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Comprehensive Esthetic Evaluation of Maxillary Central Incisor Single-Tooth Implant: Utilizing Visual Analogue Scale and Assessing Alignment with PES/WES Criteria by Dental Specialists

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ABSTRACT

Introduction: Single-tooth implants are a common dental treatment, with a growing emphasis on esthetic out-comes due to their high survival and success rates, especially in esthetic areas. This study assessed consensus among specialists using the Visual Analogue Scale (VAS), focusing on the objective criteria of Pink Esthetic Score (PES) and White Esthetic Score (WES).

Materials and Methods: This cross-sectional study evaluated the esthetic aspects of a maxillary central single-tooth implant using VAS, involving 18 prosthodontists, 11 restorative specialists, 12 periodontists, and 11 Oral Maxillofacial Surgeons. A photo of an ideally contoured implant-supported restoration, taken three months post-delivery, underwent alterations to create 15 variations based on PES/WES criteria. Specialists provided VAS scores (0 to 10) for restoration esthetics and soft tissue surrounding the implant. Scores were compared with PES/WES, and Pearson correlation coefficients determined relationships. The significance level of the p-value is 0.05.

Results: Prosthodontists showed a strong correlation with PES (0.86±0.09), WES (0.88±0.07), and PES/WES (0.88±0.08). Restorative specialists exhibited correlations of PES (0.73±0.25), WES (0.73±0.29), and PES/WES (0.74±0.28). Periodontists demonstrated correlations with PES (0.87±0.07), WES (0.84±0.08), and the ratio of PES to WES (0.86±0.07). OMF surgeons had correla-tions of PES (0.83±0.11), WES (0.85±0.09), and PES/WES (0.85±0.1). Inter-group correlations did not significantly differ (P Value>0.05).

Conclusion: Robust correlations exist among specialists in evaluating implant esthetics using VAS and PES/WES, with restorative and surgical specialists displaying a stricter approach.

Keywords: White esthetic score; Pink esthetic score; Visual analog scales; Implant-supported single crown.

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Introduction

The face is a symbolic representation of identity, with a smile acting as a revealing glimpse into one's personality. Achieving a harmonious smile involves considering eight essential elements, where the alignment and appearance of teeth significantly contribute to overall facial harmony and symmetry [1,2]. Currently, edentulous patients can effortlessly replace their missing teeth with implants to regain the same functionality as natural teeth [3,4]. Dental implants are considered a standard treatment in modern dentistry. With their impressive sur-vival and success rates, there is a growing emphasis on achieving not just functional but also esthetic excellence, particularly in esthetic regions [5].

Recently, dental implants serve not only to restore functionality for patients but also to ensure aes-thetic enhancements. Hence, a comprehensive evaluation of success involves both objective aesthet-ic assessments and patient-reported treatment outcomes [6]. The aesthetic evaluation can be conducted through both subjective and objective methods. In the subjective approach, the perception of beauty and the surrounding soft tissue is assessed by a clini-cian or a patient using a pre-designed Visual Analogue Scale (VAS) tool [7,8]. The Visual Analogue Scale (VAS) serves as a psychometric response tool, capturing nuanced subjec-tive perceptions with a continuous line that represents a spectrum of experiences. It proves to be a versatile and effective means for assessing the intensity of subjective responses, particularly in eval-uating aesthetic and emotional dimensions [9]. For the assessment of implant esthetics, multiple beauty indices are employed to evaluate the soft tissue around the implant and the implant restoration. These indices, such as the Pink Esthetic Score (PES) and White Esthetic Score (WES), serve as objective measures for evaluating the aesthetic outcomes of implant treatment [10]. It is worth mentioning that PES comprises five parameters:

1. Mesial papilla 2. Distal papilla, 3. Fa-cial mucosal margin, 4. Facial mucosal surface, and 5. Root convexity–evaluating color and surface structure of soft tissue on the facial aspect of the implant. Scores for each parameter range from 0 to 2. The cumulative score, with a maximum of 10, established a clinically acceptable threshold set at 6 [8,11]. WES specifically assesses the visible part of the implant restoration, focusing on the crown that emerges from the surrounding mucosa. This evaluation is based on 5 parameters: **1.** Tooth form, **2.** Volume and external boundaries of the clinical crown, **3.** Tooth color, including Hue and Value, **4.** Surface, and **5.** Translucency. The maximum achievable score is 10, with a clinically acceptable threshold set at 6. Consequently, the highest attainable composite score for PES/WES is 20 [8,12]. It is noteworthy that numerous studies have utilized the Pink Esthetic Score (PES) and White Es-thetic Score (WES) as reliable criteria for aesthetic evaluation across various contexts [14-20]. The Pink Esthetic Score (PES) and White Esthetic Score (WES) are widely accepted indices for as-sessing the aesthetic outcomes of single implants, while the Visual Analogue Scale (VAS) is recom-mended for overall satisfaction evaluation. However, consistency between VAS and PES/WES scores may vary due to scorer perception. Thus, combining these scoring systems is crucial for clini-cians to achieve a comprehensive evaluation of implant restoration aesthetics [13,21,22].

Given the limited studies that explore the correlation of specialists' opinions with WES and PES, this study was undertaken to evaluate the subjective correlation among specialists in Prosthodontics, Restorative Dentistry, Periodontics, and Oral and Maxillofacial Surgery using VAS. The aim was to compare these subjective assessments with the objective indices of PES and WES. Our study aims to test two null hypotheses: first, whether there is a correlation between specialists' VAS assessments and PES/WES results, and second, whether VAS scores vary among specialists from different dental specialties.

Materials and Methods

For this study, we acquired an initial image of the ideal implant-supported restoration of a right maxillary incisor, captured three months post-delivery. This benchmark image, obtained with per-mission from cases treated by Professor Dennis Tarnow, is assumed as the standard, boasting the highest PES and WES scores (Figure 1). To ensure a controlled and systemic evaluation, the image underwent modifications using Adobe Photoshop 2020 software, aligning with the 15 specified modes detailed in Table 3 (Figures 2 & 3). Fifteen scenarios, developed based on the PES/WES index, were assessed by a prosthodontist and a periodontist, and their scores were documented. These 15 images were uploaded as an online check-list on the Google Forms platform and shared with prosthodontists, restorative specialists, periodon-tists, and oral and maxillofacial surgeons through virtual platforms such as WhatsApp (Figure 4). Specialists from the dental school of Tehran University of Medical Sciences were invited to partici-pate, resulting in the involvement of

18 prosthodontists, 11 restorative specialists, 12 periodontists, and 11 oral and maxillofacial surgeons. They were tasked with providing a score from 0 to 10 for each photograph based on the Visual Analogue Scale (VAS) index. Furthermore, they were asked to share their subjective opinions regarding the aesthetics of the restoration and the soft tissue around the implant. Participants were also encouraged to note any specific issues that influenced deduction in the beauty score (with 0 representing the least beautiful and 10 representing the most beautiful).

In the final step, the scores given by prosthodontists, restorative specialists, periodontists, and oral and maxillofacial surgeons, utilizing the VAS, were compared to the assigned PES/WES scores for each photograph. Correlations were obtained separately for the scores of each specialist with the PES/WES, WES, and PES indices. The Pearson Correlation Coefficient was utilized to assess the correlation between each specialist's opinions and the PES/WES, WES, and PES indices. Descriptive one-way ANOVA analysis was employed to calculate the average correlation within each group. Tukey HSD post hoc test was then used to compare the mean correlations between the two groups. Statistical significance was assumed for p-values<0.05.

Results

The correlation results obtained in the groups of Prosthodontics, Restorative Dentistry, Periodontics, and Oral and Maxillofacial Surgery with the PES/WES, WES, and PES indices are as follows (Tables 1 & 2). The results indicate a strong correlation between the opinions of specialists in all four groups with all three indices. (Statistically, a correlation above 0.7 is considered strong). The statistical differences in the mean correlation scores of specialist groups with the PES/WES, WES, and PES indices are as follows (Table 3).

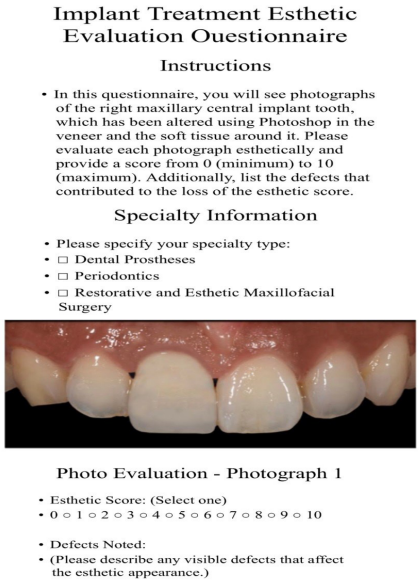
Among respondents who provided reasons for their ratings (12 out of 18 in the Prosthodontics group, 8 out of 11 in the Restorative group, 7 out of 12 in the Periodontics group, and 5 out of 11 in the Oral and Maxillofacial Surgery group responded to the open-ended question), Prosthodontists predominantly focused on factors associated with the PES index. The majority directed their atten-tion to the deficiency of the mesial papilla (55.5%) while paying the least attention to the deficiency of the gingival margin (8.86%). In the Restorative group, the highest attention was given to the de-ficiency of the distal papilla (88%), with the least attention related to the color deficiency of the gingiva (12%). Periodontists showed the highest attention on the deficiency of the mesial papilla (100%) and the least attention on the color deficiency of the gingiva (31.4%). Within the Oral and Maxillofacial Surgery Group, specialists paid the most attention to factors related to the PES index, specifically the deficiency of the mesial papilla (90.9%), and the least attention to the deficiency of the gingival margin (12.9%). For WES index factors, Prosthodontists devoted the most attention to the deficiency in the color of the implant restoration (78.8%) and showed the least attention to translucency (24.6%).

In the Re-storative group, the highest attention was given to the deficiency in the form of implant restoration (85.7%), while the lowest attention was towards translucency (19%). Periodontists exhibited the highest focus on form (85.4%) and color of the implant restoration (79.6%), while the least emphasis was on translucency (2.4%). In the Oral and Maxillofacial Surgery Group, specialists paid the most attention to factors related to the WES index, specifically the color mismatch of the implant restora-tion (80%), and the least attention to the surface structure of the restoration (0%).

Figure 1. An ideal picture of the Right Maxillary Central Incisor Implant with the highest WES and PES.

Figure 2. Major modifications have been applied to all PES and WES factors, resulting in a total score of zero for this image (Table 1-Row 1).

Figure 3. Minor modifications have been made across all PES and WES factors, resulting in a total score of 10 (Table 1- Row 6).



Implant Treatment Esthetic Evaluation Questionnaire

Instructions

- In this questionnaire, you will see photographs of the right maxillary central implant tooth, which has been altered using Photoshop in the veneer and the soft tissue around it. Please evaluate each photograph esthetically and provide a score from 0 (minimum) to 10 (maximum). Additionally, list the defects that contributed to the loss of the esthetic score.

Specialty Information

- Please specify your specialty type:
- ☐ Dental Prostheses
- ☐ Periodontics
- ☐ Restorative and Esthetic Maxillofacial Surgery

Photo Evaluation - Photograph 1

- Esthetic Score: (Select one)
- 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10

- Defects Noted:
- (Please describe any visible defects that affect the esthetic appearance.)

Figure 4. Part of the prepared online checklist.

Table 1. Pink Esthetic Score sheets as interpreted by Belser [11].

Parameter	*Absent*	*Incomplete*	*Complete*
Mesial papilla	*0*	*1*	*2*
Distal papilla	*0*	*1*	*2*
	Major discrepancy	*Minor discrepancy*	*No discrepancy*
Curvature of facial mucosa	*0*	*1*	*2*
Level of facial mucosa	*0*	*1*	*2*
Root convexity/soft tissue color and texture	*0*	*1*	*2*

Table 2. White Esthetic Score sheets as interpreted by Belser [13].

Parameter	*Major discrepancy*	*Minor discrepancy*	*No discrepancy*
Tooth form	*0*	*1*	*2*
Tooth volume/outline	*0*	*1*	*2*
Color (hue/value)	*0*	*1*	*2*
Surface texture	*0*	*1*	*2*
Translucency	*0*	*1*	*2*

Table 3. 15 different modes of altering photographs in Adobe Photograph-shop software.

Photograph	*Changes made in PES*	*Changes made in WES*	*Total scores PES, WES*
1	*All items are major*	*All items are major*	*0*
2	*Major: distal papilla, color, lining, gingival curvature harmony. Minor: mesial papilla*	*Major: volume, form, veneer texture, translucency incisal edge Minor: restoration color*	*2*
3	*All items in major (except mesial papilla which remained unchanged)*	*All items are major (except for the resto-ration form which remained unchanged)*	*4*
4	*Major: Color, lining, gingival margin harmony. Minor: distal papilla*	*Major: color, volume, restoration form minor: translucency incisal edge*	*6*
5	*Major: mesial papilla, color, gingival lining*	*Major: form, volume of restoration Minor: texture and color of the resto-ra-tion*	*8*
6	*All items are minor*	*All items are minor*	*10*
7	*Major: lining, gingival margin harmony*	*Major: form, restoration volume*	*12*
8	*Major: gingival color Minor: gingival margin harmony*	*Major: restoration color Minor: Surface texture*	*14*
9	*Major: distal papilla*	*Major: veneer form*	*16*
10	*Minor: Gingival color*	*Minor: Incisal edge translucency*	*18*
11	*All items unchanged*	*All items unchanged*	*20*
12	*All items unchanged*	*Minor: form, restoration volume*	*18*
13	*Minor: Gingival lining, distal papilla*	*All items unchanged*	*18*
14	*All items unchanged*	*Major: restoration color*	*18*
15	*Major: mesial papilla*	*All items unchanged*	*18*

Discussion

In this study, our objective was to evaluate the alignment between specialists' subjective assessment using the Visual Analogue Scale (VAS) and the objective measures of aesthetic evaluation, specifi-cally the Pink Esthetic Score (PES) and White Esthetic Score (WES). Notably, our findings demon-strated a significant level of consensus among participants, with the vast majority exhibiting con-sistent opinions when employing the VAS for aesthetic assessment. This outcome supports our null hypothesis, confirming a correlation between specialists' subjective assessments using VAS and PES/WES results. While most studies in implant treatment esthetics have focused on comparing patient-rated VAS scores with PES/WES indices, our study uniquely evaluated the correlation between the perceptions of specialists in Prosthodontics, Restorative Dentistry, Periodontics, and Oral and Maxillofacial Surgery based on VAS and PES/WES scores. Kristian Kniha et al. conducted a comprehensive assessment of the esthetic evaluation of maxillary single-tooth implants using PES, WES, and the Peri-implant Crown Index (PICI), involving various dental specialists. Orthodontists reported significantly lower scores compared to other groups, while patient satisfaction remained notably high [23]. Several studies, including those by Cho et al., have demonstrated a strong connection between pa-tients' assessments using the Visual Analogue Scale (VAS) and objective indices, such as PES/WES, evaluated by dentists [24]. Additionally, Ruchika Rupchandani et al. found a significant correlation between PES/WES scores and VAS assessments [25]. Moreover, Gjelvod et al., in their randomized clinical trial comparing immediate and delayed load-ing single-tooth implants, utilized WES and PES over a 5-year follow-up period, revealing no statis-tically significant differences between the two loading techniques [26]. However, other studies, including those by Belser et al., Altay et al., Angkaew et al., Boon et al., and Adam R.Jones et al., found no significant correlation between PES/WES and patient-rated VAS [6,11,27-29]. Additionally, Khaireddine Hamadane et al. observed a weak correlation between the perception of non-expert subjects and aesthetic indices. Furthermore, Chu-Nan Zhang et al. assessed the esthetic outcomes of different

zirconia implant restorations and found discrepancies between professional and patient evaluations [30,31]. Xiao-Lin Deng et al. and Alethea Li Foong et al. conducted studies evaluating various aspects of esthetic outcomes in dental restorations, highlighting significant differences in perception between clinicians and patients [32,33]. Moreover, L. Chen et al. compared conventional and socket shield techniques (SST) for immediate implant restorations, revealing variances in PES and WES scores among different groups. Similarly, Adrien Pollini et al. assessed single implant restoration esthetics among different dental profession-als and lay-people, finding color to be the most crucial parameter affecting esthetic outcomes [34,35].

In a singular study undertaken by Hartlev and colleagues involving 54 implants, they not only scru-tinized patients' perspectives on the aesthetic aspects of implant restorations and the adjacent soft tissue using the VAS tool, comparing with scores derived from PES/WES index but also delved cli-nicians' viewpoints regarding implant aesthetics and surrounding soft tissue, utilizing the VAS tool. The study showcased a robust correlation between the VAS scores assigned by specialists in sur-gery, periodontics, and prosthodontics and the corresponding PES/WES scores they allocated [7]. In the current study, the perceptions of specialists in prosthodontics, restorative dentistry, and maxillofacial surgery were assessed using the VAS tool. The results revealed a correlation between the specialists' opinions based on the VAS tool and the outcomes derived from the PES/WES in-dex, aligning with the findings of the Hartlev study [7].

Many studies have been conducted to examine the type of specialization in assessing the esthetic aspects of implant restoration and the surrounding soft tissue using the PES/WES index. Cho and colleagues, as well as Tettemanti et.al, stated that there is no significant difference in the PES/WES scoring among different specialist groups [10,27]. Al-Dosari et.al, who examined the opinions of periodontists, orthodontists, and oral surgeons, con-cluded that there was a significant difference in PES/WES and WES scoring among different spe-cialties. In their study, oral surgeons gave the highest, while prosthodontists gave the lowest PES/WES scores. Periodontists, after oral surgeons, are considered to have the highest PES/WES scores [36]. None of the reviewed studies assessed the perception of restorative specialists regarding the aesthet-ics of implant restorations and the surrounding soft tissue. In our study, the perception of prosthodontists, restorative specialists, periodontists, and oral and maxillofacial surgeons regarding the beauty of implants and the surrounding soft tissue, as measured by the VAS tool, did not show a significant difference in correlation with the PES/WES index. However, restorative specialists and oral surgeons were stricter in their scoring, and their correlation with the PES/WES index was lower compared to periodontists and prosthodontists (Restorative Specialists<Oral Surgeons<Periodontists<Prosthodontists).

In the present study, regarding the soft tissue around the implant, the deficiency of the mesial papil-la and distal papilla garnered more attention from specialists in all four groups. The least attention, from the perspective of specialists, was allocated in the prosthodontics group to the facial mucosal margin, in the restorative specialists' group to color and surface structure, in the periodontics group to the mucosal color, and in the maxillofacial surgery group to the lack of harmony in the facial mu-cosal margin. Based on these studies, the significant factor of gingival color was notably overlooked by special-ists. While changes in gingival color can indicate inflammation and, beyond its impact on the aes-thetics of implant treatment results, it holds substantial importance in evaluating the health of the surrounding soft tissue, demanding more attention and precision in assessment [37]. In the Cho study, the lowest scores were assigned to the mesial and distal papillae. They stated that most examined samples in their study had lost their teeth due to periodontal disease, which could be a significant influencing factor in the development of papillae in the interdental space [27].

However, this issue indicates that interdental papillae play a significant and crucial role in beauty assessment and scoring by specialists. It appears that the patient's perception of the beauty of im-plant restoration and the surrounding soft tissue is not significantly influenced by the position of the papillae [7]. Hartlev et al. demonstrated in their study that in 2/3 of the samples, the inter-implant papillae and adjacent teeth were imperfect. However, patients expressed very high satisfaction with their implant treatment, the beauty of the implant restoration, and its surrounding soft tissue [7]. In the evaluation of implant restorations by specialists from all four groups, existing flaws in the form and color of the restorations garnered the highest attention, while, according to the prostho-dontists, restorative specialists, and periodontists, the translucency of the incisal edge of the restora-tion received the least importance. Interestingly, none of the oral surgeons found the surface texture of the restoration to be noteworthy. The analysis of these studies revealed

that translucency and surface structure of implant restorations are aspects that have not received much attention from specialists. However, in the present study, maxillofacial surgeons and prosthodontists showed the highest emphasis on the color of implant res-torations based on the WES criteria. Considering that shade mismatch is the second most common reason for redoing restorations, this underscores the importance of color harmony [38].

Restorative and periodontics specialists paid more attention to the form of teeth. Since the percep-tion of the size and contours of objects falls on the cone receptors in the human retina, which in-clude the highest number of receptors, any inconsistency in the form and contour of restorations at-tracts significant attention. Thus, ensuring harmony in the form and contour of restorations, similar to natural teeth, is crucial [39]. The least attention among specialists was devoted to surface structure and translucency, as the per-ception of these two elements is the responsibility of cone cells in the eyes, which are fewer in num-ber and require meticulous attention to detail. Translucency and surface texture, although challeng-ing to replicate accurately in dental laboratories, can make the restoration appear vital and indistin-guishable from natural teeth when closely matched to the patient's natural dentition [39].

Conclusion

PRP leads to reduction of complications after surgerIn the present study, a strong correlation was demonstrated among the opinions of prosthodontists, restorative specialists, periodontists, and maxillofacial surgeons regarding the evaluation of the aes-thetic aspects of implant restorations and the surrounding soft tissue. This correlation was assessed based on the VAS tool and compared with the PES/WES index. However, specialists in restorative dentistry and surgery tended to be stricter in their scoring. Among the soft tissue components, papillary deficiency attracted the most attention, while color and the curvature of the facial mucosa received the least focus from specialists. The color and form of the restoration, among factors related to the beauty of implant restorations, garnered more atten-tion than other elements, with less emphasis on structure and translucency.

Conflict of Interest

There is no conflict of interest to declare.

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