

“Impact of Extraction in Preservation of Palatal Rugae Pattern as a Personal Identification Marker- A Prospective Study”

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Abstract

Rugae patterns are used in forensic investigations, owing to its uniqueness. In severely deceased burn victims, palatal rugae aid in identification process due to the resistance of hard palate. However changes in rugae form seen in diseases or trauma are intense in nature to alter identification process. Studies focusing on the effects of growth, tooth loss, or its combination are very few. Hence, the present study was carried out to determine the influence of tooth loss following extraction on rugae pattern in dentulous maxillary arch. A total of 25 patients with completely or partially dentulous maxillary arch indicated for extraction were selected based on inclusion and exclusion criteria. Following consent, Impressions of maxillary arch of patients were made using irreversible hydrocolloid material, and a cast was poured. The procedure was repeated over a period of 6 months after extraction and the rugae patterns traced every month were compared with the previous cast. All the observations were subjected to statistical evaluation. Based on the rugae pattern it was observed that line (mean $1.0 \pm S.D$ 1.22), curved (1.3 ± 1.37) and sinuous (1.9 ± 1.56) patterns were predominant while circular, interrupted and trifurcated rugae patterns were less common. Though the frequency of circular rugae was low; conversely, it showed a high statistically significant difference between post-extraction follow up ($P < 0.001^*$) in their mean followed by Line and bi-furcated rugae pattern. We conclude that rugae patterns are not always consistent, as they are susceptible to changes during extractions that can alter substantial identification process.

Keywords: Alveolar bone, edentulous arch, Forensic investigations, Post-Extraction, Rugae pattern, Soft tissue identification.

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INTRODUCTION

Identification of any individual for forensic investigations, social and medico-legal purposes can be a challenging task. Most commonly positive identification methods such as fingerprint analysis, dental records and DNA comparison were employed in establishing individual identity [1]. However in difficult situations where the body is severely burnt or decomposed these methods are unfavorable to arrive at a conclusion. Several studies have shown that palatal rugae patterns may be considered as an alternative method of identifying a deceased individual based on comparison of ante-mortem and postmortem reports in establishing personal identity [2].

Palatal-Rugae refer to a series of transverse ridges on either side of the median palatal raphe and on the anterior part of the palatal mucosa behind the incisive papillae. It is a well-established fact that the rugae pattern is unique to every human being and maintains their shape throughout life once formed during third month of intra- uterine life and is present from birth in the anterior third of the palatal mucosa which remains unchanged until the oral mucosa degenerates after death [3]. Being the soft tissue protected by the lip, cheeks, dento-alveolar apparatus including teeth and buccal pad of fat, they resist decomposition and remain stable during high or extreme temperatures and also resist destruction by trauma or surgical procedures [4]. It also serves as a

tool for identification in edentulous patients, when teeth cannot be used for identification [5].

In the recent years, studies have shown that the typical arrangement of the rugae does not change due to growth and remains unchanged from fetus to death however events, such as physical injury, habitual finger sucking from infancy, orthodontic treatment, and dentures can cause change in these rugae patterns [6]. Changes in rugae form seen in diseases, chemical aggression, or trauma are less intense than those which happen to the whole body [7]. Studies focusing on the effects of growth, extractions, palatal expansion, or a combination of these are very few. Hence the present study was carried out to determine the influence of tooth loss following extraction on these rugae pattern in the dentulous maxillary arch and also to find whether rugoscopy can be a useful personal identification tool as they are susceptible to changes influenced by the loss of teeth.

MATERIALS AND METHODS

The present prospective study was carried out in the Department of Prosthodontics and Implantology, Sathyabama Dental College, Chennai. A total of 25 patients having completely and/or partially dentulous maxillary arch indicated for extraction were selected based on several inclusion criteria such as Patients with mobile teeth or periodontally compromised teeth, undergoing full mouth extraction, multiple teeth missing indicated for total and/or partial extraction for full mouth rehabilitation were included in the study. Individuals with palatal asymmetries, with a history of palatal surgery or orthodontic treatment, and with lesions causing mucosal or bony changes in the maxillary anterior region were excluded. Patients were selected only based on the criteria mentioned and were independent of age, gender, dietary habits and other external factors. After the institutional ethical committee clearance and a written consent from patient, a detailed history of all the patients was recorded.

Impression of maxillary arch of patients were made using irreversible hydrocolloid (alginate) material, and a cast was poured using type V gypsum (die stone) depending on the levels of rugae prominences. The rugae pattern was traced using graphite pencil and trace paper and the different patterns (Figure 1) were identified based on the classification of Martins dos Santos (Figure 2) which presented a practical classification based on rugae location [8]. Patients were recalled after one month and a similar procedure was done (Figure 3). It was compared with the old cast. This procedure was repeated over a period of 6 months (Figure 4) by recalling all the patients on monthly basis. The patterns were traced after making a new impression and model every month and compared with the previous month. All the observations were tabulated and sent for statistical evaluation.



Fig-1: Image showing the tracing of different rugae pattern on the dentulous cast of the study subjects

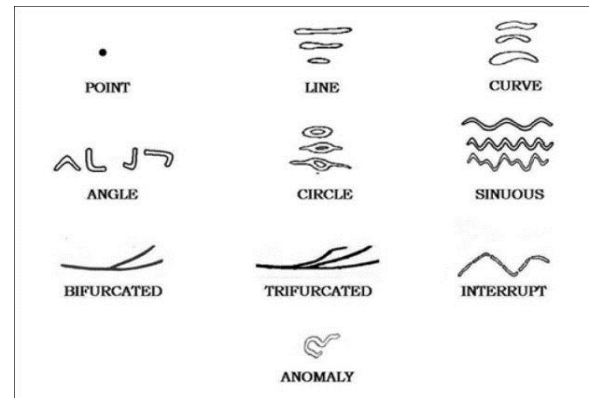


Fig-2: Representative image of Martins dos Santos Palatal rugae classification



Fig-3: Tracing of rugae pattern on the individual cast obtained 3-month post extraction

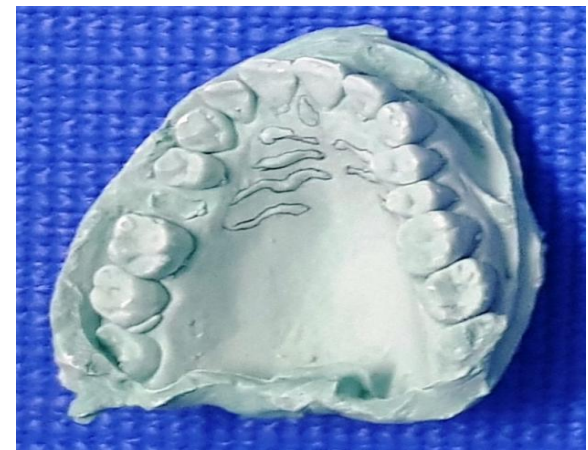


Fig-4: Tracing of rugae pattern on the cast obtained 6-month post extraction

STATISTICAL ANALYSIS

To analyze the data, Statistical Package for the Social Sciences (SPSS) version 20 was used. Descriptive statistics and inferential statistics have been applied to evaluate the results. The level of significance was set at 5%. The data obtained are not normally distributed therefore non parametric analysis by Mann-Whitney U-test analysis was performed.

RESULTS

This study revealed that no two palates are alike in their configuration, with each presenting an organized pattern of rugae specific to the individual. Based on the rugae pattern it was observed that the line (mean $1.0 \pm S.D$ 1.22), curved (1.3 ± 1.37) and sinnous (1.9 ± 1.56) patterns were predominantly common while circular (0.1 ± 0.18), interrupted (0.1 ± 0.27) and trifurcated (0.1 ± 0.24) rugae patterns were less common among the study population (Table 1). It was also observed that the predominant patterns, sinnous, curved and line were found to be more on the left while the less predominant patterns, circular and interrupted of rugae were more on the right side.

Table-1: Table showing the mean observations of different types of rugae patterns before tooth extraction

Variables	Mean \pm S.D
Line	1.0 ± 1.22
Curve	1.3 ± 1.37
Sinnous	1.9 ± 1.56
Point	0.3 ± 0.63
Bifucated	0.9 ± 0.22
Trifurcated	0.1 ± 0.24
Angle	0.3 ± 0.54
Anomaly	0.1 ± 0.31
Interrupt	0.1 ± 0.18
Circle	0.1 ± 0.27

The associations between post-extraction follow up and mean number of palatal rugae was calculated (Table 2). The frequency of circular rugae was least; however, it showed a high statistically significant difference ($P < 0.001^*$) in their mean followed by Line ($P < 0.002^*$) and bi-furcated ($P < 0.035^*$) rugae pattern.

Table-2: Table showing the mean Comparison Based on Various Parameters Using Mann-Whitney U Tests.

Variables	3 months follow-up		6 months follow-up		Z value	p value
	Mean	S. D.	Mean	S. D.		
Line	1.4	1.39	2.6	1.71	-3.074	0.002*
Curve	1.4	1.48	1.5	1.54	-0.382	0.702
Sinnous	2.1	1.65	2.2	1.74	-0.209	0.834
Point	0.3	0.69	0.2	0.43	-0.693	0.488
Bifucated	0.6	0.81	0.3	0.61	-2.103	0.035*
Trifurcated	0.1	0.27	0.0	0.00	-1.755	0.079
Angle	0.3	0.70	0.2	0.49	-0.382	0.702
Anomaly	0.1	0.38	0.0	0.00	-1.755	0.079
Interrupt	0.1	0.32	0.0	0.00	-1	0.317
Circle	0.1	0.52	0.6	0.78	-3.72	0.001**

p value $< 0.05^*$ - Statistically significant. p value $< 0.001^{**}$ - Highly significant.

DISCUSSION

Palatal rugae aid in personal identification process owing to its uniqueness, post-mortem resistance, and dependability. Several authors showed the diversity of rugae patterns among different ethnic groups with different results [9]. In the present study it was observed that the line (straight), curved and sinnous (wavy) patterns were predominantly common while circular, interrupted and trifurcated rugae patterns were less common among the study population. Our study findings were consistent with the study done by Kapili *et al.* in Australian Aborigines and Cacusians [10], Nayak *et al.* in South and West Indian Population [11] and Gautam N *et al.* among North Indian population [7]. However, our results were in contrary to the study conducted by Paliwal *et al.* [12] and Kallianpur *et al.* [13] who observed that the predominant shape was wavy among the study group. These findings indicate racial and gender differences in rugae patterns play a very important role in personal identification process.

The stability of the palatal rugae is considered as an important factor when teeth are extracted for various orthodontic and full mouth rehabilitation purposes. In the present study though the frequency of circular rugae was least; however, it showed a high statistically significant difference in their mean followed by Line and bi-furcated rugae pattern following extraction indicate and contribute to similar studies by Pooja *et al.* [14], Hoggan *et al.* [15], Gupta M *et al.* [16], Peavy DC Jr [17] who illustrated that palatal rugae adjacent to the alveolar arch slightly change their position after tooth extraction. Furthermore Limson *et al.* [18] reported that extraction can make a local effect on the direction of the palatal rugae.

In the present study it was also observed that the patterns like circular, line, bifurcated and curvy were found to be more on the left adjacent to the alveolar arch while the other patterns are more on the posterior regions. These findings are similar to studies

done by Rajguru *et al.* [19], Pandey *et al.* [20], Pooja *et al.* [14], Hoggan *et al.* [15] who demonstrated that the more posterior rugae are less vulnerable to changes with tooth movement when compared to anterior rugae. Nonetheless Bhat G [21], Limson *et al.* [18] suggested that some events may contribute to changes in the pattern of palatal rugae such as finger sucking in childhood and persistent pressure due to orthodontic treatment.

Our study reveals that no two palates are alike in their configuration, with each presenting an organized pattern of rugae specific to the individual. The most predominant patterns were line, curved and sinuous patterns in the study population. However, there exists a statistically significant difference between post-extraction follow up and palatal rugae pattern such as circular, line and bifurcated type. This may be attributed to the significant changes occurring in the rugae position especially at their lateral ends which were believed to follow the direction of tooth migration that occurs after loss of adjacent teeth, in correlation with the bone resorption at the maxillary arch circumference. Thus uniform standards and procedures for palatal rugae pattern collection, recording in edentulous cases have to be established which could facilitate identification consequently serving as an adjunct tool in forensic science.

CONCLUSION

The absence/loss of teeth due to extraction should be considered as an important tool in personal identification using palatal rugae examination since continuous forces exerted by chewing and mechanical stimulation can result in morphological degeneration in the palatal mucosa involving rugae. The present study revealed that the rugae patterns are not consistent as they are susceptible to changes occurring during extractions and tooth movement that significantly alter the pattern of rugae. Further studies should be carried out to rule out the controversies concerning the factors affecting palatal rugae pattern to establish itself as a significant forensic dental marker in personal identification process.

Ethical Clearance

Obtained from Institutional Ethical Committee, Sathyabama Dental College, Chennai.

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