Esthetics and patient-reported outcomes with dental single tooth implants 10 years after placement, a cross-sectional study

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Research Article

Keywords: dental esthetics, mucosa, implant crown, patient reported outcome measures, single tooth implant

Posted Date: May 10th, 2023

DOI: https://doi.org/10.21203/rs.3.rs-2895479/v1

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Abstract

Background

Survival and success rates for single tooth implants have shown excellent results when measuring clinical outcomes. Less attention has been on patient’s perception of function and esthetics with single tooth implants. Therefore, the aim of the study was to describe patient reported function and esthetic outcomes in single tooth implants. A second aim was to compare the patient perceived esthetics with objective esthetics in single tooth implants.

Methods

Patients with one single-tooth implant reconstruction in the esthetic zone were selected. Two questionnaires with visual analogue scales (VAS) were filled in by the patients and intraoral photographs were taken. One questionnaire concerned satisfaction with cleaning and function and the other involved esthetics of the single tooth implant. One dentist reviewed the photographs using the pink esthetic score/white esthetic score index (PES/WES). Spearman correlation test was used to evaluate the relationship between VAS and PES/WES.

Results

For chewing and for speaking the scores were 0.1 respectively 1.2 on a VAS (best 0). The overall esthetics, on a VAS was 8.6 (best 10). PES/WES in the present study was 14.6 (SD ± 1.9) and 3/45 (6.7%) of the patients never reached clinical acceptability. VAS and PES or WES or PES/WES showed no correlation with Spearman’s correlation test (p = 0.435, p = 0.296, p = 0.245 respectively).

Conclusions

Patients reported high satisfaction with the function and the esthetics with single tooth implants. Patients’ satisfaction with the esthetics and the objective esthetics was not correlated.

Background

Dental implant treatment is a commonly used therapy to replace missing single teeth. Both survival and success rates for single tooth implants have shown excellent results [1]. There are many studies on clinical outcomes of single tooth implant treatments [2, 3, 4, 5] but more concern of the patient’s perception of implants needs to be captured by future research. Following the VIII European Workshop on Periodontology a new definition of implant success criteria including patient-reported outcome measures (PROMs), peri-implant tissue health, functional and esthetic outcomes related to implant supported reconstructions was proposed [6].

The esthetic outcome of dental implant treatment is sometimes considered more important, than the functional result, especially in the esthetic zone [7]. In a study over a 5-year follow-up 9.7% of implant-
supported single crowns presented with soft-tissue complications with unacceptable esthetics [8]. A major challenge for the clinician is to achieve a harmonious mucosal margin without abrupt changes in tissue height and obtaining a convex contour of the alveolar crest [9]. Absence of inter tooth-implant papilla will result in a “black triangle” space that negatively affect the esthetics [10].

Evaluation of the esthetics can be performed both objectively and subjectively. Subjective evaluation using the patient’s perception of the esthetics may be evaluated using questionnaires in which satisfaction or dissatisfaction can be expressed by the patient [11]. Studies on patient satisfaction are in the early literature on single tooth implants few [12]. Evaluation of implant treatment should reflect patient opinions as they represent one part of the effectiveness of care [13]. Objective evaluation of esthetics following implant therapy can also be performed by a professional examiner. An objective evaluation is based on predefined criteria of the harmonic appearance and the integration of the restoration with the rest of the dentition of the patient [14]. Both an objective and a subjective evaluation should be considered for a more complete evaluation of the esthetic outcome of the therapy [15].

Different objective evaluation methods of esthetic outcomes exist [15]. The peri-implant esthetics should include both the esthetics of the surrounding mucosa and the prosthetic reconstruction [16]. Fürhauser et al. 2005 evaluated soft tissue esthetics around implants using the pink esthetic score (PES) [17]. Concerning the esthetic outcome of the visible part of the implant crown the white esthetic score (WES) was introduced by Belser et al. 2009 [18]. Only a few studies have investigated the correlation between the patient’s subjective and the professional’s objective evaluations of the esthetics [19, 20, 21, 22].

Patients treated with single tooth implant often have high esthetic demands and oral esthetics is an important variable in dentistry [18, 23]. Only a few studies evaluate the functional and esthetic perceptions from a patient centered perspective [14, 24, 25, 26]. An understanding of the patient's perception of the function and esthetics of single tooth implants would increase the satisfaction with single tooth implant treatment and may enhance the oral-health related quality of life. Therefore, the aim of the study was to describe the patient reported function and esthetic outcomes in single tooth implants. A second aim was to compare the patient perceived esthetics with objective esthetics in single tooth implants.

**Methods**

**Study design**

The present cross-sectional study was part of a clinical study investigating the peri-implant and technical status of single tooth implants at a 10 year follow up. The study was approved by the Regional Ethics Board in Lund (Dnr 300/2006) and conducted in accordance with the World Medical Association Declaration of Helsinki.

All implants were of Brånemark trademark (Nobel Biocare AB), the abutments were either standardized titanium abutments or single abutments DCA 085–089 and the crowns were of all ceramic (Cera-One) or
metal ceramic design (MK).

**Patient selection**

Patients having prosthetic single tooth implant treatment at an Oral Prosthodontic Specialist Clinic in Kristianstad (Folkandvården, Public Dental Service Kristianstad, Sweden) between 1991–1996 were consecutively invited to participate in the study. The patients were examined in 2005–2006 by an experienced dental hygienist. Patients were selected for inclusion if they only had one single-tooth implant reconstruction in the esthetic zone, defined as teeth from the area of the upper right canine to the upper left canine. The study participants should also have two completed questionnaires filled in and intraoral photographs taken. Patients were excluded if there was an edentulous area next to the implant to be studied. All patients were informed of the procedures and gave their written informed consent.

**Patient’s perspective**

Patients were asked to complete two different questionnaires related to their satisfaction regarding the received treatment. The patients were informed to mark their satisfaction with the single tooth implant on a visual analogue scale (VAS). The VAS, consisted of a 10-point graded straight horizontal line with the left end indicating 0 “yes, absolutely” and the right end indicating 10 “absolutely not”. The mean visual analogue score was calculated per patient based on their answers.

**Questionnaire 1**

This questionnaire concerned the function and the cleaning ability with the single tooth implant from which the different statements were adopted from Pjetursson et al. 2005 [27]. The statements were as follows:

1. My single implant functions very well, and I can chew on it very well
2. I feel more secure biting on my teeth compared to my implant supported crown
3. To speak I can very well use my implant-supported crown/bridge
4. I can clean my single implant very well
5. It is easier for me to clean my single implant than to clean my teeth
6. I need more time to clean my implant than to clean my teeth
7. The tissues around my single implant bleed less than around my teeth
8. I got exactly what I expected
9. I would like this treatment again, if needed
10. I would recommend this treatment to a friend or relative, if indicated

**Questionnaire 2**

The other questionnaire evaluated how the patient perceived the esthetics of the single tooth implant. The mean VAS score was calculated per patient based on their answers to the following areas:
1. Crown colour
2. Crown shape
3. Mucosal appearance
4. Overall satisfaction

**Dentist’s perspective**

Each implant was photographed with a digital camera and included a front photograph and a close up-photograph of the crown. The contralateral reference tooth had to be visible to ensure compatibility. A dentist (VWN) reviewed the intraoral photographs according to the pink esthetic score (PES)/White esthetic score (WES) index [18]. PES/WES is a composite index of the peri-implant soft tissue score index (PES) [17] and the white esthetic score index (WES) [18]. The PES/WES assess mesial papilla fill, distal papilla fill, curvature of the facial mucosa, level of the facial mucosa, root convexity/soft tissue colour and texture as well as crown form, crown volume/outline, crown colour, crown surface texture and crown translucency. All items have score 0, 1 or 2. Score 2 represent the best outcome and 0 the worst. The papilla scores were assessed for completeness (score 2), incompleteness (score 1) or absence of papillary tissue (score 0). The curvature of the facial soft tissue line was evaluated as identical (score 2), slightly different (score 1) or markedly different (score 0) compared to a reference tooth, for most cases the contralateral tooth. The level of the facial mucosa was scored as identical vertical level (score 2), slight $\leq 1$ mm discrepancy (score 1) or major $\geq 1$ mm discrepancy (score 0). Presence (score 2), partial presence (score 1) or absence (score 0) of a convex profile as well as the colour and texture of the facial mucosa was combined according to Belser et al. 2009 [18]. A score of 2 for this combination variable presupposed all three variables were identical to the reference tooth. If optimal conditions were fulfilled a maximum PES score of 10 was obtained, and a PES score of 6 was determined clinical acceptable. In WES the maximum score, under optimal conditions of the implant crown, resulted in a WES score of 10 and score 6 was considered clinical acceptable [18].

**Statistical analysis**

For statistical analysis the statistics software The Statistical Package for the Social Sciences (SPSS) Predictive Analytics Software (PASW) 27.0 statistical software package (SPSS Inc., Armonk, NY, USA) for Personal Computer (PC) was used. Descriptive analysis with mean, standard deviation, median and range for continuous data was conducted. For categorial data percentages are given. Estimates (odds ratio, mean difference) are given with corresponding 95% confidence interval. The significant level for the p value was set at 0.05. No data was missing. Cronbach's Alpha was used for testing the reproducibility of the PES/WES index used for objective assessment of the esthetic outcome. To evaluate the relationship between VAS and PES/WES index Spearman correlation test was used.

**Results**

In the study 45 patients with one single tooth implant met the inclusion criteria. Of the 45 patients 19/45 (42.2%) were women. The mean age of the patients was 40 years ($\pm 10.5$ range 30-80 years). Current
smokers among the patients were 7/45 (15.5%). All implants were of trademark Nobel Biocare and the abutments were standardized titanium abutments in 41/45 (91.1%) and single abutment DCA 085-089 in 4/45 (8.9%). The single crowns were all ceramic in 38/45 (84.4%) and the remaining 7/45 (15.6%) were of metallic ceramic. The single tooth implant had been in function for 12.6 years (± 1.39, range 10-15). The intraclass correlation coefficient (ICC) for the PES/WES index between the two observer measurements was 0.89; range 0.58-0.97; \( p=0.001 \) and was based on a total of 10 observations.

### 3.1 Function and cleaning ability of the single tooth implant

**Visual Analogue Scale reported by the patients**

The total mean score of VAS for function and cleaning ability was 34.1 (± 7.8, range 21-51) and the median 32.0. For all statements mean and median values and the range for each statement are given (Table 1).

**Table 1 Satisfaction with function and cleaning ability of the single tooth implant on a Visual Analogue Scale**
<table>
<thead>
<tr>
<th>Statement</th>
<th>Mean SD Range</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. My single implant functions very well, and I can chew on it very well</td>
<td>1.2 ± 2.5</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>(range 0-10)</td>
<td></td>
</tr>
<tr>
<td>2. I feel more secure biting on my teeth compared to my implant supported crown</td>
<td>7.2 ± 3.5</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>(range 0-10)</td>
<td></td>
</tr>
<tr>
<td>3. To speak I can very well use my implant-supported crown/bridge</td>
<td>0.1 ± 0.5</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>(range 0-3)</td>
<td></td>
</tr>
<tr>
<td>4. I can clean my single implant very well</td>
<td>0.8 ± 1.9</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>(range 0-8)</td>
<td></td>
</tr>
<tr>
<td>5. It is easier for me to clean my single implant than to clean my teeth</td>
<td>7.5 ± 3.0</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>(range 0-10)</td>
<td></td>
</tr>
<tr>
<td>6. I need more time to clean my implant than to clean my teeth</td>
<td>8.7 ± 2.6</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>(range 0-10)</td>
<td></td>
</tr>
<tr>
<td>7. The tissues around my single implant bleed less than around my teeth</td>
<td>5.6 ± 3.8</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>(range 0-10)</td>
<td></td>
</tr>
<tr>
<td>8. I got exactly what I expected</td>
<td>1.8 ± 2.3</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>(range 0-7)</td>
<td></td>
</tr>
<tr>
<td>9. I would like this treatment again, if needed</td>
<td>0.6 ± 1.5</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>(range 0-7)</td>
<td></td>
</tr>
<tr>
<td>10. I would recommend this treatment to a friend or relative, if indicated</td>
<td>0.4 ± 1.2</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>(range 0-7)</td>
<td></td>
</tr>
</tbody>
</table>

Patient reported statements 0=yes, absolutely, 10=no, absolutely not,

SD=Standard deviation

Concerning statement 1 “My single implant functions very well, and I can chew on it very well”. The mean score on this statement was 1.2 (± 2.5, range 0-10) and the median was 0.00. In statement 3 “To speak I can very well use my implant-supported crown/bridge”. The mean rating was calculated as 0.1 (± 0.5, range 0-3) and the median was 0.0. Regarding statement 4 “I can clean my single implant very well”. On this statement the mean score was 0.8 (± 1.9, range 0-8) and the median was 0.0.

3.2 Esthetics of the single tooth implant
Visual Analogue Scale reported by the patients

Patients were most satisfied with the colour and shape of the single crown. Less satisfaction was perceived with the mucosal margin surrounding the implant. The overall satisfaction with the esthetics of the implant was in mean 8.6 (± 1.3, range 6-10) and the median value was 9.0 (Table 2).

Table 2 Patient perceived esthetics of the single tooth implant according to a Visual Analogue Scale

<table>
<thead>
<tr>
<th></th>
<th>n=45</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crown colour</td>
<td></td>
<td>9.2</td>
<td>1.1</td>
<td>6-10</td>
<td>10.00</td>
</tr>
<tr>
<td>Crown shape</td>
<td></td>
<td>9.2</td>
<td>1.4</td>
<td>5-10</td>
<td>10.00</td>
</tr>
<tr>
<td>Mucosal appearance</td>
<td></td>
<td>7.1</td>
<td>2.8</td>
<td>2-10</td>
<td>8.00</td>
</tr>
<tr>
<td>Overall satisfaction</td>
<td></td>
<td>8.6</td>
<td>1.3</td>
<td>6-10</td>
<td>9.00</td>
</tr>
</tbody>
</table>

Patient perceived esthetics 0=not satisfied at all, 10=completely satisfied

SD=Standard deviation, n=number

The Pink Esthetic Score (PES) and the White Esthetic Score (WES) reported by the dentist

The overall PES was in mean 6.2 (± 1.4, range 3-9) and median 6.0 (Table 3). Of patients 13/45 (29 %) had a PES score < 6. The corresponding figure for WES was 8.4 (± 1.2, range 5-10) and median 9.0 (Table 3).

Table 3 Mean pink and white esthetic scores of the single tooth implants
<table>
<thead>
<tr>
<th>PES</th>
<th>Mesial papilla</th>
<th>Distal papilla</th>
<th>Curvature of facial mucosa</th>
<th>Level of facial mucosa</th>
<th>Root convexity, soft tissue colour and texture</th>
<th>Total PES (Max 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.2</td>
<td>1.0</td>
<td>1.6</td>
<td>1.3</td>
<td>1.1</td>
<td>6.2</td>
</tr>
<tr>
<td>SD</td>
<td>0.6</td>
<td>0.5</td>
<td>0.7</td>
<td>0.8</td>
<td>0.4</td>
<td>1.4</td>
</tr>
<tr>
<td>Median</td>
<td>1.0</td>
<td>1.0</td>
<td>2.0</td>
<td>1.0</td>
<td>1.0</td>
<td>6.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WES</th>
<th>Tooth form</th>
<th>Tooth volume/outline</th>
<th>Colour (hue/value)</th>
<th>Surface texture</th>
<th>Translucency and characterisation</th>
<th>Total WES (Max 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.7</td>
<td>1.2</td>
<td>1.6</td>
<td>2.0</td>
<td>1.9</td>
<td>8.4</td>
</tr>
<tr>
<td>SD</td>
<td>0.5</td>
<td>0.7</td>
<td>0.5</td>
<td>0.2</td>
<td>0.3</td>
<td>1.2</td>
</tr>
<tr>
<td>Median</td>
<td>2.0</td>
<td>1.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>9.0</td>
</tr>
</tbody>
</table>

PES=pink esthetic score, WES=white esthetic score

Pink and white esthetic score minimum=0 and maximum=2 reported by a dentist (VWN)

SD=standard deviation

A WES score < 6 was reported in 1/45 (2.2%). When PES/WES was calculated together the mean was 14.6 (± 1.9, range 9-18) and median 15.0. A score < 12 for PES/WES was noted in 3/45 (6.7%) patients. For detailed PES and WES (Table 4).

Table 4 Number of single tooth implants with different pink and white esthetic scores
### Esthetic score

<table>
<thead>
<tr>
<th></th>
<th>2</th>
<th>0</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mesial papilla</td>
<td>4</td>
<td>27</td>
<td>14</td>
</tr>
<tr>
<td>Distal papilla</td>
<td>5</td>
<td>35</td>
<td>5</td>
</tr>
<tr>
<td>Curvature of facial mucosa</td>
<td>4</td>
<td>11</td>
<td>30</td>
</tr>
<tr>
<td>Level of facial mucosa</td>
<td>10</td>
<td>13</td>
<td>22</td>
</tr>
<tr>
<td>Root convexity/soft tissue colour and texture</td>
<td>1</td>
<td>39</td>
<td>5</td>
</tr>
<tr>
<td><strong>WES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tooth form</td>
<td>1</td>
<td>11</td>
<td>33</td>
</tr>
<tr>
<td>Tooth contour</td>
<td>7</td>
<td>23</td>
<td>15</td>
</tr>
<tr>
<td>Colour</td>
<td>0</td>
<td>14</td>
<td>31</td>
</tr>
<tr>
<td>Surface texture</td>
<td>0</td>
<td>2</td>
<td>43</td>
</tr>
<tr>
<td>Translucency</td>
<td>0</td>
<td>6</td>
<td>39</td>
</tr>
</tbody>
</table>

PES=pink esthetic score; WES=white esthetic score

Pink and white esthetic score minimum=0 and maximum=2 reported by a dentist

**Correlation between the patient’s and the dentist evaluation of the esthetics**

No significant association between the total mean VAS and PES or WES or PES/WES could be shown with Spearman’s correlation test ($p=0.435$, $p=0.296$, $p=0.245$ respectively) (Table 5).

**Table 5 Spearman’s correlation test between VAS and PES or WES or PES/WES**

<table>
<thead>
<tr>
<th></th>
<th>PES</th>
<th>WES</th>
<th>PES/WES</th>
<th>VAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spearman’s rho VAS</td>
<td>0.119</td>
<td>0.159</td>
<td>0.177</td>
<td>1.000</td>
</tr>
<tr>
<td>Sign (two-tailed)</td>
<td>0.435</td>
<td>0.296</td>
<td>0.245</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>45</td>
<td>45</td>
<td>0.245</td>
<td>45</td>
</tr>
</tbody>
</table>
VAS=Visual Analogue Scale; PES=pink esthetic score; WES=white esthetic score

Discussion

In this study subjective evaluation of the function for single tooth implants showed for chewing 1.2 and for speaking 0.1, on a VAS with 0 indicating absolutely agreement. Regarding the subjective esthetic evaluation, the overall esthetics, on a VAS was 8.6 and the highest values were crown colour and crown shape (9.2 for each) with 10 indicating absolutely agreement. The surrounding mucosa exhibited the lowest score 7.1 on the VAS.

In a study by Wang et al. 2021 [25] patients with implant crowns and PROMs 10 years after implant placement showed that 91.6% of patients were satisfied with their chewing ability and the remaining 8.4% of patients reported with slight restrictions. The results in Wang et al. study 2021 [25] are in concordance with the high satisfaction with the chewing comfort in the present study. In our study the patients reported their speaking ability after implant therapy close to absolutely agree. In the study by Pjetursson et al. 2005 [27], 5–15 years after implant installation, phonetic problems were reported by 2% of the patients, which should be somewhat to the same degree as in our study.

The perceived esthetics with maxillary anterior single implants found in the present study is in accordance with previous data reported by Altay et al. 2019 [28] although the questions asked to the patients were not entirely the same.

The mean comprised pink esthetic score and white esthetic score (PES/WES) in the present study was 14.6 (SD ± 1.9). In a study by Belser et. al 2009 [18] the same objective index was used on maxillary anterior single tooth implants in 45 patients but only with a 2–4-year follow-up. The PES/WES esthetic score was strikingly about the same with a score of 14.7 (SD ± 1.18). In the present study 3/45 (6.7%) of the patients never reached clinical acceptability according to the threshold in PES/WES of score12 by Belser et. al 2009 [18]. The PES score was in mean 6.2 and 13/45 (29%) of patients was below the threshold for clinical acceptability < 6 whereas the WES score was in mean 8.4 and only 1/45 (2.2%) of the patients was below the threshold for clinical acceptability < 6. It is apparent that the esthetics with the surrounding mucosa is deemed less appealing than the implant supported crown. In a study by Cho et al. 2010 [29] single tooth implants in 41 patients were evaluated with PES/WES by eight observers. The mean PES was 5.17 whereas WES was 6.02. In the present study the same tendency with a lower PES than WES value was apparent even though the values by Cho et al. 2010 [29] was lower for both PES and WES. In the same study the main reason for extractions of the natural teeth was periodontitis. Periodontitis with subsequent loss of bone and interproximal crest height should determine the presence or absence of the peri-implant papilla [30]. In the present study the reasons for tooth extractions were not reported but the scores for the approximal papilla showed scores of 1.2 for the mesial respectively 1.0 for the distal papilla. Studies showed that the papilla height primarily was dependent on the bone level height at adjacent root-surfaces [30, 31] which was not investigated in the present study. The papilla scores in the present study were in between those by Cho et al. 2010 [29] (0.63 mesial and 0.64 distal)
and by Belser et al. 2009 [18] (1.6 mesial and 1.3 distal). In our study the implants were placed according to a late placement protocol as in Cho et al. study 2010 [29], in contrast to the study by Belser et al. 2009 [18] in which the implants were placed according to an early placement protocol. Studies showed that early implant placement initially showed better papilla fill but at later follow-ups the interproximal fill was about the same [31]. The reasons why there is some differences between the papilla variable could depend on the follow-up time which was the longest in our study. In the present study the follow-up was 10 years or more, in the study by Cho et al. 2010 [29] it was 1–8 years and in the study by Belser et al. 2009 [18] it was 2–4 years. Another reason that can influence the differences in the papilla scores may be that in the present study the implants were placed in the position of the central incisors, the lateral incisors or the canines unlike the studies by Belser et al 2009 [18] and by Cho et al. 2010 [29] in which the first premolar position was included.

No significant correlation between PES/WES and VAS scores was shown in this study. In the literature some studies showed a correlation [29] and some never did [32]. The subjective instrument VAS used by the patients may illustrate the subjective nature of esthetics which may be influenced by factors such as age, gender, educational background, and psychological well-being and are not always the same as the objectively perfect esthetic result [15].

A strength with this study is that the objective combined PES/WES index for the surrounding mucosa and the implant supported crown was used, as it has high reproducibility [15]. The PES has by the 6th EAO Consensus Conference 2021, been stated as one of the two most validated esthetic indices for single tooth implants [33].

The PROMs using a questionnaire and VAS concerning the cleaning and function ability and the esthetics were neither standardised nor validated which must be considered a weakness in this study. As far as we know to date, a validated implant-specific, patient-reported outcome measure focused on esthetic evaluation is still not available.

After 10 years follow-up, patients with single tooth implants were satisfied with the cleaning ability as well as the chewing and speaking function. Patients also reported overall high satisfaction with the esthetics including both the peri-implant surrounding mucosa and the crown. From an objective point of view the esthetics of most single tooth implants and the surrounding peri-implant mucosa was clinical acceptable. The PES was somewhat less favourable than WES indicating less esthetic result with the mucosa and therefore more treatment efforts should focus on the surrounding peri-implant mucosa. Both subjective and esthetic outcomes of single tooth implants must be considered together to obtain an overall esthetic evaluation from both the patient’s and the clinician’s perspective.

**Conclusions**

Patients reported high satisfaction with the cleaning and chewing ability as the overall esthetics with single tooth implants. The surrounding peri-implant mucosa was less favourable than the crown of the
single tooth implant when assessed both subjectively and objectively. Satisfaction with the esthetics assessed by the patients and the objective esthetics was not correlated.

**Abbreviations**

DCA: Direct cast abutment; MK: metal ceramic; PES: Pink esthetic score; PROMs: Patient-reported outcome measures; VAS: Visual Analogue scale WES: White esthetic score

**Declarations**

**Acknowledgements**

The authors would like to thank Professor Stefan Renvert for his contribution in the conception and design of the study.

**Author’s contributions**

CL contributed to conception and design, investigation, data management, critically reading, and revising the manuscript. SS contributed to conception, design, provided the data, critically reading, and revising the manuscript. VWB contributed to analysis and interpretation of data, preparations of manuscript and tables, critically reading, and revising the manuscript. All authors revised and approved the manuscript prior to submission.

**Funding**

This study was supported by the Research foundation at Kristianstad University, Sweden.

**Availability of data and materials**

Authors elect to share data on reasonable request.

**Ethics approval and consent to participate**

The study was conducted in accordance with the World Medical Association Declaration of Helsinki 1975 and revised in 2008 and was approved by the Regional Ethics Board in Lund (Dnr 300/2006). All participating patients signed an informed consent form, for having their data used for scientific purpose.ORCID Viveca Wallin Bengtsson https://orcid.org/0000-0002-8092-665X.

**Consent for publication**

Not applicable.

**Competing interests**

The authors declare no conflicts of interest.
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