Comparative study of palatal rugae pattern in class II div 1 and class I individuals

Chandrasekhar Gandikota, Yudhister Palla Venkata¹, Padmalatha Challa¹, Shubhaker Rao Juvvadi, Anirudh Mathur²

ABSTRACT

Aims: To determine if the palatal rugae have a characteristic pattern in untreated class II div 1 malocclusions compared to normal class I occlusions, and to provide a valuable insight whether palatal rugae can be taken up as additional criteria for classifying malocclusions. Materials and Methods: The study was conducted on initial maxillary dental casts of 24 individuals with untreated class II div 1 malocclusion with an overjet of minimum of 5mm, of whom 12 were females and 12 were males, with age ranging from 16 to 24 years and compared with Class I patients casts. Results: There was no statistically significant difference in the mean intermolar widths of the two groups. The first, second and third palatal rugae were shorter in class II div 1 patients than in class I patients which was statistically significant. All the patients with Angle’s class I occlusion had good pattern of palatal rugae falling in the score range of 1–3, whereas 22% of the patients with class II div 1 had poor pattern of palatal rugae, with score 4 and 2 patients exhibiting a score of 4 and 5, respectively, but this was not statistically significant. Conclusion: There was a significant constriction of the palatal rugae in class II div 1 individuals as compared to class I individuals, though they were matched for the same intermolar widths. There was a distinct pattern of palatal rugae between the two groups.

KEY WORDS: Palatal rugae, class II div 1 malocclusion, class I malocclusion, intermolar widths

Palatal rugae are the ridges situated in the anterior part of the palatal mucosa on each side of the median palatal raphe and behind the incisive papilla [Figure 1]. Goria¹ defined the rugae as the ridges that extend at least one-half the distance from the median palatal raphe to the dental arch. The palatal rugae appear toward the 3rd month of intrauterine life, from the covering connective tissue in the palatine process of maxillary bone, and its development and growth is mutually controlled by epithelial-mesenchymal interactions, where specific extracellular matrix molecules are spatiotemporally expressed during development.² The first rugae are distinguished in human embryos of 32-mm Crown-rump length (CRL) next to the incisive papilla.³ Then, in the prenatal stage, they are relatively prominent,⁴ the palatal rugae at birth are well trained with a typical orientation pattern and during adolescence they acquire the final feature shape of each individual.⁵ Once formed, they may experience changes in their size due to growth of the palate, but their shape is maintained.⁶,⁷ Physiologically, the palatal rugae are involved in the oral swallowing and help to improve the relationship between food and the taste receptors in the dorsal surface of the tongue.³ They also participate in speech and in suction in children.⁸ The palatal rugae form elevations more or less prominent and take various configurations. The stability of palatal rugae as a landmark for dental cast analysis was reported by Almeida et al.,⁹ Bailey et al.,¹⁰ and Patil et al.¹¹ Form, layout, and characteristics are not affected by the eruption of the teeth or their loss, but sometimes

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palatal rugae adjacent to the alveolar arch slightly change their position after tooth extraction.\[12\] However, some events may contribute to changes in the pattern of PR, such as finger sucking in childhood and persistent pressure due to orthodontic treatment. Furthermore, it has been reported that extractions can produce a local effect on the direction of the PR.\[13\] The PR has been considered relevant for human identification due to its stability,\[14\] and being equivalent to the fingerprint, is unique for each individual.\[15\] This study on the identification of persons is called palatoscopy or palate rugoscopy.\[16\] The idea of this study was spurred whether this pattern of rugae can be mapped for a category of patients.

**Aims and Objectives**

The aims of the study were the following:

1. To determine if the palatal rugae have a characteristic pattern in untreated class II div I malocclusions compared to normal class I occlusions.
2. To provide a valuable insight whether palatal rugae can be taken up as additional criteria for classifying malocclusions.

**Materials and Methods**

The study was conducted on initial maxillary dental casts of 27 individuals with untreated class II div 1 malocclusion, of whom 14 were females and 13 were males, with age ranging from 16 to 24 years. Initial maxillary dental casts of 24 individuals (12 males and 12 females) with untreated class I occlusion matched to the same age group as above were taken up. Impressions were made of alginate and poured with type III dental stone.

**Further Criteria of Selection**

Class II div 1 samples with an overjet of a minimum of 5 mm were selected. Intermolar width measured from central fossae of molars was taken up as a standardization criterion.

The palatal rugae were carefully highlighted using 0.5-mm pencil and the precise measurements were done on a transparent measurement template. The traced palatal rugae were observed for size, shape, direction, and pattern.

A median palatal plane was constructed as a reference plane [Figure 2]. Based on the length, the rugae were classified as: Primary, 5 mm and above; secondary, 3–5 mm; and fragmentary, less than 2 mm [Figure 3]. Primary rugae were then interpreted based on the classification given by Lysell et al.,\[16\] Shetty et al.,\[17\] and Nayak et al.\[18\] Based on the shape, the primary rugae were classified as curved wavy straight circular [Figure 4].

Based on the direction, they were classified as: (a) forward directed (a) and (b) backward directed [Figure 5]. Based on the unification, the primary rugae were classified as (a) converging and (b) diverging [Figure 6].

A final ordinal scale was put up [Figures 7–12].

**Statistical Methods Used**

- Unpaired t-test was used to compare differences between two means.
- Chi-square test was used to find the distribution of proportions among the samples.
• Analysis of variance (ANOVA) was used to find out if any relationship existed between the size and pattern of palatal rugae.

Software used – SPSS Version 14.0

The following parameters were analyzed:

a. Mean intermolar width and comparison between two groups.
b. The total widths of the primary rugae 1, 2, 3, and comparison between two groups.
c. Ordinal scale index of each cast and comparison between two groups.
d. ANOVA test to compare if any relationship existed between the size and pattern of palatal rugae.
The second palatal rugae were shorter in class II div 1 patients than in class I patients by 3.1 mm and this difference was statistically significant as evident by a $P$ value $= 0.001$ [Table 3].

The third palatal rugae were evidently shorter in class II div 1 patients than in class I patients by 4.24 mm and this difference was statistically highly significant as evident by a $P$ value $= 0.000$ [Table 4].

All the patients with Angle’s class I occlusion had good pattern of palatal rugae falling in the range of 1–3, whereas 22% of the patients with class II div 1 had poor pattern of palatal rugae, with 4 and 2 patients exhibiting a score of 4 and 5, respectively, but this was not statistically significant according to chi-square test with a $P$ value $= 0.12$ [Table 5].

**Discussion**

The mean intermolar width was taken as a standardization for both the groups, with the mean intermolar width in class I sample being 47.25 ± 2.06 mm and in class II div 1 sample being 46.81 ± 1.88 mm. There was a significant difference in the total transverse widths of all the three palatal rugae between the two groups, with the third rugae showing a highly significant difference. This shows the constriction of the arch in class II div 1 individuals than in class I individuals, even with matched intermolar widths. The ordinal scale we have put up in this study has provided a method of categorizing the pattern for each group, though the palatal rugae possess unique patient characteristics. The results of the individual distribution of rugae pattern among the groups, though statistically not significant according to chi-square test, show that to some extent there is a near-normal pattern for the class I sample than the class II div 1 sample.

There were no significant differences between sexes for most of the above findings.

The findings of the ANOVA test showed no significant relationship between the size and pattern of the palatal rugae between the two groups. Hauser* et al.* [19] in 1989 stated that size of the palate affected rugae development. They reported that individuals with broader palates showed greater rugae development.

Most of the studies were done to establish the stability of palatal rugae as landmarks by Almeida* et al.* [9] By comparing extraction and non-extraction cases, Bailey* et al.*[10] had studied the effects on palatal rugae, before and after orthodontic treatment in both children and adults. The transverse widths were taken into consideration and they were longitudinal studies comparing the treatment effects in the same cohort. In our study, an effort was made to compare the differences between two groups, namely class I occlusion and class II div 1 patients. Here, not only the transverse widths were taken into consideration, but also the pattern was observed. A new ordinal scale was put up to categorize the pattern. An effort was made to standardize both the groups and the selection criteria were followed. A simple

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**Results**

With $P$ value of 0.435, there was no statistically significant difference in the mean intermolar widths of the two groups [Table 1].

The first palatal rugae were shorter in class II div 1 patients than in class I patients by 1.43 mm and this difference was statistically significant as evident by a $P$ value $= 0.021$ [Table 2].
Table 1: Inter molar width

<table>
<thead>
<tr>
<th>Ang. Cl</th>
<th>Mean</th>
<th>Std. deviation</th>
<th>Min</th>
<th>Max</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>47.25</td>
<td>2.069</td>
<td>44</td>
<td>53</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>46.81</td>
<td>1.882</td>
<td>44</td>
<td>51</td>
<td>7</td>
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<tr>
<td>Total</td>
<td>47.02</td>
<td>1.965</td>
<td>44</td>
<td>53</td>
<td>9</td>
</tr>
</tbody>
</table>

With P value of 0.435 there was no statistically significant difference in the mean inter molar widths of the two groups.

Table 2: Total transverse width of primary palatal rugae 1

<table>
<thead>
<tr>
<th>Ang. class</th>
<th>N</th>
<th>Mean</th>
<th>Std. deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1+L1</td>
<td>1</td>
<td>24</td>
<td>20.54</td>
</tr>
<tr>
<td>R1+L1</td>
<td>2</td>
<td>27</td>
<td>19.11</td>
</tr>
</tbody>
</table>

Unpaired t test

\[
t \quad df \quad \text{Sig. (2-tailed)} \quad \text{Mean difference} \quad 95\% \text{CI of difference} \quad \text{Lower} \quad \text{Upper}
\]

<table>
<thead>
<tr>
<th>Ang. class</th>
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</tr>
<tr>
<td>R1+L1</td>
<td>2</td>
<td>27</td>
<td>19.11</td>
</tr>
</tbody>
</table>

Table 3: Total transverse width of primary palatal rugae 2

<table>
<thead>
<tr>
<th>Ang. class</th>
<th>N</th>
<th>Mean</th>
<th>Std. deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>R2+L2</td>
<td>1</td>
<td>24</td>
<td>25.58</td>
</tr>
<tr>
<td>R2+L2</td>
<td>2</td>
<td>27</td>
<td>22.48</td>
</tr>
</tbody>
</table>

Unpaired t test

\[
t \quad df \quad \text{Sig. (2-tailed)} \quad \text{Mean difference} \quad 95\% \text{CI of difference} \quad \text{Lower} \quad \text{Upper}
\]

<table>
<thead>
<tr>
<th>Ang. class</th>
<th>N</th>
<th>Mean</th>
<th>Std. deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>R2+L2</td>
<td>1</td>
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<td>25.58</td>
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<tr>
<td>R2+L2</td>
<td>2</td>
<td>27</td>
<td>22.48</td>
</tr>
</tbody>
</table>

Table 4: Total transverse width of primary palatal rugae 3

<table>
<thead>
<tr>
<th>Ang. class</th>
<th>N</th>
<th>Mean</th>
<th>Std. deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>R3+L3</td>
<td>1</td>
<td>24</td>
<td>31.50</td>
</tr>
<tr>
<td>R3+L3</td>
<td>2</td>
<td>27</td>
<td>27.26</td>
</tr>
</tbody>
</table>

Unpaired t test

\[
t \quad df \quad \text{Sig. (2-tailed)} \quad \text{Mean difference} \quad 95\% \text{CI of difference} \quad \text{Lower} \quad \text{Upper}
\]

<table>
<thead>
<tr>
<th>Ang. class</th>
<th>N</th>
<th>Mean</th>
<th>Std. deviation</th>
</tr>
</thead>
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<tr>
<td>R3+L3</td>
<td>1</td>
<td>24</td>
<td>31.50</td>
</tr>
<tr>
<td>R3+L3</td>
<td>2</td>
<td>27</td>
<td>27.26</td>
</tr>
</tbody>
</table>

Table 5: Angle's class vs index cross tabulation

<table>
<thead>
<tr>
<th>Ang. class vs index cross tabulation</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>% within Ang. class</td>
<td>29.2%</td>
<td>54.2%</td>
<td>16.7%</td>
<td>0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>% within ang. class</td>
<td>4%</td>
<td>11%</td>
<td>6%</td>
<td>4%</td>
<td>2%</td>
</tr>
<tr>
<td>% within ang. class</td>
<td>14.8%</td>
<td>40.7%</td>
<td>22.2%</td>
<td>14.8%</td>
<td>7.4%</td>
</tr>
<tr>
<td>Total</td>
<td>11%</td>
<td>24%</td>
<td>10%</td>
<td>4%</td>
<td>2%</td>
</tr>
<tr>
<td>% within</td>
<td>21.6%</td>
<td>47.1%</td>
<td>19.6%</td>
<td>7.8%</td>
<td>3.9%</td>
</tr>
</tbody>
</table>

method of recording the size of palatal rugae was followed rather than the reflex metrotograph (RMG), a 3D digitizer as suggested by Scott,[20] and Richmond and Jones.[21] Bansode and Kulkarni[22] found that some changes do occur in the rugae during orthodontic treatment and the morphology of palatal rugae remains stable throughout life. Palival et al.[23] concluded that straight rugae pattern on the right side of the palate in the male subjects was found to be significantly predominant in the MP population, whereas wavy shape was predominant in Keralites; however, rugae patterns on the right side of the palate in female subjects exhibited no significant difference. Jibi et al.[24] revealed with regard to shape and unification, females showed a significantly higher diverging rugae type while males had a significant number of circular and converging type of rugae.

Conclusion

There was a significant constriction of the palatal rugae in class II div 1 individuals as compared to class I individuals, though they were matched for the same intermolar widths. There was a distinct pattern of palatal rugae between the two groups. It is too premature to make a comment on the use of palatal rugae to classify malocclusions. Though an interrelationship between size and pattern was not obtained, further studies in this direction can provide a valuable insight.

References


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