Comparison between different papillary recession classification systems

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Abstract  Background/purpose: Traditional classification systems to assess interdental papillary levels are based only on the vertical relationship among the papilla tip, contact point, and cementoenamel junction. However, the width of papilla recession (PR) is highly visible in terms of dental esthetics. A new classification system is presented to assess central PR and compare differences between the new system and existing systems.

Materials and methods: The central papilla was visually assessed in 450 adults using standardized periapical radiographs of the maxillary central incisors. The PR classification system presented here is based on vertical and horizontal dimensions of the PR area. Central PR was classified according to the PR system and the system of Nordland and Tarnow (TC).

Results: Ninety individuals who had no PRs were classified as degree 0 according to the classification of both TC and Chang. A total of 330 individuals (73.3%) were classified as PR I (Tarnow), and 46, 89, 16, and 183 participants were classified as PR II, PR III, and PR IV (Chang). Thirty individuals were classified as TC II, and all were classified as PR IV.

Conclusion: This study confirmed a significant correlation between the two existing classification methods. The proposed PR classification system characterizes open embrasures in greater detail than previous systems.

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Introduction

The presence or absence of interdental papilla is of great aesthetic and functional interest to both dentists and patients.¹ The presence of papilla between the maxillary central incisors is a key esthetic factor in any individual.² The morphology and physiology of the papilla are more
complex than those of other gingival regions. If papilla loss occurs solely due to soft-tissue damage, reconstructive interventions can be completely restorative; however, in cases of severe periodontal disease and interproximal bone resorption, reconstruction is generally inadequate.

The presence of a space apical to the contact area, defined as papillary recession (PR), can lead to esthetic impairment, phonetic problems, and food impaction. A number of studies demonstrated a significant relationship between the bone crest–contact point (BC–CP) distance and interdental and inter-implant papillary presence and maintenance. In addition, factors such as age, angulation of the roots of adjacent teeth, shape of the crown, space between adjacent teeth, embrasure morphology, and location of the cementoenamel junction (CEJ), are important in determining the shape and presence of the interdental papilla.

PR is a more common problem than gingival recession in esthetic dentistry. The classification of gingival recession usually utilizes the classification system of Miller. Traditional classification systems to assess the interdental and inter-implant papillary levels are based only on the vertical relationship among the papilla tip (PT), CP, and CEJ. For example, the classification system of Nordland and Tarnow (TC) is divided as follows: normal class I (the tip of the interdental papilla lies between the intended CP and the most coronal extent of the interproximal CEJ, indicating that the space is present, but the interproximal CEJ is not visible); class II (the tip of the interdental papilla lies at or apical to the interproximal CEJ, but coronal to the apical extent of the facial CEJ; interproximal CEJ is visible); and class III (the tip of the interdental papilla lies level with or apical to the facial CEJ).

The width of PR is highly visible and an important factor in dental esthetics. A newly designed classification system (PR classification system) presented here is based on the vertical and horizontal relationships of the PR area, with recession height defined as the vertical distance between the PT and the apical point of the contact area (PT–CP), and the recession width defined as the horizontal width of the PT (Fig. 1).

The various PR classes are described as follows. PR class 0 (PR 0; normal papilla): The papilla completely fills the

**Materials and methods**

**Data collection**

This retrospective study protocol was approved by the ethical committee of Chang-Gung Memorial Hospital. A previously described method was used for data collection. Briefly, if no space was visible apical to the contact area, the papilla was recorded as being present. If a space was visible apical to the contact area, which was gently filled with a temporary soft, radiopaque restorative material (Caviton, GC Corporation, Tokyo, Japan), it was recorded as central PR. Between July 2004 and March 2008, periapical radiographs of the maxillary central incisors of 450 individuals (264 males and 186 females; with an age range of 18–73 years) were obtained using a paralleling technique with an XCP film holder (Rinn Corp., Elgin, IL, USA). The age and gender of each participant were also recorded.

Further measurements made on the radiographs were done using an electric measurement ruler (King Life Technology, Taipei, Taiwan). The following vertical distances were measured: PT–CP, PT–proximal CEJ (PT–pCEJ), PT–buccal CEJ (PT–bCEJ), pCEJ–CP, bone crest–CP (BC–CP), BC–PT, and BC–pCEJ. Vertical lines were measured along the long axis of an adjacent tooth. The following horizontal measurements were determined: interdental width (the width between the two central incisors at the pCEJ level), PT width, and inter-root width (the width between the two central incisors at the bCEJ level).

**PR classification system (PR system)**

The proposed classification system is based on the vertical and horizontal relationships of the PR area, with recession height defined as the vertical distance between the PT and the apical point of the contact area (PT–CP), and the recession width defined as the horizontal width of the PT (Fig. 1). The various PR classes are described as follows. PR class 0 (PR 0; normal papilla): The papilla completely fills the

Figure 1 The horizontal distance of papilla recession area is recession width papilla [papilla tip (PT) width], and the vertical distance is recession height [PT–contact point (CP)]. The central papilla recession is "Wide-long" papilla recession area, defined as recession height (RH) > 2 mm and recession width (RW) > 1 mm (PR IV).
interproximal embrasure (no space apical to the contact point). PR class I (PR I): defined as a PT–CP < 2 mm and a PT width of ≤ 1 mm. PR class II (PR II): defined as a PT–CP > 2 mm and a PT width of ≤ 1 mm. PR class III (PR III): defined as a PT–CP ≤ 2 mm and a PT width of > 1 mm. PR class IV (PR IV): defined as a PT–CP > 2 mm and a PT width of > 1 mm.

The classification system of Nordland and Tarnow is described follows. Normal (TC 0): The interdental papilla fills the embrasure space to the apical extent of the described follows. Normal (TC 0): The interdental papilla as a PT width of 1 mm. PR class I (PR I): defined as a PT–CP > 2 mm and a PT width of ≤ 1 mm. PR class II (PR II): defined as a PT–CP ≤ 2 mm and a PT width of > 1 mm. PR class III (PR III): defined as a PT–CP > 2 mm and a PT width of > 1 mm.

The tip of the interdental papilla lies level with or apical to the intended contact point and the most coronal extent of the interproximal CEJ (PT–CP > 0 and PT–pCEJ > 0). Class II (TC II): The tip of the interdental papilla lies at or apical to the interproximal CEJ, but coronal to the apical extent of the facial CEJ (PT–pCEJ ≤ 0 and PT–bCEJ > 0). Class III (TC III): The tip of the interdental papilla lies level with or apical to the facial CEJ (PT–bCEJ ≤ 0).

Participants were divided into different groups according to the PR and TC classification systems. Variables in different classes were analyzed.

Statistical analyses

Continuous variables are presented as the mean ± standard deviation, differences between classified groups were tested by one-way analysis of variance, and the Bonferroni’s adjustment was used for post-hoc pairwise group comparisons. The categorical variable, gender, is presented as a count and percentage, and associations between gender and classified groups were tested using Fisher’s exact test. Kendall’s tau-c correlation coefficient was performed to evaluate the correlation between the two classification systems (TC and PR). Trends in measurements among different classification groups were evaluated by Spearman’s correlation coefficient. The significance level of all statistical tests was set at 0.05, and performed using SPSS 15.0 (SPSS, Chicago, IL, USA).

Results

Correlation between the classifications according to Nordland/Tarnow and Chang

In total, 450 individuals were included in the study, including 186 (40.8%) females and 264 (59.2%) males with a mean age of 44.5 (standard deviation, 11.1) years. All patients were evaluated using the classifications of Nordland/Tarnow and PR. Ninety participants who had no PRs were classified as degree 0 by both Nordland/Tarnow and Chang. According to Nordland/Tarnow, 330 individuals (73.3%) were classified as TC I, and 46, 89, 16, and 183 participants were respectively classified as PR I, PR II, PR III, and PR IV according to Chang. The 30 participants who were classified as TC II according to Nordland/Tarnow were all classified as PR IV according to Chang. There was a significant correlation between the two classification methods (Kendall’s tau-c correlation coefficient of 0.545; p < 0.001; Table 1). Because one of the exclusion criteria was a BC–CP distance of > 10 mm, individuals with a BC–CP distance of > 10 mm in the C III group were not included in this study.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>The correlation between Nordland/Tarnow’s classification and Chang’s classification.</th>
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<tbody>
<tr>
<td></td>
<td>Nordland and Tarnow’s classification</td>
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<tr>
<td></td>
<td>TC 0</td>
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<tr>
<td>Chang’s classification</td>
<td>PR 0</td>
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<tr>
<td></td>
<td>PR I</td>
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<td>PR II</td>
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<td>PR III</td>
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<td>PR IV</td>
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<td>Total</td>
<td>90 (20.0%)</td>
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Kendall’s tau-c = 0.545, P < 0.001.

PR = papilla recession; TC = classification system of Nordland and Tarnow.

Different class groups according to the classifications of Nordland/Tarnow and Chang

Demographics

Age was significantly correlated to the classification groups of Chang and Nordland/Tarnow (Spearman correlation coefficient 0.637 in Chang and 0.535 in Nordland/Tarnow, both p < 0.001). Participants in the PR I, II, III, and IV groups were significantly older than those in the PR 0 group, and individuals in PR IV were significantly older than those in the PR I and II groups. Participants in the TC I and II groups were significantly older than those in the TC 0 group, and those in the TC II group were significantly older than those in the TC I group. No significant association was shown in gender versus the classification group of Nordland/Tarnow or gender versus the classification group of Chang (Table 2).

Characteristics of the central PR

The PT–CP and PT widths were 0 in 90 participants classified as PR 0 and TC 0. The pCEJ–PT measurement was significantly lower according to the Chang classification score (Spearman correlation coefficient, −0.734; p < 0.001). A similar decreasing trend was also found for the bCEJ–PT (Spearman correlation coefficient, −0.769; p < 0.001). The bCEJ–PT in PR I–III was significantly lower than that in PR 0 (7.17 mm in PR 0 vs. 5.30 mm in PR I; 4.92 mm in PR II, and 5.07 mm in PR III), and the bCEJ–PT in PR IV (3.84 mm) was significantly lower than those of all other groups (Table 2).
<table>
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<th>Table 2</th>
<th>Characteristics of the different class groups in Chang’s and Nordland/Tarnow’s classifications.</th>
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<tr>
<td></td>
<td>Chang’s classification</td>
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<tr>
<td></td>
<td>PR 0 (n = 90)</td>
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<tr>
<td>Age (y)</td>
<td>28.07 ± 9.18</td>
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<tr>
<td>Gender</td>
<td>F 40 (44.4%)</td>
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<tr>
<td>PT–CP e</td>
<td>e 1.72 ± 0.24</td>
</tr>
<tr>
<td>PT width</td>
<td>e 4.13 ± 0.90</td>
</tr>
<tr>
<td>bCEJ–PT</td>
<td>7.17 ± 0.90</td>
</tr>
<tr>
<td>BC–CP</td>
<td>5.30 ± 0.95</td>
</tr>
<tr>
<td>BC–PT</td>
<td>5.30 ± 0.95</td>
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<tr>
<td>BC–pCEJ</td>
<td>1.18 ± 0.49</td>
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<tr>
<td>bCEJ–CP</td>
<td>7.17 ± 0.90</td>
</tr>
<tr>
<td>pCEJ–CP</td>
<td>4.08 ± 0.93</td>
</tr>
<tr>
<td>Interdental</td>
<td>1.70 ± 0.42</td>
</tr>
<tr>
<td>Inter-root</td>
<td>1.97 ± 0.49</td>
</tr>
<tr>
<td>1.72 ± 0.24</td>
<td>1.75 ± 0.26</td>
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</tbody>
</table>

BC = bone crest; bCEJ = buccal cementoenamel junction; pCEJ = proximal CEJ; PR = papilla recession; PT = papilla tip; TC = classification system of Nordland and Tarnow.

* Significant difference was found as compared to PR 0 group.
* Significant difference was found as compared to PR I group.
* Significant difference was found as compared to PR II group.
* Significant difference found between all groups.
* PT–CP and PT width were all zero in PR 0 (or TC 0) group.
* Significant difference was found as compared to PR III group.
Distances from the BC to CP, pCEJ, and PT
BC–CP had an increasing trend in the classification groups of Chang and Nordland/Tarnow (Spearman correlation coefficient of 0.538 in Chang and 0.404 in Nordland/Tarnow, both \( p < 0.001 \)). A similar increasing trend also existed for BC–pCEJ in the classification groups of Chang and Nordland/Tarnow (Spearman correlation coefficients of 0.647 in Chang and 0.564 in Nordland/Tarnow, both \( p < 0.001 \); Table 2).

In contrast, a decreasing trend was observed in BC–PT (Spearman correlation coefficients of \(-0.476\) in Chang and \(-0.607\) in Nordland/Tarnow, both \( p < 0.001 \)). According to Chang, BC–PT values were 3.54, 3.45, 3.54, and 3.42 mm in PR I, PR II, PR III, and PR IV, respectively, and these were significantly lower than the 5.3 mm in the PR 0 group (Table 2).

bCEJ–CP and pCEJ–CP
According to Chang, bCEJ–CP in PR II (7.61 mm) was significantly superior to those of the PR I and IV groups (7.02 and 7.20 mm, respectively), and no significant difference was found in pCEJ–CP among the pairwise classification groups of Chang after Bonferroni’s adjustment. According to Nordland/Tarnow, no significant difference existed among groups with respect to bCEJ–CP or pCEJ–CP. In addition, no significant trend was found in bCEJ–CP or pCEJ–CP among the different classification groups (Table 2).

Interdental width and inter-root distance
According to Chang, the interdental width and inter-root distance in the PR III and IV groups were significantly superior to those of the PR 0 and II groups. According to Nordland/Tarnow, the interdental width (2.03 mm) and the inter-root distance (2.33 mm) in the TC I group were significantly superior to the interdental width (1.70 mm) and inter-root distance (1.97 mm) in the TC 0 group (Table 2).

Discussion
Results of this study showed that there was a significant correlation between the Chang classification system and the Nordland/Tarnow classification system. However, the proposed PR classification system, which includes vertical and horizontal parameters of PR, characterizes open embrasures in greater detail than the existing systems.

There was a significant association between the occurrence of central PR and increased age. \(^\text{12}\) Age was significantly correlated with the classification groups of Chang and Nordland/Tarnow in this study. No significant association was demonstrated in gender versus the Nordland/Tarnow classification groups or gender versus the Chang classification group. Central PR, as a result of aging, is most frequently associated with a wide interdental width and a long pCEJ–CP distance. \(^\text{12}\) In this study, the “wide-long” embrasure morphology was more closely associated with PR IV class, and the “wide-short” embrasure morphology was more closely associated with PR III class. In contrast, PR II class occurred more in the “narrow-long” embrasure morphology. According to Nordland/Tarnow, a 2.03-mm interdental width and a 2.33-mm inter-root distance in the TC I group were significantly superior to the 1.70-mm interdental width and 1.97-mm inter-root distance in the TC 0 group. However, no significant difference was found in bCEJ–CP or pCEJ–CP among the three classification groups of Nordland/Tarnow.

Results of this study showed that there was a significant correlation between classifications of Nordland/Tarnow and Chang. However, TC I could be divided into PR I, PR II, PR III, and PR IV in greater detail. PR I, II, and III are subtle on examination and represent little esthetic impairment to the patient. PR Class IV is the least esthetic PR class. Furthermore, PR class IV can be divided into subgroup “b” or “s” according to the etiology of the recession. Subgroup “s” represents PR due solely to a soft-tissue deficiency or damage with little interproximal bone loss. A tapered (triangular) tooth shape and divergent root angulation easily result in subgroup “s” recession. This subgroup of PR can usually be treated by either nonsurgical or surgical methods. \(^\text{1,20–24}\) If root angulation is divergent, the recession can be improved by correcting the root position. \(^\text{2}\) If the tooth shape is the problem, the recession can be corrected by restoring the open embrasure or reshaping the tooth to flatten the incisal contact. \(^\text{2,21,23}\)

In contrast, subgroup “b” is characterized by severe interproximal bone resorption inducing interdental PR. The presence of full papilla is significantly related to the BC–pCEJ distance. \(^\text{13}\) The longer the BC–pCEJ distance, the more severe the recession. Therefore, restoration of PR IVb may be more challenging than PR IVs due to greater interproximal bone loss. \(^\text{2,21,23}\)

In conclusion, the proposed PR classification system, which includes the vertical and horizontal parameters of PR, characterizes open embrasures in greater detail than existing systems. In addition, use of this system can improve both PR assessment and communication between clinicians and patients.

References
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