

# Risk Indicators of Papillary Recession in the Anterior Maxilla

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## ABSTRACT

**Purpose:** The interdental papilla is the portion of the gingiva that occupies the space between two adjacent teeth. When papillary recession occurs, an array of problems arises ranging from phonetics to food impaction and esthetic concerns. The aim of this study was to identify risk indicators for visible papillary recession in the anterior maxilla among a Caucasian population utilizing an advanced analytical approach.

**Materials and Methods:** A dataset of 211 adult dentate Caucasian patients that had undergone intraoral assessment of midline papillary recession and extra-oral assessment of visible papillary recession during maximum (“Duchenne”) smile was utilized. An enhanced analytical approach was employed to identify risk indicators for papillary recession.

**Results:** Approximately one-third of the participants (38%) demonstrated papillary recession during maximum smile (“visible papillary recession”). An association between sex (male preference) and visible papillary recession was found in this sample population, while age was found to be a risk indicator for papillary recession in individuals over 65 years of age.

**Conclusions:** Visible midline papillary recession in the maxilla is a highly prevalent clinical entity in Caucasian individuals, thus the development of efficacious treatment modalities for papillary regeneration is necessary. Findings of the present study on risk indicators for visible papillary absence, namely sex and age, may facilitate clinicians in treating patient with compromised interdental aesthetics as well as identifying patients that are in high risk for loss of interdental tissues.

## CLINICAL SIGNIFICANCE

Findings of the present study on risk indicators for visible papillary absence, namely sex and age, indicate the need for careful assessment and meticulous treatment planning with respect to preservation of the interdental tissues. The consideration of these risk indicators can help dentists to identify patients at risk for papillary recession.

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## INTRODUCTION

The interdental papilla is the portion of the gingiva that occupies the space between two adjacent teeth. The papilla has a pyramidal shape with its tip being located immediately apically to the contact area.<sup>1</sup> Its role lies in acting as a barrier to protect the periodontal structures

from microbial invasion while playing a crucial role in phonetics and aesthetics. When the papilla recedes, an array of problems arises ranging from phonetics to food impaction as well as esthetic disharmony.<sup>2</sup> On the contrary, when a normal papilla fills the interdental embrasure, a long facial-lingual col area is minimized, adequate space for the interdental gingiva is provided,

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food impaction and retention is minimized, and undisrupted plaque removal by the patient is allowed for.<sup>3</sup>

As the field of esthetic dentistry evolves, parameters that affect the esthetic outcome of the dental rehabilitations emerge as significant elements in clinicians' and patients' perception of restorative success. The identification and characterization of elements that define beauty commenced in the classical times with the Greek philosophers pondering on questions that implemented symmetries, angles, and parallelism in the esthetics of the smile. Polycleitus, a Greek sculptor, studied the ideal proportions of the human head in the 4th Century BC. Leonardo Da Vinci completed the unprecedented work of Polycleitus several centuries later with the application of principles of symmetry in the human face.

Papillary proportions in the anterior maxilla have been a matter of investigation in contemporary times as well. The essence of papillary proportions in individual perception of smile esthetics has been investigated by and verified in the work of Kokich and colleagues (1999).<sup>4</sup> In the work of Kokich and colleagues, alterations were produced on images of smiles. As a result, unilateral papillary discrepancies were found to be significant unsettling factors for dentists and laypersons as well.<sup>4</sup> In an attempt to characterize the physiologic papillary proportions, Bergstrom and colleagues (1984) described the healthy papilla as expected to reach half way to the incisal edge of the maxillary incisor.<sup>5</sup> Chu and colleagues (2009) also estimated the mesial-distal papilla proportions as being 42% and 43% of papilla height to crown-length ratio, respectively.<sup>6</sup> These proportions could also be utilized as reference goals when treatment planning for the replacement of hopeless teeth with conventional rehabilitations or even dental implants.

The aim of this study was to assess the prevalence and identify risk indicators for papillary recession in the anterior maxilla among a large Caucasian population according to the modified Nordland and Tarnow classification.<sup>7,8</sup>

## MATERIALS AND METHODS

In the present study, an enhanced analytical approach was utilized to analyze the association between papillary recession and various potential risk indicators. Data from Kotsakis and colleagues (2014) were utilized in this secondary analysis<sup>8</sup>. Briefly, an extra-oral and intraoral assessment of 211 adult dentate Caucasian patients was performed between May 2010 and February 2011, by an experienced and calibrated examiner. The clinical examination aimed to record midline papillary recession according to the modified Nordland and Tarnow classification<sup>7,8</sup> (Table 1).

Results of the intraoral assessment were combined with an extra-oral observation of visible papillary recession during maximum ("Duchenne") smile with the participant positioned in an upright position and the physician positioned outside of the person's "intimate" space<sup>8,9</sup> (Figures 1, 2).

Consequently, patients were assigned to either the high interdental smile line group (H-ISL) or the low interdental smile line group (L-ISL) according to Hochman and colleagues (2012).<sup>9</sup> Since, H-ISL patients whose vermilion border rested coronal to the

**TABLE I.** Modified Nordland and Tarnow classification for papillary recession<sup>7,8</sup>

Normal	There is a contact point between the two teeth, and the interdental papilla covers all the surface of the interdental triangle
Class I	A contact point exists between the two teeth, and the tip of the papilla is located coronal to the interproximal CEJ (Cemento - Enamel Junction) of the neighboring teeth, but does not reach the contact point
Class II	There is a contact point between the two teeth, and the tip of the papilla is located apically from the interproximal CEJ, but coronal to the position of the buccal CEJ
Class III	There is a contact point between the two teeth, and the tip of the papilla is located apically to the most apical part of the facial CEJ
Class IV	No contact point exists between the two neighboring teeth, thus the interdental space does not form a pyramidal area that can define the interdental papilla



**FIGURE 1.** A, The interdental smile line covers the midline papilla during partial Duchenne smile. No visible papillary recession is recorded in this case. B, Class I visible papillary recession; note the high interdental smile line in the patient that allows for display of the Class I recession during a Duchenne smile, in the same patient as in Figure 1A. Contraction of the orbicularis oculi, levator labii superioris and zygomaticus major muscles is a characteristic of the Duchenne smile. C, A higher magnification of the Class I defect in Figure 1B.



**FIGURE 2.** A, Class IV papillary recession, visible during partial Duchenne smile. B, Case of class IV papillary recession during a forced smile. A forced smile is not representative of a natural social smile; note the contraction of the orbicularis oris muscle that lifts the lower lip upwards, this is not characteristic of the Duchenne smile. C, The same defect as seen in Figure 2A, visible during a true Duchenne smile; note the different action of the orbicularis oris muscle, distinguishing it from a forced smile, giving to the person a natural esthetic smile.

interproximal contact point exhibited papillary recession that did directly impact the esthetic appearance of their smile, this case definition was referred to as “visible papillary recession.”

In addition to the clinical examination, individuals were interviewed to collect information pertinent to clinical and socioeconomic risk indicators for papillary recession. Age, sex and educational level were recorded for all individuals. The same examiner also scored the participants’ tooth brushing technique after asking the person to demonstrate their tooth brushing routine chair side. Information on gradients for each co-variable is shown in Table 2.

A generalized regression model was constructed that considered “visible papillary recession” as the regressor

**TABLE 2.** Explanation of co-variables included in the present analysis

Age	Age of years as estimated at the time of the exam
Sex	Male/Female
Education level	High school or less/Professional or technical school/university
Brushing technique	Random/Horizontal/Stillman/Bass
Classification <sup>a</sup>	Normal/Class I/Class II/Class III/Class IV

and demographic, socioeconomic and clinical covariates as explanatory variables. In the enhanced analytical approach presented in this study, a quasi-likelihood approach was employed. The benefit of this approach

lies in the ability of quasi-likelihood functions to compensate for over-dispersion of the data. This is essentially practical for capturing the heterogeneity seen in distributions from sample populations in comparison to theoretical distributions that would occur in the true population; in this case binomial distribution of “visible papillary recession” among individuals. As a result, the statistical model may be better powered to identify associations between the regressor and the co-variables even in the presence of skewed data. In this study, a quasi-binomial generalized regression model that considered all the co-variables was constructed. Subsequently, backward stepwise selection was performed using the Akaike information criterion (AIC) as a goodness of fit measure to identify the model including the most informative covariates.

A sensitivity analysis for patients at least 65 years of age was also performed based on previous findings from the same sample population.<sup>8</sup> The significance level was set at  $\alpha = 0.05$  for all comparisons. A specialized software was used for statistical analysis, and the threshold for significance was set at  $p < 0.05$ . (R Core Team [2013]). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <http://www.R-project.org/>.

## RESULTS

The sample population consisted of 211 participants (42.2% females) with a mean age of 47 years ( $\pm 15.7$ ). A detailed description of the sample population characteristics has been previously provided by Kotsakis and colleagues (2014).<sup>8</sup> Briefly, 46.4% of study participants were found to have papillary recession. Furthermore, the maxillary midline papilla was visible in 84.4% of the participants when they were exhibiting maximum smiling. The vermilion border of the lip was masking any midline papillary recession during maximum smile in the remaining 15.6% of the participants. As a result, the prevalence of visible papillary recession was calculated to be 38.4%. A trend was also found for less visible papillary recession with age in patients over 65 years old that was consistent

with a similar trend for masking of the interdental tissue by the vermilion border of the upper lip.

Results of the advanced statistical analysis presented in this paper elucidated sex as a significant risk indicator for papillary recession with an odds ratio (OR) of 0.5 favoring females versus males (Table 2). The sensitivity analysis in elderly patients verified previous finding of an association between age and visible papillary recession in this subpopulation (Table 2). The OR for age in patients 65 years or older was 1.29 ( $p < 0.05$ ), while in the total sample population, a nonsignificant OR of 1.01 ( $p > 0.05$ ) was found. Level of education and tooth brushing technique were not found to be indicators of visible papillary recession in this sample population (Table 3).

## DISCUSSION

The aim of this study was to identify risk indicators for visible papillary recession in the anterior maxilla among a Caucasian population utilizing an advanced analytical approach. Various factors seem to affect the presence of the interdental papilla. In addition to pathological conditions, such as periodontal disease and trauma, an element that affects the presence of the interdental papilla is the level of the contact point between two adjacent teeth.<sup>10</sup> When the interdental contact point or area is placed high, it may lead to the formation of black triangles.<sup>10</sup> This causes both esthetic and functional problems, such as food impaction and phonetic abnormalities. The present study showed that loss of the interdental papilla could be attributed to the complete absence of a contact point in the case of Class IV papillary recession. This new category of papillary absence that was introduced by Kotsakis and colleagues (2014) is restoratively informative as Class IV papillary recession can be corrected by re-establishing an appropriately positioned contact point between two adjacent teeth.<sup>8</sup> This direct association between the classification of papillary absence and its treatment may inaugurate a transition from a descriptive classification to a treatment-oriented one. In dealing with Class IV papillary recession, the guidelines for papillary fill, as described by Tarnow and colleagues (1992) should be

**TABLE 3.** Association of visible papillary recession with other co-variables

Co-variables	Main model		Sensitivity analysis (≥65 years)	
	OR	95% CI	OR	95% CI
<b>Age</b>	1.01	0.95–1.03	1.29*	1.02–1.69
<b>Sex</b>				
Female	0.53*	0.29–0.97	0.21*	0.03–0.52
Male	Ref	Ref	Ref	Ref
<b>Educational level</b>				
University	0.43	0.17–1.07	1.03	0.16–7.1
Professional or technical school	1.16	0.60–2.25	1.53	0.29–12.6
High school or less	Ref	Ref	Ref	Ref
<b>Interdental smile line level</b>				
Low	0.85	0.39–1.36	0.67	0.24–1.12
High	Ref	Ref	Ref	Ref
<b>Oral hygiene technique</b>				
Bass <sup>1</sup>	0.73	0.12–1.75	— <sup>†</sup>	—
Stillman's	0.35	0.09–1.05	—	—
Horizontal	1.42	0.65–3.25	—	—
Random	Ref	Ref	Ref	Ref
<b>Participants</b>	<b>N = 211</b>		<b>N = 34</b>	
*Statistically significant at $\alpha=0.05$ .				
<sup>†</sup> "Oral hygiene technique" was removed from the multivariable model during stepwise fitting, as the sensitivity analysis model was underpowered when adding this co-variable.				

considered. Tarnow and colleagues (1992) found that the interdental papilla is present 100% of the time when the distance from the contact point of two adjacent teeth to the bone crest is between 3 mm and 4 mm, while it drops to 98% when this distance increases to 5 mm. When the distance from the contact point reaches 6 mm, the rate of fill ebbs to 65%.<sup>10</sup> These guidelines are also corroborated by the earlier work of van der Velden and colleagues (1982).<sup>11</sup> Another risk indicator of interest is tooth or restoration shape. Squared teeth, or implant crowns usually favor papillary fill, because of their longer interproximal contact areas.<sup>12</sup> Around teeth, Kim and colleagues (2008), showed that an interproximal distance between

adjacent roots, which is less than 0.8 mm is associated with 28% more chance of losing 0.5 mm of soft tissues and 56% more probable to lose of more than 1 mm in a decade.<sup>13</sup>

In terms of patient-related risk indicators, studies have shown that age may significantly affect papillary recession.<sup>14</sup> According to Chow and colleagues (2010), the papillary tissue height decreases by 0.012 mm for each year of age.<sup>14</sup> However, Kotsakis and colleagues (2014) found that there is a trend for less visible papillary recession with age in patients over 65 years old that is consistent with a similar trend for masking of the interdental tissue by the

vermillion border of the upper lip.<sup>8</sup> This could also be attributed to the fact that the epithelium of the interdental papilla becomes thinner and less keratinized with age.<sup>15</sup> In addition to age and sex, tooth brushing technique and the level of education were investigated as potential risk indicators for visible papillary recession in the present study. Based on results from the enrolled sample population, in contrast to age and sex, educational level and tooth brushing technique were not found to be significantly associated with visible papillary recession. The lack of association noted in this study does not necessarily mean that there is a lack of a true relationship between the co-variables and visible papillary recession. This lack of association may be due to a lack of adequate sample size that leads to type II bias. Although 211 participants were analyzed, this study was not powered for small effects or for the adjustment for multiple co-variables. One example was the covariable “level of education.” An OR of 0.43 was found for University or higher education as compared to high school or less education; however, this was not found to be significant due to the wide 95% confidence interval [0.17, 1.07]. A larger sample size would have been necessary to include more co-variables in this case. Based on the introduction of visible papillary recession from our work, an implication for future research would be to conduct adequately powered observational studies to investigate the effect of potential risk indicators for visible papillary recession additionally to age and sex, such as oral hygiene technique, tooth form, gingival phenotype, periodontal condition and smoking status among others. Also, in order to enhance the external validity of these associations, there is a need to include more ethnically diverse populations in future studies.

## CONCLUSIONS

Findings of the present study on risk indicators for visible papillary absence, namely sex and age, indicate the need for careful assessment and meticulous treatment planning with respect to preservation of the

interdental tissues. The consideration of these risk indicators can facilitate dentists to identify patients at risk for papillary recession.

## DISCLOSURE

The authors do not have any financial interest in the companies whose materials are included in this article.

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