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Assessment of Palatal Rugae Changes Following Orthodontic Treatment and Awareness Amongst Dental Students: A Comparative Study

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KEYWORDS
Palatal rugae, Forensic science, Personal identification, Dental casts, Rugae pattern, Undergraduate students, Postgraduate students

ABSTRACT:

Introduction: Palatal rugae are irregular ridges of mucosa located on the anterior third of the hard palate, extending laterally from the mid-palatal raphe behind the incisive papilla. These structures are unique to every individual, much like fingerprints and remain relatively stable throughout life. The distinct patterns of palatal rugae provide a basis for observation and documentation, making them valuable in forensic science for personal identification.

Objectives: To compare the shape and length of rugae before and after orthodontic treatment and to evaluate the level of knowledge regarding palatal rugae among undergraduate and postgraduate dental students.

Methods: 60 pre-operative and 60 post-operative dental casts were selected from the archives of the Department of Orthodontics and Dentofacial orthopaedics, GDCHJ. The shape of the rugae was marked and length of the rugae was measured using vernier caliper. Total 120 participants including post-graduate and undergraduate students were selected as evaluators. They were instructed to mark and note the shape of the rugae on dental casts and length of the rugae was measured by postgraduate students. The data collected was statistically analysed using appropriate statistical methods.

Results: Overall analysis revealed that orthodontic treatment has a minimal effect on the shape of the rugae, out of 120 participants only 13 participants (10.8%) noted change in the shape while 107 participants (89.2%) noted no change in the shape of rugae. In contrast, changes in the rugae length were commonly observed, with 103 participants (85.8%) noting alterations in rugae length and only 17 participants (14.2%) reported no change in the length of the rugae after orthodontic treatment.

Conclusions: Overall, the finding support the concept that palatal rugae, particularly in terms of shape, are relatively resistant to alteration by orthodontic treatment, reinforcing their potential value in forensic identification.

1. Introduction

Forensic science plays a crucial role in the scientific investigation of crimes and the administration of justice. Forensic odontology, a specialized branch of forensic science, focuses on the proper management, analysis, and interpretation of dental evidence for legal purposes. It involves the identification of individuals through dental features such as teeth, bite marks, and other oral structures, which are often encountered in cases of child abuse, sexual assault, mass disasters, and unidentified human remains. Dental identification is considered a reliable method of personal identification; however, its accuracy largely depends on the availability of antemortem dental records. [1]

Human identification in forensic medicine commonly relies on distinctive features such as fingerprints, DNA profiling, and dental records. However, in situations where these conventional methods are unavailable or compromised—such as in cases of severe burns, decomposition, or trauma—the palatal rugae can serve as a valuable alternative. These anatomical ridges exhibit unique and individual-specific patterns, making them

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useful for personal identification in forensic investigations. [2]

Palatal rugae, also known as *plicae palatinae transversae* or *rugae palatinae*, are irregular, asymmetrical ridges of the mucous membrane situated on the anterior third of the hard palate. They extend laterally from the mid-palatal raphe, originating near the incisive papilla, and are arranged in a transverse pattern. These anatomical structures are formed by folds of connective tissue and play an important role in oral physiology and forensic identification. [3]

Palatoscopy, also known as palatal rugoscopy, refers to the study of palatal rugae patterns for the purpose of establishing a person's identity. This technique was first introduced in 1932 by the Spanish researcher Trobo Hermosa. Palatal rugae are considered valuable in forensic investigations because of their protected intraoral location, remarkable stability, and permanence throughout life. In addition to their forensic significance, the analysis of palatal rugae has applications in sex determination, orthodontic diagnosis, and forensic odontology.[2] The present study was aimed to assess the potential of palatal rugae as a tool in forensic science for individual identification and to evaluate the level of knowledge regarding palatal rugae among undergraduate and postgraduate dental students.

CLASSIFICATION OF PALATAL RUGAE

Several classifications of rugae patterns have been proposed; however, for identification purposes, the most commonly used classifications are as follows:

1. Kapali *et al* classification [1] [Figure:1]
2. Thomas classification [4] [Figure:2]
3. Trobo Classification [1] [Figure:3]

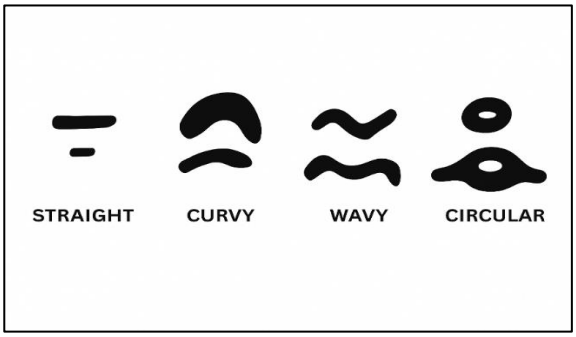

Figure 1. *Kapali et al classification*

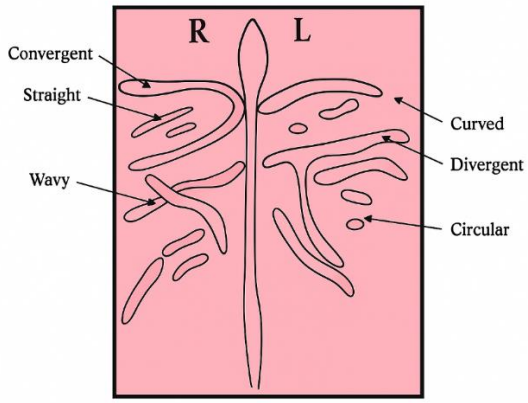

Figure 2. *Thomas classification*

Classification	Rugae type	Shape
Type A	Point	
Type B	Line	
Type C	Curve	
Type D	Angle	
Type E	Sinuous	
Type F	Circle	

Figure 3. *Trobo classification*

2. Objectives

To compare the shape and length of rugae before and after orthodontic treatment and to evaluate the level of knowledge regarding palatal rugae among undergraduate and postgraduate dental students.

3. Methods

This study was conducted in the Department of Oral and Maxillofacial Pathology and Oral Microbiology at Government Dental College and Hospital, Jamnagar. 60 orthodontic casts of patients were obtained from the archives of the Department of Orthodontics and Dentofacial orthopedics, GDCHJ for this study. These

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120 casts were divided into 2 groups. The first group of 60 pre-operative and the second group of 60 post-operative orthodontic casts.

The rugae pattern on all the casts was delineated using a sharp graphite pencil under adequate light and magnification according to the classification given by Thomas *et al* [(4)] (Figure: 2). The shape of the rugae was assessed. The length of the rugae was measured with the help of Vernier caliper on either side of mid-palatine raphe and then readings was recorded. Total 120 participants including post-graduate and undergraduate students were selected as evaluators, in this study group-1 includes third year students, final year students and group- 2 include interns and postgraduate students from the Department of Oral & maxillofacial Pathology and oral Microbiology.

Materials

60 pre-operative orthodontic casts

60 post-operative orthodontic casts

Graphite pencil

Digital Vernier caliper

Figure 4. *Figure showing pre- and post- orthodontic casts, graphite pencil and digital vernier caliper*

4. Results

The data was inputted into the computer (MS word-Excel) and analyzed statistically through utilization of SPSS version 20.0. A significance level of ≤0.05 was established. The comparison of group with rugae shape and rugae length was assessed by using Chi-square test.

The present study evaluated 120 participants to determine changes in the shape and length of palatal rugae following orthodontic treatment and compared these changes between two academic groups: Group-1 (BDS 3rd and 4th year students) and Group-2 (Interns and postgraduate students).

Overall distribution of rugae shape

Assessment of rugae shape showed that only a small proportion of participants exhibited changes following orthodontic treatment. Out of 120 participants, 13 (10.8%) reported a change in rugae shape, whereas the majority, 107 participants (89.2%), showed no change in rugae shape (Table:1). This finding suggests that orthodontic treatment has a minimal effect on the shape of palatal rugae.

Table 1. *Shows the distribution of study participants based on rugae shape response. Out of the total 120 participants 13(10.8%) noted change in the shape of rugae after orthodontic treatment while 107(89.2%) noted no change in rugae shape after orthodontic treatment.*

RUGAE SHAPE	NUMBER	PERCENTAGE
YES	13	10.8%
NO	107	89.2%
Total	120	100%

Yes= Change in rugae shape, No= No change in rugae shape

Overall distribution of rugae length

In contrast to rugae shape, changes in rugae length were commonly observed. A total of 103 participants (85.8%) reported changes in rugae length following orthodontic treatment, while only 17 participants (14.2%) showed no change (Table:2). This indicated that orthodontic therapy is more likely to influence rugae length than rugae shape.

Table 2. *Shows the distribution of study participants based on rugae length response. Out of the total 120*

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participants 103(85.8%) noted change in the rugae length after orthodontic treatment while 17(14.2%) noted no change in length of the rugae after orthodontic treatment.

RUGAE LENGTH	NUMBER	PERCENTAGE
YES	103	85.8%
NO	17	14.2%
Total	120	100%

Yes= Change in rugae length, No= No change in rugae length

Intergroup comparison demonstrated a statistically significant difference in responses for both rugae shape and length. For rugae shape, group-1 showed a higher proportion of reported changes (20.0%) compared to group-2 (1.7%), with the difference being statistically significant (P=0.002) (Table:3). regarding rugae length, group-2 exhibited a greater proportion of changes (93.3%) than group-1 (78.3%) and this difference was also statistically significant (P=0.034) (Table:4).

Table 3. *Shows the study participants based on Group. Out of the total 120 participants, 13(10.8%) noted change in the rugae shape after orthodontic treatment while 107(89.2%) noted no change in the shape of the rugae after orthodontic treatment. Group-1 (n=60) of undergraduates BDS 3rd Year and 4th Year participants, 12(20.0%) noted change in the shape of the rugae while 48(80.0%) noted no change in the shape of the rugae after orthodontic treatment. Group-2 (n=60) of Intern and PG participants, 1(1.7%) noted change in the shape of the rugae while 59(98.3%) noted no change in the shape of the rugae after orthodontic treatment.*

RUGAE SHAPE	3rd YEAR and 4th YEAR (Group- 1)	INTERN and PG (Group-2)	TOTAL
YES	12 (20.0%)	1 (1.7%)	13 (10.8%)
NO	48 (80.0%)	59 (98.3%)	107 (89.2%)
Total	60 (100.0%)	60 (100.0%)	120 (100.0%)
p value = 0.002*			

*Level of significance p value ≤0.05, *Significant, **Non-significant*
Yes= Change in rugae shape, No= No change in rugae shape

Table 4. *Shows the study participants based on Group. Out of the total 120 participants, 103(85.8%) noted change in the length of the rugae while 17(14.2%) noted no change in the length of the rugae after orthodontic treatment. Group-1 (n=60) of undergraduates BDS 3rd Year and 4th Year participants, 47(78.3%) noted change in the length of the rugae while 13(21.7%) noted no change in the length of the rugae after orthodontic treatment. Group-2 (n=60) of Intern and PG participants, 56(93.3%) noted change in the length of the rugae while 4(6.7%) noted no change in the length of the rugae after orthodontic treatment.*

RUGAE LENGTH	3rd YEAR and 4TH YEAR (Group-1)	INTERN and PG (Group-2)	TOTAL
YES	47 (78.3%)	56 (93.3%)	103 (85.8%)
NO	13 (21.7%)	4 (6.7%)	17 (14.2%)
Total	60 (100.0%)	60 (100.0%)	120 (100.0%)
p value = 0.034*			

*Level of significance p value ≤0.05, *Significant, **Non-significant*
Yes= Change in rugae length, No= No change in rugae length

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5. Discussion

Palatal rugae serve as a valuable aid in forensic dentistry due to their anatomical protection and inherent stability. Situated within the oral cavity, they are well-shielded from external insults and post-mortem changes by surrounding oral structures, including teeth and soft tissues, which enhances their resistance to decomposition. Moreover, the individualized pattern, comparable to fingerprints enables reliable personal identification. [5]

Palatoscopy as a method of human identification was introduced in the late nineteenth century, with Harrison Allen (1889) proposing its use as an alternative means of personal identification. The anatomical features central to palatoscopy, namely the palatal rugae, were recognized much earlier, they were initially described by Winslow in 1753 and subsequently illustrated in detail by Santorini in 1775, laying the foundation for their later application in forensic science. [6]

Palatal rugae are believed to exhibit long-term morphological stability and are generally considered resistant to changes induced by orthodontic treatment. [7] Our study evaluated the effect of orthodontic treatment on the shape and length of palatal rugae and compared observations between undergraduates, interns and postgraduates. The finding of our study demonstrated that changes in palatal rugae shape were minimal, with only 10.8% of participants showing alterations following orthodontic treatment. This supports that rugae shape remains relatively stable despite orthodontic intervention. In contrast, a high proportion of participants (85.8%) exhibited changes in rugae length following orthodontic treatment. This suggests that although the morphology of rugae is preserved, their linear dimensions may be susceptible to modification.

Different studies conducted by Shetty *et al* and Shukla *et al* to evaluate the stability of rugae patterns in pre- and post-operative orthodontic casts. They concluded that changes may occur in bony structures during orthodontic treatment but rugae patterns remain stable and can be used in forensic odontology. [8,9]

Bansode *et al* conducted a study to determine the stability of palatal rugae during fixed orthodontic treatment on pre- and post-operative orthodontic casts. They have stated that in the cases of arch expansion, the morphology of the rugae was not altered, but there was increase in the length of the rugae. [10]

Similar studies conducted by Deepak *et al* and Smitha *et al* stated that when ante-mortem data are available, palatal rugae patterns can be used to confirm identity, making them useful in forensic medicine. However, orthodontic treatment may influence the stability of palatal rugae; therefore, investigators should take this into consideration during identification. [11,12] Similar study done by Bavaresco *et al* stated that application of palatal rugae in forensic identification should be avoided in patients who have undergone invasive orthodontic treatment particularly maxillary expansion and dental extraction. [13]

Hashim A *et al*, Padhye V *et al* conducted similar studies they concluded that detailed evaluation of palatal rugae patterns may have a definite role in forensic identification. [14,15]

According to the present study, the findings indicated that orthodontic treatment has a minimal effect on the shape of palatal rugae but a substantial influence on rugae length. Additionally, significant variations were observed between undergraduate students, interns and postgraduate students in reporting changes, highlighting possible variations in clinical exposure, observation skills or interpretative ability across academic levels.

6. Conclusion

Based on the findings of the present study, it can be concluded that orthodontic treatment has a differential effect on palatal rugae, with rugae length being significantly more affected than rugae shape. The majority of participants demonstrated changes in rugae length following orthodontic therapy, whereas changes in rugae shape were observed in only small proportion of cases, indicating that rugae shape remains relatively stable. The finding supports the concept that palatal rugae in terms of shape are relatively resistant to alteration by orthodontic treatment, supporting their reliability and potential utility in forensic identification. Nevertheless, the significant changes observed in rugae length suggest that this parameter may be influenced by orthodontic intervention and should therefore be interpreted with caution when considered as a stable anatomical landmark.

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