Evaluation of Soft Tissues Around Single Tooth Implants in the Anterior Maxilla Restored With Cemented and Screw-Retained Crowns

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Implant-supported restorations can be attached as screw-retained or cemented prostheses. In both situations, the characteristics of the soft tissues around the implants are crucial for oral rehabilitation and patient satisfaction. Therefore, this study uses the Pink Esthetic Score (PES), which allows evaluation of gingival esthetics around implants, to evaluate the soft tissues around implants in the anterior maxilla rehabilitated with cemented prostheses (CP) and screw-retained prostheses (SP). Forty implants placed in the anterior maxilla were evaluated, and these had been rehabilitated with prosthetic crowns for a minimum of 1 year. Periodontal examination was performed to evaluate probing depth (PD) and bleeding on probing (BOP) of the implant and the corresponding natural tooth. The total mean (±SD) PES for SP was 10.73 (±1.98) and 10.41 (±2.67) for CP, which was not statistically significant (P ≥ .05). Periodontal examination revealed that CP and SP showed no difference for BOP (P ≥ .05). Differences were only detected in PD when comparing the reference teeth of both groups to CP and SP (P ≤ .05). The present study demonstrates that the PES proved to be an efficient index to assess peri-implant tissues, and that the type of crown retention does not influence the health and quality of the soft tissues around implants.

Key Words: implants, prosthesis, screw retention, cement retention, esthetics

INTRODUCTION

Implant-supported restorations can be attached as screw-retained or cemented prostheses, according to the type of retention. Screw retention was developed in response to the need for prosthesis retrievability, which can be obtained with this attachment. This innovation was essential given the high rates of complications in the early development of implant dentistry, when removal of the prosthesis was often required for repair or replacement.1 Currently, many implant systems use abutments retained by screws, and the prosthesis can be cemented on these abutments using techniques that mimic the procedures used to prepare conventional fixed prostheses on natural teeth.2 The selection of the type of prosthesis to be used may influence the esthetic result.1 Ideally, implant-supported prostheses should mimic a natural tooth3; therefore, the quality of the peri-implant soft tissues plays a decisive role.4

The success of dental implants based on the classic criterion of Albrektsson et al5 considered implants to be successful if they osseointegrated and were functional after loading. Later, Smith and Zarb6 added the possibility of placing a prosthesis with good esthetic result to the definition of a successful implant. This fact was taken into consideration in the assessment of esthetically sensitive
regions such as the anterior maxilla.\textsuperscript{7} In 1997, Jemt\textsuperscript{7} proposed a papilla fill index that assessed the size of the interproximal gingival papilla. This index is accepted and used by many researchers in the esthetic evaluation of single tooth implants. However, other characteristics of the soft tissues, such as color and texture, are important for a good esthetic result around implants.\textsuperscript{8}

In 2005, Fürhauser et al\textsuperscript{9} created a comprehensive index, the Pink Esthetic Score (PES), which assesses multiple soft-tissue characteristics around implants and teeth. The PES was used to objectively evaluate peri-implant soft-tissue esthetics. This index is based on 7 soft-tissue variables that can be assessed using the natural tooth as reference. The PES has proved to be a reliable index for rating peri-implant soft tissues because it can be replicated.\textsuperscript{9} According to Gehrke et al,\textsuperscript{10} the PES allows an objective assessment of esthetics in the short and long term.

Belser et al\textsuperscript{11} considered the PES to be a very useful tool; however, further comparative studies may be performed to investigate the different possible clinical uses of implants and such factors as implant loading time, implant design, surgical access route used, and the types of prostheses. The 2 types of prostheses present advantages, disadvantages, and limitations. Screw-retained prostheses are retrievable and recommended for use in regions with multiple connected implants or areas with limited interocclusal space. On the other hand, cemented prostheses are often used when implant misalignment is present and for better esthetics when occlusal access holes are a concern. Therefore, each clinical situation will specifically dictate which type of implant prosthesis is most appropriate.\textsuperscript{12}

The purpose of this study was to compare peri-implant tissue esthetics and health of single tooth implants in the anterior maxilla using PES, probing depth (PD), and bleeding on probind (BOP) indices.

**Material and Methods**

**Selection of patients**

The present study was submitted to and approved by the Research Ethics Committee of the Federal University of Maranhão (Protocol No. 23 115 003 219/2010–48). All the selected patients gave informed consent and filled out a form with their personal data. Thirty-two patients were included in the study. The group consisted of 18 women and 14 men aged 24–63 years, and the mean age was 43 years.

The selected sample included healthy patients who attended the clinic of the Federal University of Maranhão. All the participants met the following inclusion criteria: no heavy smoking (>10 cigarettes/day), systemically healthy, no uncontrolled diabetes, presence of an available contralateral natural tooth in the anterior region for comparison, and presence of a well positioned implant 3-dimensionally.

**Study design**

This was a cross-sectional study that evaluated 40 single-unit implants placed in the anterior maxilla region: 23 screw-retained prostheses (SP) and 17 cemented prostheses (CP), corresponding to 19 central incisors, 11 lateral incisors, and 10 canine teeth. The implants used the externally hexed Branemark system with 3.75 mm and 3.3 mm diameter. All 40 of the single tooth implants evaluated were placed in the anterior maxilla region and extended until the canine region, and their tridimensional position was correct. The prosthesis crowns had been placed for a minimum of 1 year. Each prosthetic crown on an implant and peri-implant soft tissue were photographed. The pictures were taken by the same trained and calibrated operator using a Canon Powershot SD7901S digital camera (Lake Success, NY). A front-view photograph of the anterior maxilla and an occlusal photograph were obtained, using cheek retractors to make it possible to visualize and symmetrically represent the implant and the respective tooth for comparison up to the mucogingival line. For each view, 2 photographs focused on the upper teeth and implants were taken to ensure proper documentation and further analysis of PES. One occlusal photograph of the respective elements was included to provide better assessment of the alveolar process.

**Clinical procedures: periodontal clinical examination**

For each selected implant and contralateral tooth, BOP was determined using the index of Ainamo and Bay.\textsuperscript{13} Also, PD measurement was performed using a North Carolina probe (diameter 0.5). The values of the 6 sites (mesio-vestibular, vestibular, disto-
vestibular, mesio-palatine, palatine, and disto-palatine) were recorded for each tooth and implant.\textsuperscript{15}

**Assessment criteria**

The photographs were enlarged to twice their size and printed with the list of variables. The prosthetic crowns were marked by arrows and delineated (Figure 1). All the photographs were developed and processed by the same person for standardization purposes.

The PES is based on 7 variables: mesial papilla, distal papilla, soft-tissue level, soft-tissue outline shape, deficient alveolar process, soft-tissue color, and soft-tissue texture. Each variable was assessed using the 0-1-2 scoring, with 2 being the highest score and 0 the lowest score (Table 1). The highest possible score of 14 reflects a peri-implant tissue that is most similar to the soft tissues of the reference tooth. The mesial and distal papillae were assessed as complete, incomplete, or absent. All the other variables were assessed by comparison with the reference tooth (Table 1).

The PES was assessed by the same examiner. To reduce bias and ensure excellent reproducibility, a complete evaluation of all the restorations were carried out in the same period and repeated on 2 different days. In case of different scores, the examiner reassessed the photographs carefully for 2 more days to obtain the final result.

**DATA ANALYSIS**

Statistical analysis was performed by comparing PES between the groups restored with CP and SP. The variables were assessed separately and the PES values then determined. The Mann-Whitney test was used to compare the PES between the 2 types of prostheses. A comparison of PD and bleeding on probing (BOP) was also performed between CP, SP, and their respective natural teeth. One-way analysis of variance and Tukey’s multiple comparison test (\(\alpha = 0.05\)) were used for PD, and the Mann-Whitney test was used for BOP. The level of significance used for all the analyses was 5%.

**RESULTS**

The summarized scores, including means and standard deviations of PES scoring of the 40 implants examined are shown in Table 2. The total mean PES was \(10.73 \pm 1.98\) (range = 5–13) in the SP group and \(10.41 \pm 2.67\) (range = 5–14) in the CP group (see the example on Figure 2). The difference between these 2 values was not statistically significant (\(P \geq .05\); Table 2). The distal papilla (1.13 ± 0.62) and soft-tissue texture (1.43 ± 0.50) variables had the lowest values in the SP group, whereas in the CP group, the lowest values were for the alveolar process (1.35 ± 0.78) and soft-tissue texture (1.35 ± 0.78) (Table 2).

![Figure 1](image.png)

**Figure 1.** Illustration of the variables assessed in the Pink Esthetic Score index.

<table>
<thead>
<tr>
<th>Table 1</th>
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<tr>
<td><strong>Pink Esthetic Score variables</strong>^*^</td>
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<table>
<thead>
<tr>
<th>Variables</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
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<tbody>
<tr>
<td>1. Mesial papilla</td>
<td>Absent</td>
<td>Incomplete</td>
<td>Complete</td>
</tr>
<tr>
<td>2. Distal papilla</td>
<td>Absent</td>
<td>Incomplete</td>
<td>Complete</td>
</tr>
<tr>
<td>3. Soft-tissue level</td>
<td>&gt;2 mm</td>
<td>1–2 mm</td>
<td>&lt;1 mm</td>
</tr>
<tr>
<td>4. Soft-tissue shape</td>
<td>Not very natural</td>
<td>Natural</td>
<td>Very natural</td>
</tr>
<tr>
<td>5. Deficient alveolar process</td>
<td>Obvious</td>
<td>Slight</td>
<td>None</td>
</tr>
<tr>
<td>6. Soft-tissue color</td>
<td>Different</td>
<td>Slight difference</td>
<td>No difference</td>
</tr>
<tr>
<td>7. Soft-tissue texture</td>
<td>Different</td>
<td>Slight difference</td>
<td>No difference</td>
</tr>
</tbody>
</table>

^*Source: Adapted from Fuhauser et al.\textsuperscript{10}
Eleven of 17 CP and 17 of 23 SP achieved PES values >10 (71%) out of a maximum possible value of 14, which corresponds to 70% of the cases. (Data not shown.)

Regarding the periodontal parameters PD and BOP, when comparatively assessed between the 2 types of prosthesis (SP and CP) and their respective reference teeth, no statistically significant difference for BOP was observed among all groups (Table 4). Differences were only detected in PD (Table 3) when comparing the reference teeth of both groups to CP and SP ($P < 0.05$).

**DISCUSSION**

This cross-sectional study with 32 patients showed the results of peri-implant soft tissues in 40 implants restored with screw-retained and cement-retained crowns in function for a minimum of 1 year. Assessment of gingival esthetics was performed using the PES index created by Fürhauser et al., which compares the implant to a contralateral natural tooth. The total mean PES in the SP and CP groups showed no statistically significant differences, demonstrating that an esthetically satisfactory result can be obtained with both types of prosthetic connections. Eleven of 17 CP and 17 of 23 SP achieved PES values >10 (71.42%) out of a maximum possible value of 14, corresponding to 70% of the patients. According to Belser et al., PES scores above 60% represent a threshold of excellent clinical acceptability. No minimum value of acceptability was established for the PES; however, the authors observed that the PES may change with time and could therefore be a useful tool in longitudinal monitoring of peri-implant soft tissues. Besides allowing critical evaluation of the esthetic results in implant-based prostheses, the PES could also assist in planning surgical strategies and prosthetic treatments. The authors recognize the importance of the papilla fill index initially proposed by Jemt in 1997, which was widely accepted and used by many researchers for the evaluation of single tooth implants. However, this index only evaluates the size of the interproximal gingival papilla, while the PES index includes tissue height, position, color, and texture and therefore is much more comprehensive.

Periodontal evaluation of PD and BOP performed in the present study showed that there was no soft-tissue inflammation around implants and the respective selected teeth that might affect PES assessment. The probing of peri-implant tissues has been suggested as a useful diagnostic procedure. Studies report a PD of approximately 3 mm in periodontally healthy implants, which was observed in the present study. However, the shallower probing of teeth, when compared to their respective implant, might be related to the density of peri-implant tissues, which may influence

![Figure 2. Cemented prosthesis (tooth #9) with a Pink Esthetic Score = 14.](http://meridian.allenpress.com/joi/article-pdf/38/6/700/2038631/aaid-joi-d-11-00125.pdf)
The peri-implant tissue offers less resistance to clinical probing, and consequently, deeper penetration can be achieved by the probe around implants. Restoration of dental implants can be challenging because of inadequate interdental, vestibular, or interocclusal space, especially in the anterior region, and SP and CP present advantages, disadvantages, and some limitations. There are few studies comparing the 2 types of retention of implant-supported prostheses, even though this decision is essential regarding the functional and esthetic results of implant restorations. Alterations in the peri-implant tissue are observed after the placement of the prosthetic crown, which may compromise the esthetics of the prosthesis and lead to a compromised clinical result and patient dissatisfaction. Complications related to peri-implant tissues are frequently associated with inadequate adaptation of components, screw loosening, and malpositioned implants. The present study has demonstrated that there is no statistically significant difference in esthetics between the 2 types of prostheses. Both types of connections may obtain an excellent esthetic result when using single implants in an esthetically sensitive region such as the anterior maxilla. More important than the type of prosthesis is correct tridimensional positioning of the implant and a well-designed prosthesis. A 3-mm inter-implant distance and a 3–34 mm distance between the implant and the tooth has been recommended for obtaining adequate interproximal papilla, although this relationship remains controversial. Nisapakultorn et al found that the interproximal papilla levels in anterior maxillary single-tooth implants are mostly influenced by the crestal bone level of the adjacent tooth, and the level of vestibular mucosa is affected by multiple factors, including periodontal biotype, vestibular crestal bone level, implant angulation, interproximal crestal bone level, and depth of the implant platform. The authors do not correlate these gingival parameters to the type of prosthesis. However, these factors are intrinsically related to PES variables.

In an article by Keller et al, the type of fixation (screw retained or cemented) has little impact on the microbiology and clinical parameters. It is only important to stress that peri-implant soft tissues respond more favorably to SP than CP, probably because of the better finish surface of the prosthetic element and the lack of a cement line in the peri-implant sulcus. Therefore, CP tend to show increased gingival sulcus bleeding and plaque index, although recession of soft tissue around the implant was not found to be predominant in any type of prosthesis. Nevertheless, this study has not detected any significant differences regarding BOP and PD scores for the 2 types of prosthesis, a clinical aspect that may have contributed to the favorable PES obtained in both types of prostheses.

Concerning the use of cement in CP, the technique has the inconvenience of allowing the overflow of cement residues, and thus, causes peri-implant inflammation associated with swelling, pain, increased depth, bleeding, or exudation on depth, which can lead to peri-implant bone loss. To prevent such consequences, the selected cement must be easy to handle and remove, so that no damage is caused to the component or the peri-implant soft tissue. However, in the present study, no data were found to corroborate the referred consequences related to CP. On the other hand, the clinician’s ability and experience may influence cementing and the adequate control of cement.
regardless of the technique used.\textsuperscript{27} Hence, biomechanical and esthetic factors, as well as clinical experience, should be considered when deciding which type of prosthetic connection should be used.

CONCLUSION

The present cross-sectional study compared, using the PES index, the esthetic results obtained between 2 different types of prosthetic restorations, screw and cement retained. The study has successfully demonstrated that both types of connection may achieve satisfactory results regarding peri-implant esthetics in the anterior maxilla using externally hexed single tooth implants.

ABBREVIATIONS

BOP: bleeding on probing
CP: cemented prostheses
PD: probing depth
PES: pink esthetic score
SP: screw-retained prostheses

REFERENCES