Review of the Current Esthetic Indexes Used for Evaluation of Single Implant Success in the Esthetic Zone

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Abstract

Objectives: This literature review that aims to study and evaluate current esthetic indices used for evaluation the esthetic success of single implant in the esthetic zone.

Methods: Used PubMed to search electronic database for evaluation of single implant success rate in aesthetic zone and esthetic index with no restrictions or filters for language or time to find related articles published till March 2019.

Results: Terms used: single implant aesthetic zone and immediate implant 109 articles; dental implant esthetic index esthetic zone 57 articles; immediate implant in esthetic zone and pink and white esthetic score 7 articles; single implant aesthetic zone and immediate implant esthetic index 12 articles.

145 articles excluded because they were not related or significant for the thesis. As they not answering research questions. 43 articles excluded due to many variants or duplication. 2 articles are removed after reading the full article.

Conclusion: Esthetic index must be accurate, valid, reliable and reproducible. According to the current findings and limitations of the study we found that IRES index considered the most professional and accurate available index as it includes sufficient parameters to evaluate peri-implant soft tissue and implant restoration.

Keywords: Single Implant; Aesthetic Zone; Esthetic Index; Success Rate

Abbreviations


Introduction

Dental implant is one of the treatment options for replacement of missing natural teeth or teeth with a poor prognosis. According to Branemark and co-workers carried out the initial research on osseointegrated implants. The stability, aesthetic result, patient satisfaction and implant outcome are related to the bone and soft tissues. Implant placement in the anterior area is considered to be a sensitive clinical technique especially for patients with deficiency of bone or soft tissue that require augmentation procedure to overcome any complications.

If there are any mistakes, it may cause failure of treatment outcome and patient dissatisfaction [1]. It was proved that implants in different parts of the jaws part have the same treatment outcome and survival rate, even in posterior or anterior teeth [2]. Nowadays aesthetic considerations represents a role in implant treatment of equal importance to functional purposes, which place reliance on the compatible relation between teeth and gingival tissue. To achieve the optimal result of implant insertion in the anterior aesthetic zone, one must consider the gingival biotype that covers the implant area, color, thickness of gingiva and bone status, all important to implant outcome and the stability and filling of the papillae. These factors have a relation with time of implantation to successful implant, which implies that the homogeneity between implant and soft tissue outline and adjacent teeth will contribute to the success of aesthetic outcome [3]. Osseointegration is one of the parameters that are required for achieving primary stability with good soft tissue appearance to achieve an esthetically successful implantation as well as a long term use, especially in the anterior aesthetic area [4].

Dental implant treatment used to be made by two stage surgical stages. However, patients demand for immediate esthetic restoration after implant placement and clinician skills have resulted in immediate implant protocols. Some clinicians preferred two stage protocol for implant placement considering it more favorable due to the healing period of 3 - 6 months which assures the complete healing of the soft tissue and the bone after tooth extraction to ensure superior esthetic results [5].

An esthetic index that includes sufficient parameters to evaluate peri-implant soft tissue and implant supported restoration is required during all the stages of dental implant procedure. In this way, the best esthetic results are achieved as well as identification of any long term esthetic deficiencies.

Research questions

1. How are clinical outcomes of dental implants defined and measured?
2. What is the current aesthetic index used to evaluate implant success?

Materials and Methods

Using PubMed and Google scholar to search the electronic database in English to find topic related articles published until now. Using Terms:

<table>
<thead>
<tr>
<th>Search term</th>
<th>Search results</th>
<th>Relevant hits</th>
<th>Repeated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single implant aesthetic zone and immediate implant</td>
<td>109</td>
<td>18</td>
<td>0</td>
</tr>
<tr>
<td>Dental implant esthetic index esthetic zone</td>
<td>57</td>
<td>20</td>
<td>17</td>
</tr>
<tr>
<td>Single implant aesthetic zone placement time success rate</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Single implant aesthetic zone and immediate implant esthetic index</td>
<td>12</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>Immediate versus delayed implant in aesthetic zone</td>
<td>6</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Single implant in aesthetic zone and bleeding index</td>
<td>11</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Single implant in esthetic zone and clinical parameters evaluation</td>
<td>7</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Immediate implant in esthetic zone and pink and white esthetic score</td>
<td>7</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Delayed implant in esthetic zone and pink and white esthetic score</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>217</td>
<td>72</td>
<td>43</td>
</tr>
</tbody>
</table>

Table 1: Search results.

145 articles excluded because it is not related or significant for the thesis.
As they not answering research questions.
43 articles excluded duo to many variant or repeated.
7 articles are removed after reading the full article.
Results

Clinical parameters

Determination of aesthetic outcome is considered as clinical evaluation between restoration and natural dentition appearance in relation to soft tissue situation [6] and is based on both clinical parameters and less clear-cut aesthetic assessments. A previous cohort study by Tenenbaum, et al. 2016 that included of 110 patients and 232 implants for a long term of follow up that lasted for 8 years ± 1.7 years that assessed implant success regarding parameters [7] bleeding index, plaque index, papilla index and pocket depth.

Bleeding index (bleeding on probing)

The bleeding index was, respectively, 0.17 ± 0.22 at baseline, 0.11 ± 0.33 after 1 year (Table 2). Additionally, it was observed that smoking may ruin the normal physiology around the dental implant. smokers having a higher bleeding index score (P = 0.02). However, no statistically significant difference was detected during the study period of 8 years [7] with no attention to time of implant placement.

Plaque index (plaque control record)

Tenenbaum et. Al showed that bleeding index was 0.5 ± 0.5 at baseline, 0.5 ± 0.5 after 1 year (Table 2) with no statistically significant differences and no relation to implant placement protocol and timing, also considering plaque control level is related to patient oral hygiene. For this reason, Plaque index remained low from baseline and the period of follow up (8 years) [7].

Mucosa marginal level

Soft tissue alteration is one of aesthetic and sensitivity problems, coronal displacement of gingival margin that could happen following implantation or any surgical intervention. Gingival marginal position (GMP) may be in apical, coronal or normal without any disposition. Apical displacement of gingival margin leads to root exposure as well as gingival recession. The gingival marginal position can change after 6 months of implant placement. This might require restorative treatment. Measurement of CEJ by using stent or cement enamel junction (CEJ) as record point, neighboring cup tip or incisal edge [8].

Papillae index

Facial and interproximal soft tissue recession can influence the interdental papillae, so to avoid peri-implant soft tissue recession, one should keep in consideration the inter implant distance or inter implant - tooth distance. Bone resorption and soft tissue recession could happen due to lack of distance between implants and or neighboring teeth where the recommended inter implant distance of 3 mm and inter implant- tooth distance 3 to 4 mm is less than advised. Romeo., et al. (2008), has shown the soft tissue biotype is due to vascularization and with high content of fibrotic tissue as well as bone support under it, unlike the soft tissue biotype that is more susceptible tissue for gingival recession is thin biotype [9].

Probing pocket depth

Previous studies showed that probing Pocket depth is always higher around dental implants than around neighboring teeth, especially in the proximal and lingual aspects of the implant. However, there was no deepening of the sulcus surrounding the implant even after 10 years [7]. The Probing pocket depth was 2.67 ± 0.75 at baseline and 3.00 ± 0.83 after 1 year follow up (Table 2) with no statistically significant difference over the period of follow up which shows a stable peri-implant condition over a mean follow-up of 10 years. Tenenbaum, et al. (2016) also reported no influence of smoking and age on readings of pocket depth.

Esthetic parameters

Esthetic evaluation or assessment is usually based on a more or less subjective index system [10,11] such as pink aesthetic score (PES) and white aesthetic score (WES) according to Furhauser, et al [12]. However, it was shown that the process of evaluation of esthetics may differ between dentists and patients [13].
Review of the Current Esthetic Indexes Used for Evaluation of Single Implant Success in the Esthetic Zone

Tettamanti., et al. (2015) investigations resulted in a higher total esthetic score and pink esthetic score from orthodontist’s point of view during the period of research of 12 months [14].

Also, Luo., et al. [15] provided the same results of increasing the mean value of Pink Esthetic score during the research period t0 and after 3 times when 2 orthodontists assessed the esthetic success of single implants in the esthetic area.

Pink esthetic score and white esthetic score PES/WES

Pink esthetic score (PES) focuses on the soft tissue around anterior implant restoration. This score is based on: mesial and distal dental papillae, soft tissue status evaluated according to contour, texture, color, soft tissue level and alveolar bone deficiency. Each one of them is evaluated with value 2-1-0 score, with 2 considered to be the best and 0 the poorest. The maximum score is 14.

Belser., et al. modified the pink aesthetic score and proposed to add “white aesthetic score” (WES) and implant restoration index. The PES/WES [16] was used to evaluate the pink (PES) and white (WES) of single implant reconstructions in comparison to the contralateral tooth, comprising five pink and five white criteria as listed (Table 3). This score assessed implant restoration part, and is based on crown shape, color, texture and restoration form. It is assessed also on a scale of 2-1-0, and 10 represents the maximum score [10,13]. Scores higher than 6 were considered esthetically and clinically acceptable.

Implant crown aesthetic index (ICAI)

Implant crown esthetic index is designed to assess the color, anatomic form and surface characteristics of implant restoration for the white parameters and for the pink parameters it includes the color, the anatomic form and surface characteristics of the peri-implant soft tissues. Similarly, the ICAI [17] evaluates (PES/WES) of single-implant superstructure and surrounding tissues in comparison with the contralateral and adjacent teeth. 4 pink scores and 5 white scores were evaluated as previously mentioned (Table 3). This index considered the least favorable index to measure the esthetic outcome regarding the reproducibility [14].

Peri-implant and crown index (PICI)

This revolutionary index was invented by Tettamanti., et al. (2015) who evaluated the pink and white esthetic values using visual analogue scale, comparing the implant with the contralateral tooth. The PICI includes three pink scores: three white scores includes shape, color and characterization of the crown (Table 3). The authors considered achieving a score of 360 or higher indicates clinically acceptable esthetics [14]. It was shown that there is no statistical difference when comparing PICI results and PES-WES scores 14.

Implant restoration esthetic index (IREI)

Xiachen Li., et al. [18] presented a new index for evaluation of the esthetic success of dental implants, using the implant restoration esthetic index. The pink index evaluates 6 parameters: mesial papilla presence, distal papilla presence, soft tissue curvature, gingival trigon, alveolar process deficiency, and soft tissue color and texture as listed (Table 3). The white index also evaluated 6 parameters including: crown contour, crown color, crown labial convexity, crown position, crown characterization and translucency, and abutment visibility. The dimension of the crown was considered significant to evaluate the crown contour. The author evaluated the contour by

### Table 2: Clinical parameters.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Baseline</th>
<th>T= 1 year</th>
<th>T ≥ 8 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bleeding index</td>
<td>0.17 ± 0.22</td>
<td>0.11 ± 0.33</td>
<td>0.17 ± 0.22</td>
</tr>
<tr>
<td>Plaque index</td>
<td>0.5 ± 0.5</td>
<td>0.5 ± 0.5</td>
<td>0.33 ± 0.67</td>
</tr>
<tr>
<td>Probing depth</td>
<td>2.67 ± 0.75</td>
<td>3.0 ± 0.83</td>
<td>1.74 ± 1.00</td>
</tr>
</tbody>
</table>

the incisal edge position and contact areas, according to the contralateral and the adjacent teeth. Also assessed were the crown position in relation to the 3D space of the crown in the arch [18]. This index is considered the most valid, accurate, reliable and reproducible index because it assesses sufficient parameters for professional implant esthetics scoring that were not available on the previous esthetic indices. Xiachen Li also used visual analog scales, these being more widely used [17,18,21,22] and allowing a wider range for evaluation with more accurate results.

<table>
<thead>
<tr>
<th>Criteria of the implant crown (white esthetic)</th>
<th>WES/PES</th>
<th>PICI</th>
<th>ICAI</th>
<th>IREI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference tooth</td>
<td>Contralateral tooth</td>
<td>Contralateral tooth</td>
<td>Contralateral and adjacent tooth</td>
<td>Contralateral and adjacent teeth</td>
</tr>
<tr>
<td>Scale used</td>
<td>NS</td>
<td>VAS</td>
<td>NS</td>
<td>VAS</td>
</tr>
<tr>
<td>Tooth form</td>
<td>Shape</td>
<td>Width</td>
<td>Crown contour;</td>
<td></td>
</tr>
<tr>
<td>Outline/volume</td>
<td>Color</td>
<td>Length</td>
<td>Crown position;</td>
<td></td>
</tr>
<tr>
<td>Color (hue/value)</td>
<td>Characterization</td>
<td>Surface</td>
<td>Crown characterization</td>
<td></td>
</tr>
<tr>
<td>Surface texture</td>
<td>Labial convexity</td>
<td>Color/translucency</td>
<td>Crown labial convexity,</td>
<td></td>
</tr>
<tr>
<td>Translucency and characterization</td>
<td>Labial convexity</td>
<td>Color and translucency</td>
<td>Crown color and</td>
<td></td>
</tr>
<tr>
<td>Cribra of the peri-implant mucosa (pink esthetic)</td>
<td>Mesial papilla</td>
<td>Papillae</td>
<td>Mesial papilla</td>
<td></td>
</tr>
<tr>
<td>Mesial papilla</td>
<td>Zenith</td>
<td>Labial margin</td>
<td>Distal papilla presence,</td>
<td></td>
</tr>
<tr>
<td>Distal papilla</td>
<td>Root Convexity</td>
<td>Papillae</td>
<td>Gingival trigon,</td>
<td></td>
</tr>
<tr>
<td>Facial curvature</td>
<td>Contour of the labial surface</td>
<td>Contour of the labial surface</td>
<td>Soft tissue curvature,</td>
<td></td>
</tr>
<tr>
<td>Level of facial mucosa</td>
<td>Color and surface</td>
<td>Color and surface</td>
<td>Alveolar process</td>
<td></td>
</tr>
<tr>
<td>Root convexity and color</td>
<td></td>
<td></td>
<td>deficiency, and</td>
<td>Soft tissue color and texture</td>
</tr>
</tbody>
</table>

**Table 3**: Comparison between 4 different implant esthetic evaluation index.

**Discussion**

Successful implant placement in the anterior esthetic zone with long term stability of the soft tissue and bone around implant neck is the prime goal. Sufficient primary stability before implant loading is considered the first predictor of successful implantation with adequate support maintained by buccal bone [19]. Osseointegration is an insufficient term to describe esthetic success especially in

relation to conditions of the esthetic zone, with all the challenges related to time of implantation, bone quality and quantity, soft tissue biotype, patient medical conditions and patient expectations that may complicate the situation.

An esthetic index must be used to evaluate implant site during dental implant planning. Taking into consideration the available hard and soft tissue and the expected deterioration of their level after implant surgery, using an esthetic index during implant planning may lead to modification of the treatment plan to get better esthetic outcome by changing implantation timing, implant angulation and position, or even using a certain flap design, and requirement or not for soft and/or bone graft. In this way, long term esthetic success is ensured.

Esthetic index must be reliable and reproducible according to the original papers for PES/WES, PICI, and IREI it was found that they meet the criteria of validity reliability and reproducibility while the ICAI found to be the lowest reproducible index with lower clinical acceptance [14].

Using numerical Scale (NS) Rather than visual analog scales (VAS) may interfere with the accuracy and inter-rater reliability of the final result of esthetic index.

Furhauser, et al. [13] presented PES/WES and used the 0-1-2 (NS) so any intermediate grade between excellent and moderate would be scored 2 by one observer and 1 by other one. The authors detected the clinical acceptance with score equals or above 6 for both WES and PES.

That makes IREI produced by Xiachen, et al. [18] more professional index because the scoring system depends on (VAS) with a maximum score of 100 for each parameter. That makes the threshold of clinical acceptance for this index starts from a score of 400 and superior.

These results agreed with a previous study by Martins, et al. [20] during which they assessed both NS and VAS for Auditory perceptual evaluation. They found that Visual Analog Scale able to detect and score the small marking differences more precisely than Numerical scale. As a result, this is why VAS is commonly used for quality of life scale and pain scale [21,22].

**Conclusion**

An esthetic index must be used to evaluate the implant site during dental implant planning, after implant prosthesis restoration and to evaluate the stability of the soft tissue after a long term follow up. Esthetic index must be accurate, valid, reliable and reproducible. According to the current findings and limitations of the study, we found that IRES index was considered to be the most professional and accurate available as it includes sufficient parameters to evaluate peri-implant soft tissue and implant restoration.

**Bibliography**


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