Dimensions of the Interproximal Gingival Papilla in the Upper Anterior Areas Rehabilitated with Different Types of Unitary Implants

Ralph Bartoski Laroca Dos Santos1, Elimário Venturin Ramos2, Geraldo Alberto Pinheiro De Carvalho3, Simone Kreve2, Aline Batista Gonçalves Franco3, Sérgio Candido Dias4

Abstract:

Background: This study compares the gingival papillary dimensions in areas restored with external hexagon and Morse taper unitary implants and in healthy natural dentition. The distance from the bone crest (BC) to the contact point (CP) and the distance from the implant platform to the axial wall of the adjacent tooth influenced the papillary extension.

Materials and Methods: Jemt’s index (1997) was used to classify the gingival papillae in 4 height levels: 0 - absent papilla; 1 - papilla occupies less than half the distance from its base to the CP; 2 - papilla occupies more than half this distance but not the entire interproximal space; 3 - interproximal space completely occupied. The sample consisted of 27 proximal areas between natural teeth, 25 proximal areas to external hexagons, and 22 proximal areas to Morse taper. Patients were clinically evaluated to assess presence - total or partial - or absence of the gingival papilla. Radiographies were taken with the adaptation of metallic millimetric meshes for the measurements.

Results: Regarding papillary height scores, no significant difference was observed between groups ($P > 0.05$).

Conclusion: Group 3 - rehabilitated with Morse taper implants - had a better index of papillary fill and the larger the distance between the CP to the BC, the smaller the papillary score. Further research with larger sample size is of paramount importance.

Key Words: Dental implantations, dental papilla, gingiva, periodontium

Introduction

Smiling is one of the most important facial expressions and non-verbal communication, with an essential role in interpersonal relationships. On natural dentition, the interdental papilla is the portion of the gingiva found between two adjacent teeth. Its lateral margins and tip are formed by the marginal gingiva, and the deepest region is formed by inserted gingiva.

Until the 1960’s, the papilla was believed to have a protective function to the interproximal area. It was then discovered that the papilla was more complex, acting not only as a biological barrier but also playing a role in esthetics, phonetics, and preventing food impaction.

For the last 30 years, the replacement of lost teeth with dental implants has become a viable and predictable solution for fixed or removable dental prosthesis.

Success of buccal rehabilitation with implantation depends highly on the implant components integration with the mouth tissues, both soft and hard. The loss of the bone crest (BC) and, as a result, of the interproximal papilla, is often found in the 1st year after the implantation, followed by a minimum bone loss, not higher than 0.2 mm annually. Six possible etiologic factors were described: Surgical trauma, occlusal overload, peri-implantitis, micro-distance, biological distance, and implant anatomy at the crest region. The distance between the BC and the interproximal contact point (CP) is also a determining factor for health and esthetics of the gingival papilla since it significantly influences the presence of interproximal gingival papilla, both in natural dentition and unitary implant restored areas, at the anterior region of the maxilla.

In this context, different types of implant connections may also influence the development, maintenance, and anatomy of the gingival papilla given the different types of forces created at the interface between the implant and prosthetic component.

This study aims to analyze, through clinical and radiological observations, the presence of gingival papilla adjacent to unitary implants with Morse taper and external hexagon prosthetic platforms at the esthetic region of the maxilla, correlating this with vertical (height) and horizontal (width) distance, periodontal/peri-implant biotype, and adjacent prosthetic tooth/crown.

Contributors:

1Master, Department of Dental Prosthesis, São Leopoldo Mandic Dental School - Campinas, São Paulo - Brazil; 2Student of the Graduate Program, Master in Dental Prosthesis, Department of Prosthodontics, São Leopoldo Mandic Dental School, Campinas - São Paulo – Brazil; 3Master, Department of Endodontics, Itaúna University, Itaúna, MG - Brazil; 4Coordinator and Adjunct Professor, Department of Restorative Dentistry, São Leopoldo Mandic Dental School, Campinas - São Paulo - Brazil.

Correspondence:

Dr. Kreve S. Rua Independência 1899, Apto 602, Centro, Toledo, Paraná -Brazil. CEP 85902-015. Phone: 55 (45)99291422.
Email: simonekreve@hotmail.com

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The project was approved by the Research Ethics Committee, under the protocol number 2012/0437, according to Resolution 196/96 of the National Health Council (Conselho Nacional de Saúde/MS). Patients were distributed in one of three groups according to:

- Group 1 (control): Patients with healthy and complete dentition of the upper arch or with a satisfactory restoring treatment;
- Group 2: Patients with osseointegrated unitary implants with external hexagon connection on the anterior region of the upper arch;
- Group 3: Patients with Morse taper unitary implants with reduced platform intermediates on the anterior region of the maxilla.

Group 1 had 27 areas assessed in 14 patients; Group 2 had 25 areas in 13 patients assessed; Group 3, 22 areas in 9 patients.

Systemic pathological condition or the administration of daily medications is considered exclusion criteria. Patients included in the study were submitted to a rigorous clinical control of their periodontal and peri-implant health to assure that diseases such as gingivitis, periodontitis, or peri-implantitis would not interfere with the data collection. To this end, a clinical exam sought for clinical signs as gingival bleeding, edematous inserted gingiva, and gingival tissue with reddish, smooth, and shining aspect, with loss of its orange peel appearance. If any of these signs were observed, the patient was subjected to scrapping (using Teflon-coated implant curettes) and to prophylaxis followed by detailed instructions for self-care and oral hygiene. Thus, measurements taken under gingival inflammation condition were prevented.

For Group 1 patients, the interdental area between upper lateral and central incisors was evaluated. For Groups 2 and 3, the interproximal area evaluated was that with an osseointegrated implant with prosthetic glazed crown adjacent to a natural tooth, always on the upper anterior region.

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This clinical exam consisted, initially, on the visualization and classification of the interproximal gingival papilla, using the index proposed by Jemt, in 1997. An imaginary line was drawn joining the most cervical points of the gingival border of the two teeth adjacent to the interproximal area evaluated (Figure 1).

From this line, the height of the interdental gingival papilla was measured in reference to the point of contact in the interproximal area. According to these measurements, the following indexes were used to classify the presence of interproximal gingival papilla:

a. Index 0: Absence of interproximal dental papilla;

b. Index 1: Presence of gingival papilla, measuring less than half the distance between the imaginary line and the interdental CP;

c. Index 2: Presence of gingival papilla, measuring at least half the distance between the imaginary line and the interdental CP, but without filling the entire interdental space;

d. Index 3: Presence of gingival papilla filling the entire interdental space;

e. Index 4: Hyperplastic gingival papilla, covering part of the crown or prosthetic crown adjacent to the studied area.

For Indexes 0-2, the distances from the papillary crest to the interdental CP were measured with a periodontal probe graduated in millimeters (Hu-Friedy, model XP23/QOWBR) (Figures 2 and 3). For Index 3, the height of the gingival papilla and the distance from the BC to the CP were considered equal.

The following step consisted of the radiographic exams. Small sterilized metallic markers, with 1 mm of diameter, were previously placed at the interdental CP for identification in the radiography (Figure 4). To place the marker on the CP, a small portion of composite resin was employed with no polymerization or previous conditioning, facilitating its removal after the procedure.
Figure 4 shows the most coronal boundary of the metallic marker as the closest surface to the CP. This was the reference used in the measurements. The radiographies were standardized using the parallelism technique with a positioner.

A millimetric mesh was applied to the radiographic film (Figure 5) to prevent small distortions to significantly influence the measurements.

The radiographic processing was manually carried and both the anatomic structures and the lines derived from the mesh applied to the films were observed (Figure 6).

The films were digitalized (Genius ColorPage HR7X Slim scanner), and the distances were estimated with the software image tool (Barcelona, Spain), assuring measurement standardization, since this software allows for calibration.

The following measurements were obtained: Distance from the most coronal portion of the alveolar BC to the interdental CP, represented by the radiopaque metallic marker at the radiography as previously described, referred to as height; in patients of Group 1, the distance from the proximal wall of a root to the proximal wall of the adjacent root over the BC, referred to as width; for patients of Groups 2 and 3, this width was also obtained over the BC and is measured from the proximal wall of the natural tooth root to the most proximal portion of the implant or the prosthetic component placed over the implant.

For regions classified as 3, the height also represented the gingival papillary height since it fills the entire proximal area. For regions classified as 0, 1, and 2, the height of the gingival papilla can be obtained by the subtraction of the probed space between the papilla and the CP from the height obtained from the radiography analysis. The study did not include any Index 4 areas since all hyperplasias of the gingiva were controlled before being included in the study.

The data collected were then statistically analyzed. If the same subject had more than one tooth assessed, the median of the scores and the mean of the heights were used in the analysis. Medians were compared with Kruskal-Wallis test. Since the distribution of papillary heights attended the requirements of a parametric analysis, a variance analysis according to one factor was used. Correlations between variables scores, CP-papilla distance, CP-bone distance, probing, and papillary height were also calculated according to Pearson’s correlation for quantitative variables or Spearman’s when at least one of the variables was qualitative. All the analyses considered 5% of significance and were conducted on SAS (Cary, NC, USA, 2010) and Bioestat (Belém, Pará, Brazil, 2009).

Figure 3: Probe graduated in millimeters measuring the distance from the gingival papillary crest to the interdental contact point. Source: Perez et al., 2012. p. 3.

Figure 4: Metallic marker placed on the contact point. Source: Perez et al., 2012. p. 4.

Figure 5: (a) Millimetric mesh, (b) millimetric mesh applied to the radiographic film. Source: Perez et al., 2012. p. 4.

Figure 6: Radiographic image obtained with the application of the millimetric mesh. Source: Perez et al., 2012. p. 5.
Results
Table 1 and Chart 1 show median, minimum, and maximum medians of the patient’s scores according to the group. There was no significant difference between groups ($P > 0.05$); however, since $P$ value (0.0698) was close to the defined threshold (0.05), we suggest further investigation with a larger sample size.

Table 2 and Chart 2 present the average and standard deviation of the papillary heights according to the group. No significant difference was found between the groups ($P < 0.05$); however, since $P$ value (0.0579) was close to the defined threshold, we encourage further research with a larger sample size.

Table 3 presents the results for the correlations between the analyzed variables. One can notice a strong negative correlation between scores and CP-papilla, a strong positive correlation between CP-papilla and CP-bone, a moderate negative correlation between score and papillary height and between CP-bone and papillary height ($P < 0.05$).

Discussion
The smile line and the morphology of the papilla between two adjacent teeth are some of the factors worth analyzing before implant treatment since the gingival papilla play important physiological functions related to mastication and phonetics, such as avoiding food accumulation at the interproximal area and avoiding air leakage during certain phoneme pronunciation.\textsuperscript{7,9-11} However, the absence of the papilla or its under sizing shows the important esthetic role of this structure.\textsuperscript{12-15}

The esthetic demand of conventional rehabilitating treatments is also observed in treatments with prosthesis on implants, where the peri-implant tissue integrity, particularly the presence of interdental papilla, is a fundamental factor for a favorable esthetic result as shown by several studies.\textsuperscript{7,9,16-18} The increase in esthetics demand require a harmonious contour of the gingival soft tissue and intact interdental papilla.\textsuperscript{19}

For several authors,\textsuperscript{20-24} the use of osseointegrated implants on the anterior region is a technically delicate procedure, where a mistake can result in irreparable esthetic flaws.

Several studies describe surgical\textsuperscript{10,13,25-27} and non-surgical techniques\textsuperscript{3,25} for gingival papillary reconstruction. Despite this abundance of studies, Cronin and Wardle\textsuperscript{28} (1983) describe the possible causes for papillary tissue loss and stress the difficulties found when the underlying bone support is deficient.

Given this amount of information, some authors argue that the presence of an esthetically sound gingival papilla is determined more by a set of previously existent anatomical factors than by the ability and technique of the surgeon.\textsuperscript{29} In addition to the development of surgical techniques for the gingival papillary reconstruction, we need to understand the anatomy of the region. Since the gingival papilla is a structure connected to periodontal support tissue, one can expect the structure will have the same histological pattern.

\begin{table}[h]
\centering
\caption{Median, minimum and maximum score (gingival papilla presence index as suggested by Jemt, in 1997) according to group.}
\begin{tabular}{|c|c|c|c|}
\hline
Group & Median & Minimum & Maximum \\
\hline
1 & 3.0 & 1.0 & 3.0 \\
2 & 2.0 & 0.5 & 3.0 \\
3 & 3.0 & 0.5 & 3.0 \\
\hline
\end{tabular}
\begin{flushleft}
Group 1: Patients with healthy and complete dentition on the upper arch or with satisfactory restoring treatment; Group 2: Patients who received osseointegrated unitary implants with external hexagon connection on the anterior region of the upper arch; Group 3: Patients who received unitary implants with Morse taper connection on the pre-maxilla. $P=0.0698$
\end{flushleft}
\end{table}

\begin{table}[h]
\centering
\caption{Mean and standard deviation of the papillary heights according to group.}
\begin{tabular}{|c|c|}
\hline
Group* & Mean±SD \\
\hline
1 & 3.86±0.84 \\
2 & 4.62±0.96 \\
3 & 3.80±0.84 \\
\hline
\end{tabular}
\begin{flushleft}
*Group 1: Patients with healthy and complete dentition of the upper arch or with satisfactory restoring treatment; Group 2: Patients who received osseointegrated unitary implants with external hexagon connection on the anterior region of the upper arch; Group 3: Patients who received unitary implants with Morse taper connection on the pre-maxilla. $P=0.0579$
\end{flushleft}
\end{table}
The present study measured the biological distances related to oral rehabilitation with unitary implants in the pre-maxilla region, using two different implant systems (external hexagon and Morse taper), attempting to establish their influences on the final esthetic result, i.e., on the dimensions of the peri-implantar papilla after the rehabilitation treatment. We used the same methodology as Perez et al., in 2012, which is similar to that used by Tarnow, in 1992, but using the radiographic images to check if the distance from the BC to the CP plays a role on the presence or absence of the interdental papilla.

Analyzing the median, and minimum and maximum score medians according to the group, there were no significant differences between groups. Comparison between mean and standard deviation of the papillary heights related to groups and also showed no significant differences in the variance analysis test. It is worth stressing that (Table 2 and Chart 2) the group with the highest mean papillary height was Group 2 (external hexagon). This result is likely due to the limited sample size (around 24 subjects per group). The analyses resulted in significance levels close to the defined threshold (0.05) both in the comparison of scores (0.0698) and variation of papillary heights (0.0579).

The data revealed that CP-BC distance (contact point - bone peak) influence the presence of the papilla, how grater the distance CP-BC, shortest is the papilla scores (Table 3). This result was similar to that found by Perez et al. (2012). The author mentions that the distance between the BC and the interproximal CP (height) plays a significant role in the presence or absence of interproximal gingival papilla, both on the anterior and posterior regions.

Rehabilitations using the concept of switching platform have been studied with regards to the advantages and disadvantages of its use on the short and long term. Some advantages, such as decreasing in peri-implantar BC resorption, were observed by Canullo et al., in 2010, who claimed, following the analysis of 60 implants, that there is an inverse relationship between the extension implant-prosthetic component and bone loss, which is, the larger the discrepancy, the smaller the bone loss on the peri-implantar crest, in addition to an influence on the longitudinal maintenance of the bone level.

Analyzing the papillary filling of the studied areas, Jemt’s Index 3 was found in 66.7% of the areas in Group 1, 32% in Group 2, and 68% in Group 3. In percentage, the group rehabilitated with Morse taper implants had a higher papillary index, outperforming the control group.

**Conclusion**

Given the methodology employed in the present work and the data analysis, one can conclude:

a. Analyzing the filling of the interproximal space by the gingival papilla, there are no significant differences between groups;

b. Group 3 - rehabilitated with Morse taper implants - has a better papillary filling index in comparison with Groups 1 and 2;

c. Comparison between the papillary heights related to the groups also shows no significant differences with the variance analysis test;

d. Distance between CP and BC plays a role in the presence of papilla, with larger CP-BC distances leading to smaller papillary scores;

e. It is of paramount importance that further research with larger sample sizes and longer follow-up time are conducted for better and more efficient statistics.

**References**


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**Table 3: Correlation coefficients (P-value) between score, contact point-papilla distance, contact point-bone distance, probing and papillary height.**

<table>
<thead>
<tr>
<th>Accessed items</th>
<th>Contact point-papilla</th>
<th>Contact point-bone</th>
<th>Probing</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score</td>
<td>-0.90 (&lt;0.0001)*</td>
<td>-0.58 (&lt;0.0001)*</td>
<td>-0.13 (0.3584)</td>
<td>0.42 (0.0017)*</td>
</tr>
<tr>
<td>Contact point-papilla</td>
<td>-</td>
<td>0.75 (&lt;0.0001)*</td>
<td>-0.02 (0.8787)</td>
<td>-0.25 (0.0743)</td>
</tr>
<tr>
<td>Contact point-bone</td>
<td>-</td>
<td>-</td>
<td>0.05 (0.7078)</td>
<td>0.45 (0.0007)*</td>
</tr>
<tr>
<td>Probing</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-0.0007 (0.9574)</td>
</tr>
</tbody>
</table>

*Significance (P<0.05)