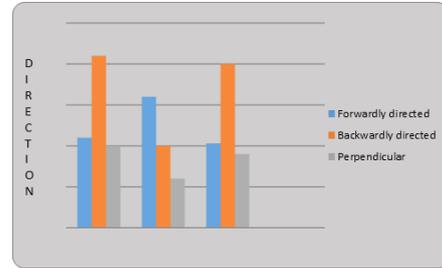**Graph 1: Distribution of palatal rugae number in three different arch forms**

Direction vs Arch form
When the direction of rugae was compared in different arch forms of the study population, backwardly & perpendicular directed rugae were more common in U-shaped & Ovoid shaped arch and it is statistically significant. Forwardly directed rugae were more common in the V-shaped arch and it was also statistically significant (Table 2 & graph 2).

Table 2: Association between arch forms and mean of palatal rugae direction

Direction	U-Shaped Arch		V-Shaped Arch		Ovoid-Shaped arch		t-Value	P-Value
	Mean	S.D	Mean	S.D	Mean	S.D		
Forwardly	1.1	0.35	1.6	0.47	1.03	0.47	2.48	0.03
Backwardly	2.1	0.29	1.0	0.51	2.0	0.44	2.27	0.04
Perpendicular	1.0	0.30	0.6	0.53	0.9	0.53	2.94	0.04

Table 2: Association between arch forms and mean of palatal rugae direction
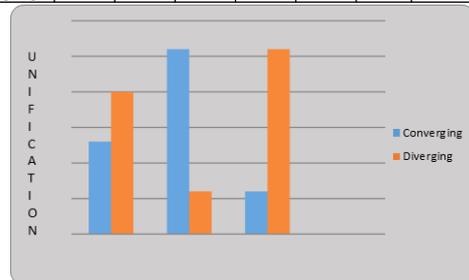

Graph 2: Distribution of palatal rugae direction in three different arch forms

Unification vs Arch form
The results for unification of rugae in three different arch forms showed that Divergence of rugae was more among U & Ovoid arch forms which is significant and the Convergence of rugae was more, in the V-shaped arch form which is also statistically significant (Table 3 & graph 3).

Table 3: Association between arch forms and mean palatal rugae unification

| Unification	U-Shaped Arch		V-Shaped Arch		Ovoid-Shaped arch		t-Value	P-Value
	Mean	S.D	Mean	S.D	Mean	S.D		
Converging	0.13	0.32	0.26	0.53	0.06	0.52	2.08	0.01
Diverging	0.2	0.41	0.06	0.34	0.26	0.53	2.25	0.01

Graph 3: Distribution of palatal rugae unification in three different arch forms

Shape vs Arch form
In the distribution of rugae shape, the sinuous shaped pattern appeared to be most predominant in three arch forms. Among three arch forms sinuous is most predominant in U- shape followed by V and Ovoid shape, but it was not statistically significant. After sinuous, curved shape is most predominant in U-shape & Ovoid shape arch. Line shaped pattern was most predominant in V-shape arch which is also statistically insignificant (Table 4 & graph 4).

Table 4: Association between arch forms and mean of palatal rugae shape

Shape	U-Shaped Arch		V-Shaped Arch		Ovoid-Shaped arch		t-Value	P-Value
	Mean	S.D	Mean	S.D	Mean	S.D		
A	0.13	0.65	0.05	0.91	0.03	0.92	1.21	0.88
B	0.53	0.80	1.10	0.94	0.46	1.11	1.12	0.84
C	0.90	1.12	0.46	1.11	0.86	0.89	1.05	0.81
D	0.10	0.92	0.06	0.56	0.08	0.97	1.64	0.89
E	2.73	0.61	1.93	0.62	1.1	0.71	1.89	0.93
F	0.03	0.59	0.02	0.82	0.02	0.72	1.83	0.96
X	0	0	0	0	0	0	0	0
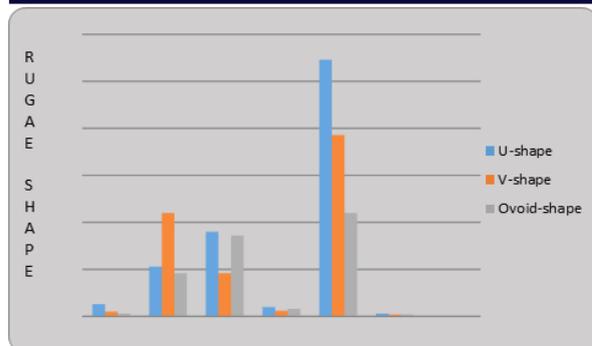
Graph 4: Distribution of palatal rugae shapes in three different arch forms

DISCUSSION

Palatoscopy or palatal rugoscopy is the name given to the study of palatal rugae in order to establish a individual identity.[18] The analysis of human palatal rugae has been suggested as an alternative method for identification in 1889 by Allen. Palatal rugae are highly individualistic and consistent in shape throughout life. Palatal rugae is used as an aid in forensic investigations primarily for population differentiation and personal identification with minimal contribution towards sexual dimorphisms. Therefore gender of the patient has not been taken into consideration in this study. Till now studies have not investigated the palatal rugae pattern changes in different arch forms. The present study was designed to evaluate the relation between rugae pattern and arch form. Various methods of palatal rugae analysis are available currently. In this study dental casts were used for rugae analysis because they simplify analysis, reduce cost and can be easily done in any laboratory.[19] For a more accurate result, the use of cast made from jaws rather than the dentures were suggested.[20] Training was needed to achieve results without errors but eyestrain was a problem and rest intervals were required to minimize the errors that could occur if the quantitative scale was retained. Several classifications have been devised by various authors to record the palatal rugae patterns;

Among them, the Thomas and Kotze, Kapali, Trobo classifications are often used in recording the patterns. After a thorough review of all classifications in literature, Trobo classification was used in the study which is most practical and easy to apply compared with other methods.

According to the present study, primary rugae were more predominant in U-shaped arch and least in Ovoid arch form where as Secondary rugae & fragmentary rugae were more in number in ovoid arch.

Total number of primary rugae was more on right side compared to the left; however it was not statistically significant. In contrast, a study done by Dipshikha Bajracharya et al. found left side of palatal rugae to be dominant.[21] Average number of rugae found in each individual was 8.5 of which 4 to 5 rugae on each side of the palate.

In our study sinuous pattern was predominant followed by curved and least was circled. This observation was in contrast to Eboh et al who reported that the commonest palatal rugae shapes were line followed by sinuous.[22] In U-shaped arch form predominant rugae were sinuous followed by curved, line & least is circle. In V-shaped arch form predominant rugae were sinuous followed by line, curved and least is circle. In ovoid arch form predominant rugae were sinuous followed by line, curved and least is circle & angle. In this study complex rugae were completely absent This is agreement with the result of Ohtani *et al* who stated that in edentulous patients, features like poorly demarcated rugae and non complex rugae pattern are mainly due to the shape of the edentulous palate itself and rarely due to the dentures.[23] where asIshizaki K et al, stated that continuous mechanical stimulation can result in much morphological degeneration in the palatal mucosa involving rugae.[24] No significant difference was found in the shapes of rugae between three arch forms.

Backwardly directed rugae were more in U-shaped & Ovoid arch on both sides followed by the forwardly directed rugae. Forwardly directed rugae were more in V-shaped arch on both sides followed by backwardly directed rugae. This observation was in contrast to Inas A Jawad et al, who reported that percentage of forward directed rugae is greater than that of backward directed ones in edentulous group.[25]

Divergnaes of rugae were more in U & Ovoid arch forms were as Convergence of rugae were more in V-shaped arch form without much difference between right and left.

No previous studies investigated the palatal rugae changes in different arch forms. Therefore comparison with other results cannot be achieved. Further investigations are needed study the influence of bone resorption on the palatal rugae changes.

CONCLUSION - Palatal rugae revealed a specific pattern in Direction and unification among three different arch forms, but rugae number and shape did not give significant results. However, these interpretations are based on limited sample size. Further research is indicated with a larger sample size in order to validate our findings and application of advanced statistical methods in attaining better accuracy levels to find out variations of rugae patterns in different arch forms.

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