Long-Term Esthetic Outcome of Tissue-Level and Bone-Level Implants in the Anterior Maxilla

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Purpose: The aim of this study was to assess and compare the esthetic outcome of tissue-level (TL) and bone-level (BL) implants that had been placed as single implants in the anterior maxilla. Materials and Methods: Between 2001 and 2008, patients were treated using TL implants (Straumann). From 2008 until 2012, patients received the newly developed BL implant (Straumann). All patients with a single anterior maxillary implant who came to check-ups regularly were contacted and invited to take part in the study. Standardized photographs were taken to conduct the evaluation. Five observers analyzed the esthetic outcome using the pink esthetic score (PES). For the purpose of statistical analysis, the Wilcoxon rank sum test was applied. Interobserver reliability was evaluated with Krippendorff’s alpha. Results: Forty-six patients agreed to take part in the study. The study comprised 10 immediate (TL = 6, BL = 4), 21 early (TL = 6, BL = 15), and 15 delayed implantations (TL = 11, BL = 4). All implant sites were simultaneously augmented. The prosthetic restorations were delivered 6 to 24 weeks after implant placement in the TL group and 10 to 14 weeks after implant placement in the BL group. Esthetic evaluation was performed after a mean period of 9.5 years for TL implants (range: 5.5 to 12.0) and 3.7 years for BL implants (range: 2.6 to 7.1). The overall PES was 8.49 (SD: 2.35) for TL implants and 9.29 (SD: 1.90) for BL implants (P = .37). Comparison of single parameters was between P = .24 and P = .83, indicating no statistically significant difference between the two implant types. Conclusion: Within the limits of this study, it can be stated that both implant designs showed comparably satisfying esthetic results. Int J Oral Maxillofac Implants 2018;33:905–912. doi: 10.11607/jomi.6419

Keywords: bone-level implant, esthetic zone, long-term esthetic outcome, pink esthetic score, single implant, tissue-level implant

Implant restoration of single missing teeth is widely practiced, and excellent osseointegration and long-term stability have been well documented.1,2 Ongoing research, development, and optimization, such as improved surface properties,3,4 have led to predictable treatment results and remarkable survival rates of dental implants.5,6 The classical parameters of implant success are immobility of the implant as well as absence of periapical radiolucency, persistent symptoms of pain, infection, and necropathies.7,8

In the anterior zone, however, mere implant survival and the aforementioned success criteria do not imply a satisfactory treatment outcome for the patient who desires a pleasing appearance.5,9 The introduction of the pink esthetic score (PES) has provided a tool to assess the esthetic implant outcome in a comparable way.10,11

Over time, two design variations were established for the connection of the prosthetic abutment to the implant body (Fig 1). In tissue-level (TL) implants, the transition from the rough to the smooth portion is level with the bone, and this design type is characterized by non-submerged healing. Consequently, a re-entry is not necessary for the restoration, which means reduced trauma and scars at the implant site.

Bone-level (BL) implants, on the other hand, are completely covered by a rough surface and are inserted level with the bone, which allows submerged...
A maxillofacial surgeon, a prosthodontist, a general dentist, a postgraduate dental student, and a dental technician evaluated the cases as blinded examiners who had not been involved in any treatment of the patients. All evaluators scored the cases once. Prior to the procedure, the first author of the study provided the evaluators with a detailed explanation. All relevant information for the evaluation process was provided as handouts, and the ratings were taken down by the first author of the study.

**MATERIALS AND METHODS**

**Patients**

To replace a central or lateral maxillary incisor, patients received Straumann TL implants between 2001 and 2008. In 2008, the Straumann BL implant was launched, and from 2008 until 2012, patients were consequently treated with the new BL implant in the esthetic zone. All patients with a single anterior maxillary implant who were treated within these timeframes and came to check-ups regularly were contacted and invited to take part in the study. For the sake of comparison, the respective contralateral incisor also had to be present in a closed dental arch. Fillings or prosthetic restorations of this tooth were tolerated. Only smokers, patients with uncontrolled diabetes mellitus, or high-dose glucocorticoid treatment were excluded from the study, as these factors are known to have a disadvantageous influence on implant treatment.

**Data Collection**

In order to conduct a consistent esthetic evaluation, standardized clinical photographs were taken with a digital camera (Nikon D90, Nikon). For each patient, a set was arranged including images from three different angles: one picture taken en face, a second focused on the implant site, and a third centered on the contralateral tooth. The soft tissue around the implant and contralateral tooth had to be fully assessable. With the aim of standardized evaluation in mind, each picture set was equally arranged and printed on glossy photo paper (240 gsm).

**Esthetic Assessment**

The PES was applied to evaluate the peri-implant soft tissue situation (Fig 2). Hereby, seven variables are specified: (1) mesial papilla, (2) distal papilla, (3) soft tissue level, (4) soft tissue contour, (5) alveolar process, (6) color, and (7) texture of the peri-implant mucosa. Each parameter is rated with a 0-1-2 score, in which 0 represents the poorest and 2 the best score. Hence, the highest total score is 14, meaning a particularly close match of the soft tissue condition around the implant and tooth. In this study, the threshold for clinical acceptance was set at 8 for the overall PES.

A maxillofacial surgeon, a prosthodontist, a general dentist, a postgraduate dental student, and a dental technician evaluated the cases as blinded examiners who had not been involved in any treatment of the patients. All evaluators scored the cases once. Prior to the procedure, the first author of the study provided the evaluators with a detailed explanation. All relevant information for the evaluation process was provided as handouts, and the ratings were taken down by the first author of the study.
Statistical Analysis
For statistical analysis, the software R (1993, Ross Ihaka, Robert Gentleman, R Development Core Team) was used. Krippendorff’s alpha coefficient was calculated to assess interreviewer reliability of the esthetic ratings.29

For both the TL and BL groups, PES values were averaged over all five observers, and mean scores and standard deviations (SDs) were calculated to depict the esthetic treatment outcome. Furthermore, mean scores and SDs for every single variable of the PES were computed for each group. The Wilcoxon rank sum test was used to compare the overall PES scores and each parameter in the two groups. For further comparison within the BL group (submerged and non-submerged healing), the two-sample t test was applied.

RESULTS
Forty-six patients with an implant-borne single-tooth restoration in the esthetic area fulfilled the guidelines and were examined at the subsequent follow-up (12 men, 34 women; mean age: 49.3 years, range: 21 to 80 years). Twenty-three of them had received a TL implant (TL group: 3 men, 20 women; mean age: 51.5 years, range: 26 to 77 years). The BL group also consisted of 23 patients (9 men, 14 women; mean age: 47.1 years, range: 21 to 80 years). Patient satisfaction was consistently high.

Examinations and data collection were carried out 5 to 12 years after implantation for TL implants (mean: 9.5 years) and 2 to 7 years after implantation for BL implants (mean: 3.7 years), respectively.

Surgical and Prosthetic Treatment
Tissue-level implants with a sand-blasted, large-grit, acid-etched (SLA) surface and a 1.8-mm polished neck had been inserted between 2001 and 2008. From 2008 to 2012, BL implants with a SLActive surface covering the whole implant were used (Straumann; Fig 1). All implants were placed by the same maxillofacial surgeon (J.E.). A mucoperiosteal flap was prepared, and implants were inserted with great attention to the correct three-dimensional (3D) position.30

In all cases where labial bone had been resorbed or marginal defects had occurred, bone augmentation was performed during surgery using autogenous bone combined with bovine bone substitute material (Bio-Oss, Geistlich Biomaterials). A membrane was placed (Bio-Gide, Geistlich Biomaterials), and the surgical site was closed with single interrupted sutures. The patients were asked to rinse with 0.1% chlorhexidine solution twice a day and to take analgesics (Ibuprofen 400 mg) if required. Sutures were removed 7 to 10 days after surgery.

The distribution of implantation protocols used is depicted in Table 1. Early implantation describes placement 4 to 8 weeks after extraction; an implantation more than 8 weeks after tooth extraction is termed conventional, standard, or delayed implant placement.5 The delayed group comprised three patients with agenesis of the lateral incisor. Lengths and diameters of the implants used are provided in Tables 2 and 3. Implant insertion torque was 45 Ncm in all cases.

In the TL group with non-submerged healing, 18 patients received a removable partial denture as a provisional restoration; four patients were provided with an adhesive bridge; and for one patient, a splint was fabricated.

In the BL group, 15 cases immediately received a healing abutment for non-submerged healing. For the remaining eight cases, submerged healing was chosen. Thirteen patients had already been provided with a removable prosthesis. Four patients received an adhesive bridge; two patients received a splint with an affixed incisor; and for four patients, a provisional crown was placed immediately after implantation.

The dentists in charge of the restorative treatment were advised to prevent any static or dynamic occlusal forces during the provisional restoration phase. Permanent restorations were delivered 6 to 24 weeks after implantation to the TL group, and 10 to 14 weeks after implantation to the BL group.

Table 1  Distribution of Implantation Protocols

<table>
<thead>
<tr>
<th></th>
<th>Immediate</th>
<th>Early</th>
<th>Delayed</th>
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<tbody>
<tr>
<td>TL</td>
<td>6</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>BL</td>
<td>4</td>
<td>15</td>
<td>4</td>
</tr>
</tbody>
</table>
Interobserver Agreement

Interassessor reliability of the five observers was investigated by applying Krippendorff’s alpha coefficient for interval data. Considering the overall PES results, the evaluators showed sufficient homogeneity. This aspect was verified by the value $\alpha = .643$, indicating a substantial agreement within the Landis-Koch scale.29

**Overall PES Analysis**

With the PES, a maximum score of 14 points is achievable. For the TL group, the mean value was 8.49 (SD: 2.35). The BL group showed a mean of 9.29 (SD: 1.90; Fig 3).

The Wilcoxon rank sum test was carried out to compare the overall PES result of the two groups ($P = .37$).

For the comparison within the BL group (submerged and non-submerged healing), the two-sample $t$ test was applied ($P = .51$).

**Single Parameter Outcome**

The single parameters of the PES are illustrated in Fig 4. The TL group reached a value of 1.31 (SD: 0.65) for the mesial papilla, and the BL group reached a value of 1.34 (SD: 0.73). The distal papilla was rated 1.09 (SD: 0.50) for the TL and 1.17 (SD: 0.68) for the BL group. Regarding the soft tissue margin, values of 1.20 (SD: 0.53) for the TL and 1.31 (SD: 0.52) for the BL group were found.

The soft tissue contour scored values of 1.40 (SD: 0.48) for the TL and 1.48 (SD: 0.39) for the BL group. The buccal contour outcome of the alveolar process was 1.19 (SD: 0.55) for the TL and 1.37 (SD: 0.51) for the BL group.

The gingiva color reached values of 1.03 (SD: 0.60) for the TL and 1.17 (SD: 0.33) for the BL group. Rating the gingiva texture, results were 1.27 (SD: 0.53) for the TL and 1.44 (SD: 0.31) for the BL group. The statistical analysis of the single PES parameters is illustrated in Table 4.
DISCUSSION

The objective of this study was to compare the esthetic outcome of implant-borne single-tooth restorations with two different implant designs. The early design type has been termed TL implants, and in 2008, the BL design for the esthetic zone was introduced. Both implant types resulted in reliable implant survival, with 5.5 to 12 years for TL implants and 2.6 to 7 years for BL implants in situ.

To evaluate the outcome with regard to hard and soft tissues, the PES was applied, meeting the requirements of a reproducible and reliable rating tool. The five evaluators showed an acceptable level of agreement (Krippendorff’s $\alpha = .643$), and therefore, sufficient homogeneity regarding overall PES results. Still, there are doubts about objective parameters in assessing dental implant esthetics. As shown in earlier studies, however, the PES serves as a reproducible tool, and also, the practical feasibility of the PES has been confirmed.

The overall PES results in this study corroborate the satisfactory esthetic outcomes of TL and BL implants in other studies. The comparison of the overall PES outcome of TL implants (8.49, SD: 2.35) and BL implants (9.29, SD: 1.90) has not shown a statistically significant difference ($P = .37$). Nevertheless, there has been an obvious tendency toward somewhat better results for BL implants.

Regarding the PES, 65% of TL and 74% of BL implants have been considered at least esthetically acceptable since scores have been above 8 (Fig 3, Table 5). This means an unsatisfying esthetic outcome from the clinician's point of view in 35% (TL) and 26% (BL) of patients. Studies that applied the same threshold had respective rates of only 15% and 24% within the cohort. Other studies showed even higher rates of esthetically acceptable cases. As in this study, inclusion criteria have been relatively broad; a few patients with gingival soft tissue deficiencies such as scars, lack of papilla, and unnatural gingiva color due to inflammation or amalgam tattooing may have been included. Consequently, because of a compromised contralateral tooth site in these cases, even with a decently reconstructed implant site, a lack of symmetry would be evident. Furthermore, compromised baseline situations at the implant site will not necessarily improve after implant treatment. These facts might be a reason for some relatively unfavorable PES outcomes.

To analyze PES single parameters, the Wilcoxon rank sum test was applied. No statistically significant differences between the groups could be found, as all $P$ values were $>.05$ (Table 4). However, BL implants tended to show generally slightly superior outcomes in all parameters (Fig 4).

The mesial papilla was the most inconsistently rated parameter in both groups, with SDs of 0.65 (TL) and 0.73 (BL), respectively, with no conclusive explanation thus far.

Distal papilla and soft tissue color have been the most difficult issues to solve for both implant types. Over the years, maintenance of the distal papilla seems to have been more delicate than preserving the mesial papilla. So far, no explanation for this phenomenon has been reported.

The highest ratings have been found for soft tissue contour in both implant designs. This parameter is a result of the height of gingival margin and papilla levels. A correct 3D positioning of the implant, and thereby, the avoidance of soft tissue recession supports a pleasing soft tissue contour outcome. By carefully extracting the failing tooth prior to implantation, the surrounding soft tissue has obviously been preserved, which has led to the natural contour outcomes.
The parameter gingiva color is notable, with rather low ratings for TL and BL of 1.03 (SD: 0.60) and 1.17 (SD: 0.33), respectively, which may be due to scar tissue formation as a consequence of flap elevation. Furthermore, the results for soft tissue color (TL, SD: 0.60; BL, SD: 0.33) and soft tissue texture (TL, SD: 0.53; BL, SD: 0.31) have been more consistent in the BL group. It can only be speculated whether the longer in situ period of the TL implants may have created situations that have been differently judged by the evaluators.

The BL design allows a more individual emergence profile, which is regarded as an advantage of this implant type. Customized abutments consistent with the natural emergence profile of the contralateral tooth can be fabricated.

TL implants are characterized by transgingival healing. This is an advantage insofar as a second approach to uncover the implant is unnecessary, thus avoiding an additional trauma. Repeated manipulation 4 to 8 weeks after implantation has been associated with dimensional changes in peri-implant hard and soft tissues.36

In the present study, non-submerged healing was chosen for 15 BL implants (65%). Adequate healing abutments for soft tissue support were applied immediately after surgery (Table 6). Research in recent years has shown that submerged healing (widely practiced with BL implants) may not be necessary for a predictable implant-borne tooth replacement.20,37 Consequently, comparable esthetic outcomes have been reported for moderately augmented, submerged and non-submerged single implants in the esthetic zone.38,39

The potentially different loading conditions with the submerged and non-submerged healing protocols in the BL group may be regarded as a confounding variable. However, the statistical analysis of the overall PES in these subgroups did not reveal a significant difference ($P = .51$).

The preservation of bone around an implant is important for soft tissue support. Papilla formation is based on the existence of underlying bone and decisive for a pleasing esthetic outcome. The microgap between the implant and abutment in BL implants occurs at bone level, and a platform-switching concept is utilized to preserve the peri-implant bone.15,16 In contrast, the microgap is at least 1.8 mm above bone crest in TL implants due to the smooth neck portion. Thus, the principle of biologic width may be even better accounted for in TL implants.

The relatively small sample size remains a limitation of the study, but nonetheless equals similar reports. A highly experienced maxillofacial surgeon specializing in implant surgery was entrusted with all cases, as delicate interventions in the esthetic zone need a lot of expertise.28,30 Obviously, the PES is basically influenced by the surgeon’s work and capabilities.6

As bone and soft tissue preservation can be achieved with both immediate and early implant placement,18 the question arises as to whether the timing of implant placement (Table 1) has played a role in the esthetic outcome of this study. For immediate, early, and delayed treatment protocols, favorable results have been found.1,5 No statistical differences in esthetic outcome between immediate and delayed implant treatment have been reported.40 Significant differences between immediate and early implants with immediate provisionalization have been stated, showing better results for immediate implantation.11 At this point, there is no complete agreement with regard to implant insertion time and esthetic effect. It must be mentioned that in this study, insertion times varied, and many more delayed implant placement patients are part of the TL group. Hence, a comparison with studies that apply a strict insertion protocol is questionable.

The heterogeneity of the follow-up dates should also be addressed when assessing the results of the

### Table 4  Statistical Analysis of PES Single Parameter Values in TL and BL Implants

<table>
<thead>
<tr>
<th>Parameter</th>
<th>$P$ values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesial papilla</td>
<td>.76</td>
</tr>
<tr>
<td>Distal papilla</td>
<td>.59</td>
</tr>
<tr>
<td>Level of soft tissue margin</td>
<td>.49</td>
</tr>
<tr>
<td>Soft tissue contour</td>
<td>.83</td>
</tr>
<tr>
<td>Alveolar process</td>
<td>.24</td>
</tr>
<tr>
<td>Soft tissue color</td>
<td>.42</td>
</tr>
<tr>
<td>Soft tissue texture</td>
<td>.32</td>
</tr>
</tbody>
</table>

Wilcoxon rank sum test. TL = tissue-level; BL = bone-level; PES = pink esthetic score.

### Table 5  Clinical Acceptance of TL and BL Implants by Means of PES

<table>
<thead>
<tr>
<th></th>
<th>PES &gt; 8</th>
<th>PES &lt; 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>TL</td>
<td>15 (65%)</td>
<td>8 (35%)</td>
</tr>
<tr>
<td>BL</td>
<td>17 (74%)</td>
<td>6 (26%)</td>
</tr>
</tbody>
</table>

TL = tissue-level; BL = bone-level; PES = pink esthetic score.

### Table 6  Healing Mode of TL and BL Implants

<table>
<thead>
<tr>
<th></th>
<th>Submerged</th>
<th>Non-submerged</th>
</tr>
</thead>
<tbody>
<tr>
<td>TL</td>
<td>0</td>
<td>23</td>
</tr>
<tr>
<td>BL</td>
<td>8</td>
<td>15</td>
</tr>
</tbody>
</table>

TL = tissue-level; BL = bone-level.
study. At the time of examination, TL implants had been incorporated for almost 10 years compared with only 4 years for BL implants. However, the greatest dimensional soft and hard tissue alterations, for instance, papilla regrowth and bone remodeling, are expected within the first year after surgery. Consequently, it is to be assumed that a steady state will prevail, and therefore, no further bone remodeling may occur and the varying points in time might not be esthetically relevant. This may be an argument for clinicians working with TL implants in the anterior maxilla, as even with longer in situ time, a comparable esthetic result has been found. Finally, it should be kept in mind that the acquisition of long-term esthetic results will involve some compromises in the design. In the present study, the long-term aspect of the results is emphasized, although in a controlled clinical trial, more parameters would be standardized.

CONCLUSIONS

Within the limits of this study, it can be stated that with BL and TL implants in the anterior maxilla, an acceptable esthetic result may be achieved over the years. These findings are valid for patients who have been included without strict preselection.

ACKNOWLEDGMENTS

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REFERENCES


