

# Dimension of Gingival Papillae between External Hexagon Dental Implants in Superior Anterior Sites

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## ABSTRACT

**Aim:** The aim of this study is to assess the height of the papillae located in interproximal, superior anterior rehabilitated areas between external hexagon implants and its relation with Jemt index, as well as correlate the height of the papillae with the distances between adjacent implants, distances from the tip of the papilla to the dental contact point, rehabilitation time, and patient's age.

**Materials and methods:** Twenty superior anterior, inter-implant areas were evaluated using clinical and radiographic exams.

**Results:** Positive correlation was found between the papilla size and the distance from the contact point to the bone crest. No significant correlation was revealed between the papilla size and the Jemt index; between the distances from the tip of the papilla to the contact point; or between the adjacent implants. In addition, there was no association between the papilla size with rehabilitation time or patient's age. No expressive difference was identified by comparing the mean papilla height measure in this study with the measures reported in the literature. However, a considerable result was found by assessing the papilla size and the distance from the bone crest to the dental contact point.

**Conclusion:** The present study did not reveal significant correlations between the papilla size and other investigated factors, such as Jemt index, inter-implant distance, contact point distance, and patient's age. The only significant association reported was a positive correlation between the papilla size and the distance from the bone crest to the contact point. Clinical significance: It is of utmost importance to observe the gingival papilla behavior over time and not only at the moment of prosthesis installation.

**Keywords:** Dental implants, Dental papilla, Gingiva, Periapical tissue.

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## INTRODUCTION

The relation between bone tissue and gingival tissue is fundamental to achieve predictable esthetic results in the

anterior segment. The presence of bone or gingival deformities mainly in interproximal areas is extremely unfavorable, even when the most modern restorative system available is selected.<sup>1</sup> In view of the frequency of rehabilitation with the use of implants, the same must offer functionality as well as phonetic integrity and optimal esthetics.

Several studies have aimed at elucidating the possible behavioral variables of the gingival papillae<sup>2-6</sup> and some works have determined the mean predictable heights of the gingival papillae located between adjacent implants.<sup>7-9</sup> Considering maxillary implants, several factors affect the papilla level,<sup>10</sup> and among them are the different implant-abutment connections,<sup>11</sup> and the influence of tissue thickness.<sup>12</sup>

The manipulation of the restorative components can influence the stability of the surrounding tissues.<sup>13</sup> Thus, the long-term maintenance of the papillae is crucial for a successful esthetic outcome.<sup>14</sup>

According to Tarnow et al,<sup>2</sup> the primary factor of interproximal papilla establishment is the distance between the adjacent teeth interproximal contact point (ICP) and the underlying bone crest. And how less is that distance, greater is the probability of papillae presence.<sup>15</sup> Considering the absence of papilla, some surgical and nonsurgical methods for papilla reconstruction were proposed.<sup>16</sup>

Considering that the gingival tissue behavior differs significantly on implants and teeth, the aim of the present study is to analyze the interference hypotheses of the Jemt index<sup>17</sup> by evaluating (1) The distance of the tip of the papillae in relation to the dental contact point, (2) the inter-implant distance, (3) the distance between the bone crest and the dental contact point, and (4) rehabilitation time and patient's age. We also compared the size or dimension of the papillae between two external hexagon implants located between the superior canine teeth with the measurements reported in the literature between tooth/tooth and tooth/implant (unitary external hexagon) in the same maxillary site.

## MATERIALS AND METHODS

The study was approved by the research ethics committee of São Leopoldo Mandic School of Dentistry and Dental Research Centre, under the protocol number 2012/0468.

Patients who have received two or more external hexagon implants were preselected for rehabilitation with

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unitary fixed dentures in the anterior maxilla, between the superior canine teeth. The patients went through a rigorous clinical control in order to check the level of periodontal health, and the ones who presented tissue alteration were excluded from the study.

Fourteen patients took part in the study (9 women and 5 men), with age between 36 and 78 years. Clinical and radiographic exams followed the same protocol for all patients.

The first stage of the clinical exam consisted of classifying the interproximal gingival papillae using the index proposed by Jemt<sup>17</sup> (Table 1).

The classification was done by drawing an imaginary reference line connecting the most cervical points of the gingival contour of the two adjacent crowns, and then a second perpendicular line connected the first reference line to the dental contact point, producing the interproximal area to be evaluated.

At the second stage of the clinical exam, the measurements from the contact point to the tip of the gingival papilla were recorded. A periodontal probe with millimeter markings (Hu-Friedy, model XP23/QOWBR) and a metallic marker fixed at the interdental contact point were used. Dental floss was used to identify the correct interdental contact point, which was trapped in the dental contact point. Then, the ends of the metallic marker were fixated at the crown structure on the dental floss with fluid light-curing resin (Opallis Flow, FGM, Joinville, Brazil). No conditioning was done in order to easily remove the marker posteriorly.

The classification as Jemt index 3 (gingival papilla filling up all interdental space) indicated that the distance from the contact point to the tip of the papilla was zero. The classification as Jemt indexes of 0, 1, and 2 was followed by the measurements which were recorded in integers, in millimeters. In cases where patients were to be classified as Jemt index of 4, they would have been excluded from the study. As the next step, still with the metallic marker fixated on the contact point, the radiographic exams

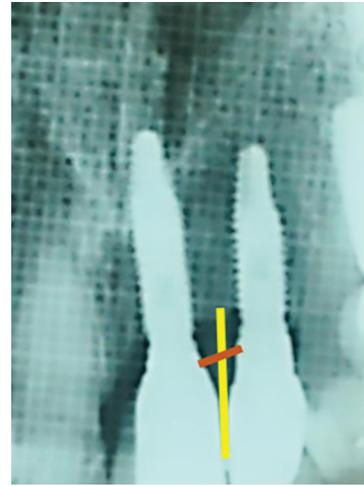


Fig. 1: Radiographic image with the millimeter markings layout used for measurements

were undertaken using the paralleling technique and a radiograph film positioner for standardization. A layout with millimeter markings was also used juxtaposed to the radiograph film so that the measurements would not be affected by imaging distortions (Fig. 1). After the radiographic processing, the images were digitalized for analyses.

The following measurements were performed: (a) Distance from the most coronal portion of the alveolar bone crest to the ICP, depicted in the radiographic image by the radiopaque metallic marker. This measure was referred to as "bone crest height to contact point"; (b) side-to-side width, which is the distance from the bone crest of the proximal wall of the implant neck to the proximal portion of the adjacent implant neck (Fig. 1); (c) height of the papilla obtained from the subtraction of the radiographic measure between the bone crest and the contact point from the clinical measure of the contact point to the tip of the papilla.

After all measurements, Spearman and Pearson tests were conducted.

The rehabilitation time and the age of the patient were stratified according to the respective medians in order to verify whether the papilla size was influenced by these variables, and Mann-Whitney tests were used.

One-sample Student's t-test was used to compare the data obtained in the present study with mean values reported in the literature for the height of the papilla in relation to the contact point. The values of 4.41 and 3.93 mm were used, corresponding to measurements between tooth/tooth and tooth/implant (unitary external hexagon) respectively.

Statistical analyses were conducted using the software Statistical Package for the Social Sciences 20 (SPSS Inc., Chicago, Illinois, USA), with significance level of 5%.

Table 1: Jemt index<sup>17</sup>

Index 0	No interproximal papilla is present
Index 1	Less than half of the height of the papilla is present (less than half of the distance between the imaginary cervical line and the interdental contact point)
Index 2	At least half of the height of the papilla is present (half or more than half of the distance between the imaginary cervical line and the interdental contact point, however without filling up all interdental space)
Index 3	The papilla is present and fills up the entire interdental space
Index 4	The gingival papilla is hyperplastic and covers part of the crown of the adjacent tooth or denture

Source: Own authorship (based on Jemt<sup>17</sup>)

**Table 2:** Descriptive statistics of the assessed variables

Assessed variables	Mean (standard deviation)	Median
Jemt index*	–	1.00
Papilla height in relation to the contact point (Pt C./PP)	5.00 (2.47) mm	6.00 mm
Distance between implants (Lat./Lat.)	1.80 (1.24) mm	1.00 mm
Distance between the bone crest and the contact point (Cr.O/PC)	10.42 (3.17) mm	10.00 mm
Papilla size	5.53 (2.61) mm	5.00 mm
Rehabilitation time	7.55 (3.27) years	8.00 years

\*Calculation of mean and standard deviation does not apply to qualitative data (scores); Source: Own authorship

## RESULTS

The sample was composed of 14 subjects who had been evaluated on 20 sites where adjacent osseointegrated external hexagon implants existed. The subjects were aged between 36 and 78 years (mean = 56.7; standard deviation = 9.3, median = 56.0).

Table 2 summarizes the Jemt index<sup>17</sup> values of median, mean, and standard deviation of the papilla height in relation to the contact point (Pt C./PP), of the distance between implants (Lat./Lat.), of the distance between the bone crest and the contact point (Cr.O/PC), of papilla size, and rehabilitation time.

Spearman test did not demonstrate significant correlation between the papilla size and Jemt index<sup>17</sup> ( $p = 0.584$ ) as shown in Graph 2A.

Spearman test also failed to reveal significant correlation between the papilla size and the distance between the tip of the papilla in relation to the contact point (Pt C./PP) ( $p = 0.276$ ), as depicted in Graph 2B.

Papilla size did not correlate with the distance between implants (Lat./Lat.) as shown by Spearman test ( $p = 0.868$ ) and illustrated in Graph 2C.

Spearman test shows a positive mild correlation ( $r^2 = 0.529$ ;  $p = 0.020$ ) between the papilla size and the distance between the bone crest and the contact point (Cr.O/PC), as shown in Graph 2D.

Pearson test shows no significant correlation between papilla size and rehabilitation time ( $p = 0.111$ ) as illustrated in Graph 2E.

Pearson test revealed no significant correlation between papilla size and patient age ( $p = 0.566$ ; Graph 2F).

Stratifying the rehabilitation time by the median value (8 years, Table 2), Mann–Whitney test indicated no significant difference on the papilla size for either rehabilitation time up to 7 years or rehabilitation time of 8 years or longer ( $p = 0.838$ ).

Stratifying the patient's age by the median value (56 years), Mann–Whitney test showed no significant

difference on the papilla size for either patient's age up to 56 years or patient's age of 57 years, or older ( $p = 0.935$ ).

Comparing the mean papilla size found in the present study with the mean value of 4.41 mm for tooth/tooth measurements reported in the literature, one-sample Student's t-test showed that the mean papilla size between two external hexagon implants (mean = 5.53 mm; standard deviation = 2.61 mm) did not significantly differ from tooth/tooth papilla size (i.e., 4.41 mm) ( $p = 0.078$ ).

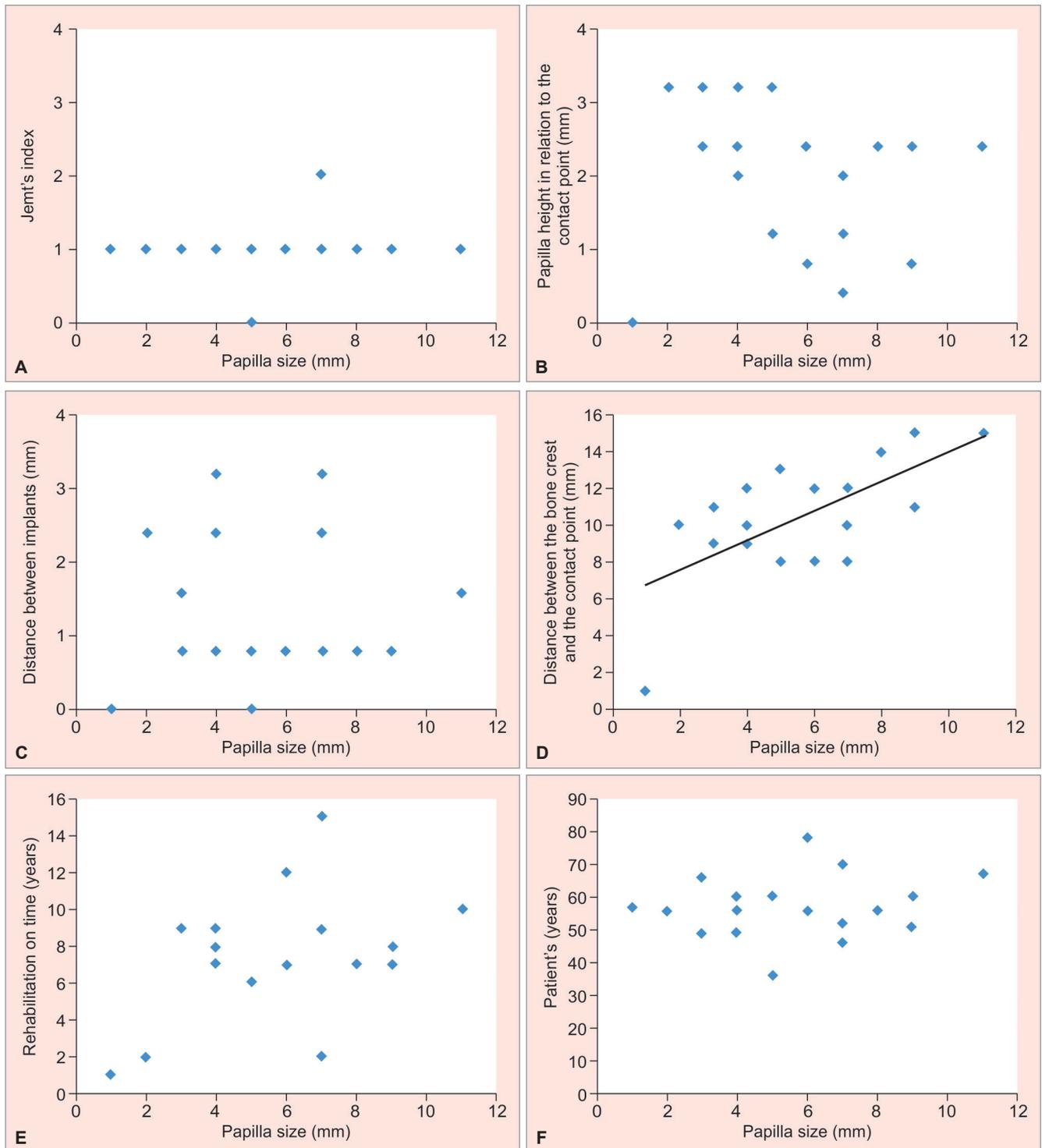
In addition, one-sample Student's t-test revealed that the mean papilla size measured in the present study (mean = 5.53 mm; standard deviation = 2.61 mm) was significantly larger than the mean value for tooth/implant (unitary external hexagon) reported in the literature (3.53 mm) ( $p = 0.004$ ).

## DISCUSSION

The gingival papilla has important physiological roles since it participates in mastication and phonetic processes.<sup>18</sup> However, when the esthetic role of the gingival papilla is also taken into account, mainly in cases with complete or incomplete loss of papillae, it is noticeable the limitation in obtaining satisfactory esthetics.<sup>19</sup> This issue becomes even more severe when the difficulty of the process for reconstituting the integrity of the gingival papilla is considered.<sup>1,15</sup>

Tarnow et al<sup>2</sup> assessed the distance from the bone crest to the interdental contact point and correlated this measure with the presence or absence of interproximal gingival papilla. When the distance from the IPC to the bone crest was shorter than 5 mm, the papillae would completely fill up the space, whereas when the IPC was 6 mm, the complete filling was observed in 56% of the cases, and when the IPC was larger than 7 mm, the papillae would completely fill up the space in only 27% of the cases. The aforementioned work has become a key reference for researchers investigating interdental areas.<sup>3,6</sup>

According to Chen et al,<sup>16</sup> for natural teeth, the shorter the distance between the alveolar bone crest and the contact point, the greater the probability of the presence of the papilla. Nevertheless, some authors show that the larger the distance between the bone crest and the contact point, the shorter is the papilla height.<sup>20</sup> However, studies with inter-implant areas have reported that the area is handled by the prosthetic dentist which could affect its stability.<sup>9</sup> A significant relation between the increase of the papilla size and the increase in the distance from the bone crest to the contact point was observed in the present study. The larger the distance from the bone crest to the contact point, the greater the papilla size—even with the



**Graphs 2A to F:** (A) Dispersion plot for papilla size as a function of Jemt index.<sup>17</sup> (B) Dispersion plot for papilla size as a function of papilla height in relation to the contact point (Pt C./PP). (C) Dispersion plot for papilla size as a function of the distance between implants (Lat./Lat.). (D) Dispersion plot for papilla size as a function of the distance between the bone crest and the contact point (Cr.O/PC). (E) Dispersion plot for papilla size as a function of rehabilitation time. (F) Dispersion plot for papilla size as a function of patient's age

mean inter-implant distance (size-to-size) found in our study (1.8 mm) being inferior to the measures reported in the literature for inter-implant areas (3–4 mm).<sup>4,5</sup>

The present study assessed the papilla size or height which corresponds to the amount of inter-implant gingival tissue that could be formed from the inter-implant bone crest or plateau. Specifically for the Tarnow et al<sup>9</sup>

study, a mean value for the papilla height of 3.4 mm which could vary from 1 to 7 mm was reported. Salama et al<sup>7</sup> showed that in proximal areas located between natural teeth, the papilla will reach a predictable height of 5 mm, and between implants and natural teeth, the height will be 4.5 mm, and also between implants, the height will be of 3.5 mm. In addition, Molina et al<sup>13</sup> claim that there

is clear evidence that the papilla in contact with adjacent implants presents impaired filling process. Kourkouta et al<sup>8</sup> observed that between adjacent implants in the anterior maxilla, the mean vertical dimension of the inter-implant papillae was 4.2 mm.

During a 3-year period, Jemt<sup>17</sup> observed that the presence of papillae between implants increased from 10 to 58%. The interdental papilla seemed to follow systematically always the same regeneration pattern, mainly when assessed after a 3-year period, and that the papilla does not remain stationary after the prosthesis placement. Similar to Jemt,<sup>17</sup> Oyama et al<sup>21</sup> studies also reported a significant increase of papilla size over time. The present study did not find significant correlation between papilla size and rehabilitation time, or between papilla size and patient's age.

In order to acquire Jemt's<sup>17</sup> classification of index 3 in rehabilitations for adjacent implants, Tarnow et al<sup>9</sup> and Cosyn et al<sup>22</sup> suggest to position the dental contact between 2 and 4 mm from the bone crest, with a complete papilla filling on the space between the crowns until the contact point. On the contrary, according to Lops et al,<sup>3</sup> the recommended dimensions of the interproximal space are 3 to 4 mm between the implant and the adjacent tooth, and 3 to 5 mm between the contact point and the bone crest.

In the present study, 95% of the evaluated areas had the papillae classified as Jemt<sup>17</sup> index 1 which theoretically would make them esthetically unsatisfactory. However, when asked, all patients were satisfied with the rehabilitation results. These findings are in accordance with other authors.<sup>23-25</sup>

Greenstein and Tarnow<sup>26</sup> described a surgical technique which makes use of small incisions in order to preserve or restore the papillary form and function without directing the papilla to the cervical. The interaction between surgical and prosthetic procedures represents the key factor to optimize predictable esthetic outcomes.<sup>3</sup>

The methodology applied in the present study attempted to follow a less invasive procedure in the assessment of the distance between the bone crest and contact point, when compared with the probing method. We also determined the contact point and the fixation of the metallic marker prior to the clinical measurements of the distance between the contact point and the tip of the papilla, so that the positioning would coincide with the radiographic measurement between the contact point and the bone crest.

A continued search is necessary for excellence regarding gingival esthetic in dental rehabilitation using adjacent osseointegrated dental implants. The comprehension of the elaboration and confection of temporary

restorations as a means to obtain more esthetically favorable gingival papillae should be better investigated.

## CONCLUSION

From the methods used and data analyses conducted in the present study, it can be concluded that:

- No significant correlation was found between the papilla size and the Jemt index<sup>17</sup>;
- No significant correlation was revealed between the papilla size and the distance of the tip of the papilla in relation to the contact point;
- The papilla size did not significantly correlate with inter-implant distance;
- Positive and mild correlation was found between the papilla size and the distance from the bone crest to the contact point;
- No significant correlation was shown between the papilla size and rehabilitation time;
- No significant correlation was found between the papilla size and the patient's age.

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