Clinical Evaluation of Hygiene Maintenance of Full-arch Implant-supported Prostheses

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Abstract:
Background: Implant-supported fixed prosthodontics is a successful treatment option for oral rehabilitation. The increased incidence of mucositis and peri-implantitis may, however, compromise the longevity of such strategy. Hygiene maintenance of the prosthetic appliance is essential for long-term success of osseointegrated implants, but unfortunately, oral hygiene has been a concern that has unaccompanied the evolution of this type of restorative approach. The aim of this study was to evaluate hygiene quality of the prosthesis and the soft tissues around implants by removing the appliance for assessment.

Materials and Methods: A total of 48 patients were included in the study. Their appliances were removed for examination, assessment, and debridement. The patients were instructed to performing hygiene methods using appropriate cleaning devices. They were reevaluated after 6 months.

Results: The G-test revealed that With the implementation of the hygiene measures provided, the patients reported differences in cleaning methods used (p < 0.001) and G test revealed significant hygiene changes in the prosthetic appliance (p = 0.024) were also observed. The data showed that cleaning was not affected by education level, but by the preference for quicker cleaning strategies that required little dedication.

Conclusions: Biofilm removal is a key factor for peri-implant health though hygiene quality remained far below acceptable standards, so that biofilm, calculus pseudomembranes were present in large quantities even after hygiene instructions.

Key Words: Biofilms, dental devices, dental implants, home care, stomatitis

Introduction
Dental implants have become routine in dental practice and are regarded as an integral part of total or partial rehabilitations in the edentulous arches. Surgical and prosthetic protocols are constantly being improved to minimize side effects and to increase patient satisfaction.¹ It is suggested that success of osseointegrated implants should not be solely based on osseointegration per se, but on the integration between the implant and the intraoral environment, including hard and soft tissues.

Treatment using dental implants has brought along new challenges, such as the growing incidence of peri-implant mucositis and peri-implantitis.

The correlation between bacterial plaque and the establishment of an inflammatory reaction was first described by Löe et al.² In the tooth-gingiva complex, this condition is known as gingivitis, whereas in the peri-implant mucosa, mucositis.³ The latter is characterized by mucosal inflammation around the implant and no evidence of alveolar bone loss. The first clinical signs of mucositis are erythema, edema of soft tissues, and bleeding on probing.⁴

In addition to mucosal inflammation, peri-implantitis is characterized by loss of alveolar bone,⁵ often associated with an increase in suppuration and probing depth.

With the increased use of osseointegrated implants and with so many implants functioning for long periods, the soft tissue around implants has become the focus of considerable attention, as the implant-gingival tissues work as a barrier, thus requiring an integration of three types of tissues: Bone, soft connective tissue, and epithelium.³

The contact between the biofilm accumulated between the prosthesis and the gingival mucosa leads to an imbalance between the microflora and the host response, which will culminate in an inflammatory reaction. A well-established biofilm around such structures will become the main source of microbes that cause peri-implantitis, which is a major cause of implant failure.⁵

The most appropriate therapeutic approach to tackle infections associated with the presence of biofilm is removing it, which in cases of gingivitis and periodontitis can be achieved with conventional oral hygiene methods. Jovanovic et al.⁶ reported an association between poor oral hygiene and peri-implant bone loss, which demonstrated that peri-implant disease is closely related to the presence of biofilm.

Consistent professional maintenance combined with effective self-performed biofilm control is key factors for long-term
stability of dental implants and prevention of biological complications.7

The aim of the present study was to evaluate the quality of biofilm control in patients with implant-supported fixed dentures, as evaluated by removing the current appliance for hygiene procedures and educating the patients regarding the practice of self-performed biofilm control and reassessing 6 months later, having the peri-implant tissue as a response variable in terms of health or inflammation.

Materials and Methods
This study was performed with the approval of the Ethics Committee of São Leopoldo Mandic College (CAAE: 44651615.7.0000.5774).

A total of 50 patients wearing full-arch implant-supported fixed prostheses were included in this study. A patient had to meet all of the inclusion criteria listed to participate in this study:
• Edentulous patients who had been treated with dental implants to achieve full-oral rehabilitation
• Patients who had been treated in program of dental implant rehabilitation in the Unipar - Universidade Paranaense at the Paraná state of Brazil, were recruited for the study on the basis of their availability
• Patients wearing full-arch implant-supported fixed prostheses either in the maxilla, the mandible or both.

The exclusion criteria were patients that have had any follow-up visit for plaque control of the prosthesis and/or the implants. The patients would have been wearing their appliances from 8 months to 4 years. At the time of fitting the prosthesis, the patients received guidance on how to perform adequate oral hygiene. They were verbally instructed to use soft or medium bristles toothbrush only on prosthetic surfaces or teeth, small-medium diameter soft bristles interdental brush, interdental floss, and even oral irrigators.

The patients were assessed on two separate occasions:
• Stage I (baseline) – Initial assessment of the above-described 50 patients
• Stage F (end-point assessment) – Second step of the study, corresponding to the same 50 patients invited to return after 6 months for re-evaluation.

Data were collected regarding the quality of hygiene and the condition of the mucosa in contact with the prosthesis and the implants. The examination was performed by a single examiner, following the criteria below:
• The mucosa surrounding the implants was regarded as healthy if it were pale pink, uniform in appearance and texture, free from edema, swelling or debris, and no sign of suppuration (Figure 1).
• Mucosal hyperemia: Presence of residues or biofilm, edema, mucosal erythema, or purpura with a flaccid appearance and bleeding on light touch (Figure 2).
• Mucosal hyperemia and suppuration: Visible erythema, spontaneous bleeding, or suppuration to the slightest touch (Figure 3a and b).

All implant-supported fixed prostheses were full dentures made of acrylic resin and a cast metal framework. They were removed to facilitate data collection, which consisted mainly of visual assessment of cleanliness (Figure 4), e.g., presence/absence of plaque (Figure 5) and/or calculus (Figure 6a and b).

Mucosal health/inflammation was assessed in terms of hyperemia and bleeding with suppuration. The patients had their prosthesis cleaned and were instructed by the same examiner on how to perform biofilm control.

The mucosal surface was first cleaned with moistened gauze, water rinses, and a regular mouthwash (Colgate, São Paulo,
Brazil) in patients presenting with plaque, residue, and inflammation.

The presence of calculus was verified around the abutments using visual inspection and a periodontal probe. Abutment stability was checked using dedicated tightening screwdrivers. Osseointegration was verified by implant mobility on palpation using the handles of a dental mirror (Figure 7).

Component cleansing was performed as needed, some of which required mechanical calculus removal using ultrasonic tools (Dabi Atlante, Ribeirão Preto, Brazil), others manual scaling using periodontal curettes, accompanied by prophylaxis with rotary brushes (DhPro, Curitiba, Brazil) and prophylactic paste (Vigodente, Rio de Janeiro, Brazil) (Figure 8).

The current study followed the proposed clinical cleaning protocol: Combined use of powered devices in plaque removal of prosthetic surfaces, manual teflon curettes for removing calculus from implant and metal curettes for dentures, and the use of interdental floss for complete the removal of plaque and calculus from the mesial and distal aspects of tilted implants. For home oral care, patients were instructed to using soft or medium brushes at dentures or teeth surfaces, interdental brushes of varied dimensions, interdental floss and, as adjuvant therapy, oral irrigators for those who owned them.

Participants wearing an upper appliance were instructed to flossing the spaces between implants and dentures using flossing guide tool (Sanifill, São Paulo, Brazil) (Figure 9).

Some patients were already using an irrigator device (Waterpik, Fort Collins, EUA).

Patients wearing lower dentures were also instructed to flossing (Sanifill, São Paulo, Brazil) interdental brushing (Bitufo, São Paulo, Brazil) single-tufted brushes for some cases, and even oral irrigators (Waterpik, Fort Collins, EUA) for those who had them (Figure 10).
At 6 months following oral hygiene instruction (Stage F), patients were reassessed by removing their appliance to access the same areas evaluated before oral hygiene guidance (baseline).

The same parameters used at Stage I were used to rate oral mucosal and prosthetic hygiene at Stage F.

The population of this observational study was characterized via independent variables such as gender, age, educational level, smoking, alcohol consumption, wages, hygiene levels (prosthesis and gingival health), and cleaning method in terms of absolute ($n$) and relative frequencies (%). The associations of variables: Level of hygiene of the prosthesis, gingival health, and hygienic cleansing method used previously and after hygiene guidelines were evaluated using the G-test.

Statistical analysis was performed on SPSS 20 (SPSS INC., Chicago, IL, EUA) and BioEstat 5.0 (Fundação Mamirauá, Belém, PA, Brazil), adopting a significance level of 5% ($\alpha = 0.05$).

Results
A total of 48 patients with full-arch implant-supported rehabilitation, 15 were males (31.3%) and 33 females (68.7%). Two patients were excluded from the study. One participant was excluded because he moved on to another country, and another one was traveling in the time of the second interview. Regarding age, the participants were 40-75 years old (mean 55.5, standard deviation [SD] 9.3 years). In terms of education level, 8 patients (16.7%) reported having completed elementary school, 7 (14.6%) reported having completed secondary school, 19 participants (39.6%) reported having completed high school, and the remaining 14 patients (29.2%) had a higher education degree.

Regarding social history, 85.4% of the patients were non-smokers, 8.3% reported smoking occasionally, and 6.3% were regular smokers (Chart 1). Regular alcohol drinking was reported by 4.2% of patients, 50.0% of them reported drinking occasionally, and 45.8% reported being non-drinkers (Chart 2).

As for income, 64.6% of the patients reported earning between 1 and 3 minimum wages (MW), 25.0% reported earning 3-5 MW, and the remaining 10.4% reported earning more than 5 MW.

Three of the participants wore fixed prosthesis on both arches; thus, 51 prosthetic appliances were evaluated, 25 in the maxilla, and 26 in the mandible.

Chart 1: Smoking habit among implant-supported fixed prosthesis wearers.

Chart 2: Alcohol consumption among implant-supported fixed prosthesis wearers.
The G-test revealed that the oral hygiene instructions given to the patients caused a statistically significant difference in the proposed cleanliness parameters of the fixed prostheses from Stage I to Stage F \( (P = 0.024) \). Note in Table 1 that 5 of the 51 prosthetic appliances (9.8\%) that were covered in plaque at Stage I were plaque-free at Stage F, though overall, the proportion of plaque and calculus remained unchanged from Stage I to Stage F.

Gingival health showed no significant change after hygiene instructions \( (P = 0.063) \), though the \( P \) value was close to 0.05, one may suggest a trend toward an improvement in gingival health, especially when considering that six of the seven initial cases that were hyperemic and supplicative at baseline were no longer so 6 months after hygiene instructions (Table 1).

The G-test revealed with hygiene instruction a significant difference was observed in the reported cleaning methods used by the patients \( (P < 0.001) \). As shown in Table 1, patients not performing adequate hygiene at the contact between the oral mucosa and the prosthetic appliance substantially dropped by 33.4\% (from 41.2\% to 7.8\%) at Stage F. A significant proportion of patients (35.3\%) began to use interdental brushes, which had no reported users at all at baseline. An increase of 58.8\% (from 3.9\% to 62.7\%) was observed in the use of floss guiding tips, which was the greatest increase among the methods investigated in this study. The use of the oral irrigator (Waterpik) only slightly increased between evaluation periods.

### Discussion

Dental plaque plays an important role in the development and maintenance of periodontal disease.\(^2\,^6\,^8\,^9\) The soft and hard tissues around implants share some similarities with the periodontium, and dental plaque plays a significant role on the success of treatment with dental implants.\(^10\)

Peri-implant mucositis is regarded as an inflammation induced by plaque confined to the soft tissues surrounding an implant without any evidence of progressive peri-implant bone loss.\(^4\,^6\,^8\,\,^{10-13}\) In contrast, progressive peri-implant bone loss in conjunction with a soft tissue inflammatory lesion is termed peri-implantitis. These two forms of disease are similar to gingivitis and periodontitis.\(^3\,\,^{10}\,\,\,\,^{14}\)

In this study, 48 out of 50 patients attended the second examination stage (Stage F). 15 were male (31.3\%) and 33 females (68.7\%), corroborating other studies\(^1\,\,\,\,^{14,\,\,16}\) that also reported a female predominance. Sociodemographic conditions were compared (age, gender, smoking habit, alcohol consumption, and education level), and none of them correlated with the condition of the prosthesis and the gingivae, as reported by Kanao \(17\) Lang \(\,\,\,\,\,18\) however, reported a greater amount of plaque in patients from a lower education background.

On the first step of this study, 19 patients (37.3\%) were registered as having peri-implant mucositis and after they had their prostheses cleaned according to the instructions provided, 23 (45.1\%) presented peri-implant mucositis. Ferreira \(\,\,\,\,\,19\) diagnosed peri-implant mucositis in 137 of the 212 patients they followed up.

Treatment of peri-implant mucositis is the only way to prevent the establishment of peri-implantitis.\(^9\,\,\,\,\,\,\,\,\,\,\,19\) Long-term maintenance care for high-risk groups is essential.\(^20\) The development of an inflammatory response in the peri-implant mucosa (i.e., peri-implant mucositis) is more severe than that around the teeth; in addition, gingiva in contact with teeth responds faster than the mucosa surrounding implants to oral hygiene.\(^21\)

In the present study, 41.2\% of 48 patients surveyed did not perform adequate cleaning between their appliance and the oral mucosa, showing that biofilm was responsible for the presence of tissue inflammation. Mucositis worsened between Stage I and Stage F, though a trend was observed toward an improvement in peri-implantitis, since six of the seven early cases of hyperemia and suppuration had been resolved by Stage F. According to Heitz-Mayfield, Mombelli,\(^22\) successful results could be observed 12 months after therapy in terms of peri-implantitis. An overall improvement in oral care is essential in the treatment of mucositis and peri-implantitis.\(^21\)

Several studies have been performed in an attempt to reduce biofilm adhesion to the implant surface. Surface texture influences biofilm formation at the abutment/implant junction and the soft tissue/implant interface.\(^23\) Depending on implant

<p>| Table 1: Distribution of absolute ((n)) and relative ((%)) frequencies for hygiene status of implant-supported fixed prosthesis, gingival health, and hygiene adopted method. |</p>
<table>
<thead>
<tr>
<th>Parameters assessed</th>
<th>Stage</th>
<th>G-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial (n) (%)</td>
<td>Final (n) (%)</td>
</tr>
<tr>
<td>Prosthesis hygienization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free from plaque and calculus</td>
<td>0 (0.0)</td>
<td>5 (9.8)</td>
</tr>
<tr>
<td>Presence of plaque</td>
<td>27 (52.9)</td>
<td>22 (43.1)</td>
</tr>
<tr>
<td>Plaque and calculus</td>
<td>24 (47.1)</td>
<td>24 (47.1)</td>
</tr>
<tr>
<td>Total</td>
<td>51 (100.0)</td>
<td>51 (100.0)</td>
</tr>
<tr>
<td>Gingival health</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Healthy</td>
<td>25 (49.0)</td>
<td>27 (52.9)</td>
</tr>
<tr>
<td>Hyperemic</td>
<td>19 (37.3)</td>
<td>23 (45.1)</td>
</tr>
<tr>
<td>Hyperemia and suppuration</td>
<td>7 (13.7)</td>
<td>1 (2.0)</td>
</tr>
<tr>
<td>Total</td>
<td>51 (100.0)</td>
<td>51 (100.0)</td>
</tr>
<tr>
<td>Cleaning method</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interdental brush</td>
<td>0 (0.0)</td>
<td>18 (35.3)</td>
</tr>
<tr>
<td>Dental floss</td>
<td>2 (3.9)</td>
<td>32 (62.7)</td>
</tr>
<tr>
<td>Oral irrigator (Waterpik)</td>
<td>25 (49.0)</td>
<td>27 (52.9)</td>
</tr>
<tr>
<td>No cleaning of the gingiva/prosthesis contact</td>
<td>21 (41.1)</td>
<td>4 (7.8)</td>
</tr>
<tr>
<td>Total</td>
<td>48 (100.0)</td>
<td>81* (100.0)</td>
</tr>
</tbody>
</table>

\(P<0.05\) indicates a significant difference between baseline and final step. \("Higher than 51 cases because the same prosthesis as may have been cleaned using a combination of method"
To increase cleaning effectiveness, adequate spacing should be thought through to provide access for hygiene. Visual markings of access and insertion of the cleansing instrument into the prosthesis facilitate oral hygiene.

Patients have difficulties flossing their prosthesis, and this factor was not related to age, sex, educational level, and socioeconomic status. Clinicians must decide on an individual basis if the quality of flossing required is achievable. While the effectiveness of interproximal cleaning by the patient is limited, in this study, the use of floss guiding tips showed the greatest increase in uptake. A significant proportion (35.3%) also began to use interdental brushes, which had not been at all mentioned at Stage I.

About 0.12% chlorhexidine can be used in combination with mechanical therapy for the treatment of mucositis. Both forms of interdental brushes (waist-shaped circum and straight soft interdental brushes) removed more plaque than floss according to Chongcharoen et al.

Powered tooth brushing was considered superior to manual brushes only in the fact that they require less manual dexterity. According to Vibhute and Vandana, there was no significant difference between them regarding the quality of hygiene.

Dental implant therapy should be regarded as a treatment of choice in elderly patients, even if oral hygiene is sub-optimal. In this study, the mean age of the patients was 58.7 ± 9.3 (SD) years (range 40-75 years). The vast majority of patients are not elderly, but the demand for oral/facial esthetics and function encouraged them to seek implant-supported restorations.

The present data showed that cleaning was not affected by education level, but by the preference for quicker cleaning strategies that required little dedication. Thus, the patient encouragement toward optimal biofilm control should be performed from the moment of planning implant-supported rehabilitation through to implant placement and maintenance follow-up visits.

**Conclusion**

Implant therapy is a consolidated approach for full and partial rehabilitation of the edentulous arches.

- Regarding the quality of cleaning observed for implant-supported fixed dentures at Stage I, it was remarkable that patients did not perform adequate hygiene in the contact area between the oral mucosa and the prostheses; and a significant number of patients reported not having information on how they should clean such area. Hygiene quality was far below acceptable standards, so that the
presence of biofilm, calculus and pseudomembrane were present in large quantities.

- After prosthetic and mucosal cleaning, the patients were provided with appropriate oral hygiene instructions, which had an overall positive impact, although the presence of biofilm on the prosthetic appliance was not significantly reduced at Stage F, yet patients began to clean the implant/gingiva contact area, which did not occur before oral hygiene instructions.

In conclusion, biofilm removal is a key factor for peri-implant health, and patient education should start at the first visit, promoting the idea that successful treatment with dental implants is a set of carefully planned steps that include the dentist as a provider and educator and the patient as a maintainer of adequate plaque control measures.

References


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