EVALUATION OF EFFICACY OF 4-D IMPLANT THERAPY IN ESTHETIC CONSIDERATION FOR SOFT TISSUE MANAGEMENT- AN ORIGINAL RESEARCH

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ABSTRACT

Aim

The purpose of the present research is to assess the efficacy of four-dimensional (4-D) implant therapy in achieving adequate esthetics when soft tissue around implants are considered.

Methodology

According to the case inclusion criteria, 29 patients subjected to single-tooth replacement with ITI implant-supported restoration in the anterior maxilla were included. Assessments of soft tissue after crown placement (baseline) and at 6 months (follow-up) were performed by two orthodontists with PES

Results

No statistically significant difference was found between the two observers. PES for the single-tooth implant varied from 6.90 to 9.55 at 6-month follow-up. The scores of the mesial and distal papilla, level of soft-tissue margin, soft-tissue contour, soft-tissue color and soft-tissue
texture increased significantly at follow-up. The highest percentage of improvement in PES was found in the cases scoring 0–4 at the baseline

Conclusion

It is imperative to re-examine the traditional treatment sequence of implant therapy so that practitioners and patients can achieve predictable and aesthetically pleasing treatment outcomes.

Keywords implant, soft tissue management, four-dimensional treatment.

INTRODUCTION

Tooth replacement by means of dental implants is considered to be a predictable procedure in modern dentistry. Peri-implant tissues significantly differ from periodontal tissues in terms of lack of cementum and periodontal ligament, less blood vessels and fibroblasts in the connective tissue and absence of an attached supra-crestal connective tissue. In the presence of plaque accumulation, these features may condition the development of inflammation and the rate of bone loss around implants. Notwithstanding, long-term clinical studies showed the efficacy of supportive therapy in preventing inflammation and bone destruction, although periodontally susceptible individuals may have a greater risk for peri-implantitis. It was suggested that expected aesthetic outcomes of implant therapy may be enhanced by manipulating or augmenting peri-implant soft tissues using periodontal plastic surgery. In addition, several factors such as presence of pre-existing ridge deformities, quality and quantity of soft tissue over the ridge and surgical strategies in implant placement/uncovering were considered to be related to the final aesthetic outcomes of implant therapy. The increasing demand over the years for highly esthetic results in all facets of dentistry has also influenced dental implants and has made achieving optimal esthetic results more challenging for the implant specialist and subsequently led to a greater consideration and study of all the contributing factors, both at the micro- and macroscopical level to achieve such a result. The challenge lies in the successful management and modeling of the papilla and gingiva, which are harmonious with the soft tissues of the adjacent natural dentition, and must also be maintainable long-term. Implant esthetics has been thoroughly studied, and several authors have proposed esthetic indices to assess peri-implant gingival tissues and implant crowns. Belser et al. proposed the New Esthetic Index: Pink Esthetic Score (PES)/White Esthetic Score (WES), a variation of previously introduced indices. Thus, an esthetically accepted result not only depends on the shade and form of the final restoration, but also in order to be achieved, it needs careful consideration, and often manipulation of the soft and hard structures adjacent to the implant, the abutment, and final restoration. This demand for better esthetics should accordingly alter the way in which implant specialists treatment plans and places dental implants, especially in the more esthetically demanding anterior region, by considering the soft and hard tissue management (SHTM) at the early treatment planning stage. Recent progress in 3D-printable smart materials has brought into fruition a newer generation of “dimensional printing” that is coined 4D printing. Four-dimensional printing is the combination of 3D printing with time as the 4th dimension. Such a printing platform produces pre-programable bio-objects that change their shape in response to the surrounding media. Timing of treatment sequencing and planning forms the 4th dimension (4-D) of the implant treatment. Ultimately this influences the outcome by limiting surgical interventions, reducing the treatment span and finally enhancing the esthetic capability of implants. So, the timing of implant positioning in three-dimensional axis, definitely helps to achieve the balance between adequate stability of the abutment and the natural tooth like appearance of soft tissue around implants, but it needs further research to
standardize the timing and sequencing of the treatment to achieve adequate esthetics related to soft tissues around the implant. In 2005, a new defined pink esthetic score (PES) was introduced for the assessment of peri-implant soft tissues. It is based on seven variables: mesial papilla, distal papilla, soft-tissue level, soft-tissue contour, alveolar process deficiency, soft-tissue color and texture. Each variable is assessed with a 2–1–0 score, with 2 being the best and 0 being the poorest score. All variables are assessed by comparison with a reference tooth. Furhauser et al. suggested that PES is a suitable instrument for reproducibly evaluating soft tissue around single-tooth implant crowns.21

AIM OF THE PRESENT STUDY

The purpose of the present research is to assess the efficacy of four-dimensional (4-D) implant therapy in achieving adequate esthetics when soft tissue around implants are considered.

METHODOLOGY

29 generally healthy patients (16 women and 13 men), age 17–65 years (mean 31 years), subjected to implant-supported single-tooth restoration in the anterior maxilla were included between December 2020 and September 2021. For inclusion, the patients should (1) have had the tooth extraction at least 3 months before implant surgery, (2) not be heavy smokers, (3) not require a graft (soft or hard tissue) before or in conjunction with implant surgery and (4) not require restorative treatment of the adjacent teeth. The implant placement was planned based on clinical and radiographic evaluation. Cases of fenestration or dehiscence where implant threads that needed any grafting had been exposed were excluded from the study. All implants were placed nonsubmerged. The timing of implant placement was given the utmost importance so that minimum surgical intervention was required. Sutures were removed 7–10 days after surgery. Patients were not allowed to use any removable prostheses during the healing period. After a healing time of 10–16 weeks, single-tooth porcelain (Ivoclar-Vivadent AG) fused to noble metal (Heraeus-Kulzer Corporation, Hanau, Germany) restorations were fabricated. Assessments of soft tissue were performed by two orthodontists with a PES 1 h after seating of the restoration (baseline). The two orthodontists scored the cases in our department, respectively, without knowledge of the PES given by the other observer. They were given a form with all the seven variables involved and were asked to give their scores for each parameter with the 0–1–2 scoring system. The patients were recalled for a radiographic and clinical examination 6–8 months after crown placements (follow-up). PES assessments were given after assessing the patients. To determine the reproducibility of PES assessment, the percentage of agreement of PES given by the two orthodontists at baseline and follow-up was calculated. The results of the two observers were calibrated using a calibration block. Descriptive statistics including mean values and standard deviations were analyzed. To compare the differences of PES assessments between the baseline and follow-up, the Wilcoxon rank-sum test for paired data was performed. Statistical significance was set at 5%. All statistical analyses were run on the statistical package SPSS 25.0.

RESULTS

The implants were distributed in 20 central incisors, six lateral incisors and three canines. The difference in the mean PES given by the two orthodontists was not statistically significant at baseline (P=0.217) and follow-up (P=0.778). (Table 1) The PES is based on seven variables. Each variable was assessed with a 2–1–0 score. The mean PES scores based on clinical evaluation obtained 1 h after crown placement and at the 6–8-month follow-up. Significant differences between baseline and follow-up were found in all single variables and the total
score except for the alveolar process. (Table 2) The mean PES score was 3.00 ± 0.87 in group 1 (0–4) at baseline assessment, and it increased to 7.83 ± 1.89 at follow-up. The percentage of improvement was 161%. The corresponding figures were 10.70 ± 1.26 and 13.00 ± 0.79 in group 3 at baseline and follow-up. The percentage of improvement was 21.5%.

DISCUSSION
Considering the increase in demand for better aesthetics in recent years, there has been a change in the treatment planning and execution of the clinical and laboratory procedures of implant-supported restorations. The realization requires collaboration between operators, including the surgeon, the prosthodontist, and the dental technician, to obtain a predictable, satisfactory and maintainable aesthetic result. It is imperative that implant specialists evaluate the presenting condition of each case individually, and carefully consider the consequences of the surgical interventions and their timing, to be able to achieve an acceptable result. Based on the initial condition of the hard and soft architecture, implant specialists must decide firstly whether hard or soft tissue augmentation are necessary prior to implant placement, and if so, which technique is appropriate. In our current study, a non-submerged implant system was used and the PES score for single-tooth implant varied from 6.90 to 9.55 after a 6-month follow-up. The esthetic outcome of soft tissue around the implant has improved significantly. These findings corroborate the recently published data with the PFI index or with other measurements. But a period of 6 months is still limited to come to a definite conclusion. Long-term results are needed to observe the stability of the peri-implant tissues. In our study, the PES score for mesial and distal papilla increased significantly at the 6–8-month follow-up. This result agreed with the findings in previous studies: papillae regenerated in most cases, although with different implant systems and observation periods. The reconstruction of periodontal attachment may contribute to this improvement, but at present the relationship between periodontal attachment and the height of the papilla is still not clear.22-24 A significant difference was also found in soft-tissue color and texture in the study. Researches on this aspect of implant esthetics are scarce. The improvement may occur due to the relief of the pressure on the soft tissue immediately after crown placement, which caused pallescence of the pink gingiva. It was interesting to find that the most significant improvement of PES (161%) was for group 1 (0–4) while group 3 (10–14) showed the least (21.5%) improvement at follow-up. This indicated that the lower the score the case had at baseline, the more potential for improvement it may have after crown placement which is dependent upon all the dimensions of the implant treatment.

CONCLUSION
It is imperative to re-examine the traditional treatment sequence of implant therapy so that practitioners and patients can achieve predictable and esthetically pleasing treatment outcomes. The importance of including patients and their individual needs and goals in treatment planning should be emphasized, as is the preservation of alveolar bone, dentition, function, and esthetics over the long term through the proper execution of periodontal treatment.

REFERENCES


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**TABLES**

**Table 1**- Mean tooth-related PES (variables and total) for implant restoration at baseline and follow-up.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Baseline (Mean± SD)</th>
<th>Follow-up (Mean± SD)</th>
<th>P</th>
</tr>
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<tbody>
<tr>
<td>Mesial papilla</td>
<td>0.93 ± 0.56</td>
<td>1.48 ± 0.54</td>
<td>0*</td>
</tr>
<tr>
<td>Distal papilla</td>
<td>1.02 ± 0.79</td>
<td>1.6 ± 0.53</td>
<td>0*</td>
</tr>
<tr>
<td>Level of soft-tissue margin</td>
<td>1.21 ± 0.79</td>
<td>1.33 ± 0.71</td>
<td>0*</td>
</tr>
<tr>
<td>Soft-tissue contour</td>
<td>1 ± 0.73</td>
<td>1.14 ± 0.66</td>
<td>0.03*</td>
</tr>
<tr>
<td>Alveolar process</td>
<td>0.98 ± 0.66</td>
<td>1.05 ± 0.69</td>
<td>0.16*</td>
</tr>
<tr>
<td>Soft-tissue color</td>
<td>0.67 ± 0.66</td>
<td>1.60 ± 0.62</td>
<td>0.02*</td>
</tr>
<tr>
<td>Soft-tissue texture</td>
<td>1.09 ± 0.6</td>
<td>1.4 ± 0.59</td>
<td>0*</td>
</tr>
<tr>
<td>Total</td>
<td>6.9 ± 2.52</td>
<td>9.55 ± 2.15</td>
<td>0*</td>
</tr>
</tbody>
</table>

*P<0.05, PES, pink esthetic score.

**Table 2**- Mean scores and percentage changes at baseline and follow-up according to the division of PES scores into three groups.

<table>
<thead>
<tr>
<th>PES scores</th>
<th>Baseline (Mean± SD)</th>
<th>Follow-up (Mean± SD)</th>
<th>Diff. (mean ± SD)</th>
<th>Percentage change % (changes/baseline)</th>
</tr>
</thead>
</table>

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<table>
<thead>
<tr>
<th>Age Group</th>
<th>Mean ± SD</th>
<th>Mean ± SD</th>
<th>Mean ± SD</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–4</td>
<td>3 ± 0.87</td>
<td>7.83 ± 1.89</td>
<td>4.83 ± 2.36</td>
<td>161</td>
</tr>
<tr>
<td>5–9</td>
<td>6.55 ± 1.37</td>
<td>8.98 ± 1.33</td>
<td>2.44 ± 0.93</td>
<td>37.3</td>
</tr>
<tr>
<td>10–14</td>
<td>10.7 ± 1.26</td>
<td>13 ± 0.79</td>
<td>2.3 ± 1.1</td>
<td>21.5</td>
</tr>
</tbody>
</table>