



Patient-Reported Satisfaction with Single-Tooth Implants in the Maxillary Esthetic Zone and an Exploratory Assessment of PES/WES Reliability

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ABSTRACT

Introduction: To provide a preliminary assessment of patient-reported satisfaction with single-tooth implant restorations in the maxillary esthetic zone and, as an exploratory objective, to evaluate the inter-rater reliability of clinician-rated Pink Esthetic Score (PES) and White Esthetic Score (WES) assessments.

Materials and Methods: This preliminary analytical cross-sectional study included 20 adults with a single implant-supported crown in the maxillary esthetic zone. The originally calculated sample size was 27 participants, but recruitment was curtailed to 20 due to COVID-19-related restrictions. Patient satisfaction was assessed using a six-item questionnaire adapted from a previously published instrument. Standardized clinical photographs were independently scored by two experienced prosthodontists using PES/WES. Inter-rater reliability was assessed using Cohen's kappa coefficients. Because the ratings did not demonstrate adequate reliability, PES/WES scores were treated as exploratory and were not used for clinical classification or confirmatory correlation analyses.

Results: Fourteen participants (70%) reported very high overall satisfaction, three (15%) reported high satisfaction, and three (15%) reported moderate satisfaction. No participant selected the very low or low category for any questionnaire item. Overall satisfaction did not differ significantly between women and men ($p = 0.750$). Kappa coefficients for the individual PES/WES parameters ranged from -0.30 to 0.29, and none demonstrated statistically significant agreement beyond chance.

Conclusion: Patient-reported satisfaction with single-tooth implant restorations in the maxillary esthetic zone was generally high. However, PES/WES scoring showed inadequate inter-rater reliability in this sample and could not support conclusions about clinician-rated esthetic outcomes or their relationship with patient satisfaction. These preliminary findings should be interpreted as hypothesis-generating rather than definitive. Future studies should use calibrated evaluators, pre-specified reliability criteria, and validated patient-reported outcome measures.

Keywords: Dental implants; Esthetics; Dental; Patient satisfaction; Patient-reported outcome measures; Reproducibility of results.

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Introduction

Esthetic expectations are particularly high when implant treatment is performed in the anterior maxilla [1]. Patients increasingly expect the implant-supported crown to resemble the adjacent teeth in color, shape, and gingival appearance [1]. The anterior maxilla is especially sensitive to minor esthetic discrepancies [2]. Differences in crown contour, gingival level, papilla fill, or shade may become noticeable when the restoration is exposed during smiling [2]. Implant treatment outcomes have commonly been reported in terms of implant survival, marginal bone levels, peri-implant soft tissues, esthetics, and patient satisfaction [3]. These clinical outcomes remain essential, but they do not fully describe how the patient perceives the final restoration [4]. Patient-reported satisfaction has therefore become an important part of implant outcome assessment [5]. Several indices have been developed to standardize professional evaluation of implant esthetics [5]. Fürhauser et al. introduced the Pink Esthetic Score to assess the soft tissues surrounding a single implant-supported crown [6]. The PES evaluates the mesial and distal papillae, facial mucosal curvature and level, and root convexity together with soft-tissue color and texture [6].

Belser et al. later introduced the White Esthetic Score to evaluate the visible implant-supported crown [7]. The WES includes tooth form, outline and volume, color, surface texture, and translucency or characterization [7]. Each PES and WES component is scored from 0 to 2, giving a maximum score of 10 for each index [7]. Although PES and WES are widely used in implant research, professional ratings do not always reflect patients' views of the restoration [2]. Patients and dentists may focus on different aspects of the same implant-supported crown [4]. Patients may also accept minor defects that are readily identified by trained evaluators [8]. Patient satisfaction is influenced by more than the appearance of the crown and peri-implant tissues [9]. Pretreatment expectations, smile line, function, comfort, and the overall treatment experience may all affect the final judgment [9]. Esthetic treatment may also influence self-confidence and oral health-related quality of life [10]. Other methods have been proposed for evaluating implant esthetics. The Jemt Papilla Index focuses on the degree of papilla fill adjacent to an implant-supported crown [11]. The Implant Crown Aesthetic Index evaluates the crown and surrounding soft tissues using a separate set of professional criteria [12]. Despite the availability of several indices, no single method has been accepted as the

definitive standard for implant esthetic assessment [5]. Consensus recommendations have also emphasized comprehensive esthetic planning and outcome assessment in implant dentistry [13]. Attempts have been made to improve the ability of PES/WES to reflect patient priorities. Siu suggested that components such as crown color and papilla appearance may deserve greater weight because they contribute more strongly to patient satisfaction [14]. However, any clinician-rated index must first demonstrate acceptable reproducibility before it can be compared meaningfully with patient-reported outcomes. Evidence concerning patient satisfaction with single implants in the esthetic zone remains limited compared with evidence on implant survival and peri-implant tissue outcomes [3]. Patient satisfaction should therefore be evaluated as a separate outcome rather than inferred from professional esthetic scores. The primary aim of this study was to assess patient-reported satisfaction with single-tooth implant restorations in the maxillary esthetic zone. The secondary aim was to examine the inter-rater reliability of PES and WES scoring. Associations involving PES/WES were considered interpretable only if the ratings showed adequate reproducibility. Given the reduced final sample and the exploratory reliability objective, the study was framed as preliminary and hypothesis-generating.

Materials and Methods

Study design and ethical considerations

This preliminary analytical cross-sectional study was conducted during the 2020-2021 academic year at a university dental school and private prosthodontic practices. The study protocol was approved by the relevant institutional ethics committee (approval number blinded for peer review). All participants provided written informed consent before enrollment. Patient information was de-identified before analysis.

Participants

The study population consisted of adults aged 18 years or older who had received a single implant-supported crown in the maxillary esthetic zone, defined as the region extending from the right first premolar to the left first premolar. Eligible restorations had been in function for at least six months. At least one adjacent natural tooth had to be present to permit comparison with the implant-supported crown. Patients were excluded if they had undergone gingival grafting or periodontal surgery after implant placement. Patients taking medications known to affect gingival tissues, including phe-

nytoin, cyclosporine, and calcium-channel blockers, were also excluded. Additional exclusion criteria were systemic conditions or medications that could interfere with healing or affect peri-implant soft tissues. Age and sex were recorded for each participant.

Sample-size calculation

Before data collection, the sample size was calculated for the originally planned correlation analysis using data reported by Fava et al. [15]. A sample of 27 participants was estimated to provide 90% power at a 95% confidence level. Recruitment was curtailed at 20 participants because of restrictions during the COVID-19 pandemic. The resulting study was therefore interpreted as preliminary and hypothesis-generating rather than as a definitive validation of the clinician-rated esthetic measures.

Patient satisfaction assessment

Patient satisfaction was assessed during a clinical visit using a six-item questionnaire adapted and translated from the instrument described by Fava et al. [15]. The items evaluated overall satisfaction with the implant-supported crown, crown color, crown form, crown size, peri-implant gingival color, and peri-implant gingival form. Each item was rated using five ordered categories: very low, low, moderate, high, and very high. Face and content validity were assessed by a panel of 10 professors with experience in implant dentistry and prosthodontics. Content validity was evaluated using the Content Validity Ratio and Content Validity Index, and face validity was assessed using an impact score. Internal consistency was evaluated using Cronbach's alpha. The overall satisfaction item was used as the summary patient-reported outcome, while responses to all six items were reported descriptively. Patient satisfaction was assessed independently of PES/WES. The prosthodontists who scored the photographs did not have access to questionnaire responses.

Photographic assessment

Standardized color photographs were obtained using a Canon EOS 80D digital camera (Canon Inc., Tokyo, Japan). Photographs were taken at a distance of approximately 30 cm, with the camera positioned at a 90-degree angle to the vertical axis. Intraoral periapical radiographs were obtained for clinical assessment but were not used for PES/WES scoring.

Exploratory PES/WES assessment

The Pink Esthetic Score was used to evaluate the

peri-implant soft tissues [6]. Its five parameters were the mesial papilla, distal papilla, curvature of the facial mucosa, level of the facial mucosa, and root convexity together with soft-tissue color and texture. The White Esthetic Score was used to evaluate the implant-supported crown [7]. Its five parameters were tooth form, outline and volume, color, surface texture, and translucency or characterization. Each parameter was scored as 0, 1, or 2. The maximum possible score was 10 for PES and 10 for WES. Two experienced prosthodontists independently scored all photographs. Each evaluator was blinded to the other evaluator's ratings and to the patient satisfaction results. Disagreements were reviewed by a third prosthodontist for completion of the original descriptive dataset. However, the ratings provided by the two original evaluators were retained for the inter-rater reliability analysis. Third-party adjudication was not considered a substitute for agreement between the original evaluators. Inter-rater reliability was treated as a prerequisite for meaningful interpretation of PES/WES-based analyses.

Statistical Analysis

Statistical analysis was performed using SPSS version 20.0 (IBM Corp., Armonk, NY, USA). Quantitative variables are presented as means and standard deviations, while categorical variables are reported as frequencies and percentages. Inter-rater agreement for each PES and WES parameter was assessed using Cohen's kappa coefficient. Overall patient satisfaction was compared between women and men using the Mann-Whitney U test. All tests were two-tailed, and $p < 0.05$ was considered statistically significant. Because PES/WES ratings did not demonstrate adequate inter-rater reliability, the scores were not used for threshold-based clinical classification or confirmatory correlation analyses involving patient satisfaction.

Results

Participant characteristics

Twenty patients with a single implant-supported crown in the maxillary esthetic zone were included. The sample consisted of 16 women (80%) and four men (20%). The mean age was 41.40 ± 13.14 years, with a range of 19-79 years.

Inter-rater reliability of PES/WES scoring

Inter-rater reliability results are presented in Table 1. Kappa coefficients for the individual PES and WES parameters ranged from -0.30 to 0.29. None of the coefficients demonstrated statistically significant agreement

beyond chance. Among the WES parameters, the highest kappa coefficient was observed for surface texture ($\kappa = 0.29$, $p = 0.199$), followed by color, hue, and value ($\kappa = 0.24$, $p = 0.164$). Negative coefficients were found for tooth form ($\kappa = -0.12$, $p = 0.460$) and translucency and characterization ($\kappa = -0.03$, $p = 0.833$). Among the PES parameters, kappa coefficients ranged from -0.30 for curvature of the facial mucosa to 0.00 for the distal papilla and level of the facial mucosa. None reached statistical significance. Because PES/WES scoring did not demonstrate adequate inter-rater reliability, the scores were treated as exploratory. They were not used to classify restorations according to esthetic thresholds or to support inferential analyses involving patient satisfaction.

Patient satisfaction

Patient satisfaction results are presented in Table 2. No participant selected the very low or low category for any questionnaire item. More than half of the participants reported very high satisfaction for all items except peri-implant gingival color. Very high overall satisfac-

tion was reported by 14 participants (70%). Very high satisfaction was also reported by 12 participants (60%) for crown color, 11 (55%) for crown form, 13 (65%) for crown size, nine (45%) for peri-implant gingival color, and 11 (55%) for peri-implant gingival form. Peri-implant gingival color had the highest frequency of high satisfaction, reported by nine participants (45%), while crown size had the highest frequency of moderate satisfaction, reported by four participants (20%).

Satisfaction according to sex

Very high overall satisfaction was reported by 12 of the 16 women (75%) and two of the four men (50%). Moderate satisfaction was reported by two women (12.5%) and one man (25%), while high satisfaction was reported by two women (12.5%) and one man (25%). The distribution of overall satisfaction did not differ significantly between women and men (Mann-Whitney U test, $p = 0.750$; Table 3). This comparison should be interpreted cautiously because only four male participants were included.

Table 1. Inter-rater reliability for individual PES and WES parameters.

Index	Parameter	Kappa coefficient	p-value
WES	Tooth form	-0.12	0.460
WES	Outline and volume	0.17	0.288
WES	Color, hue, and value	0.24	0.164
WES	Surface texture	0.29	0.199
WES	Translucency and characterization	-0.03	0.833
PES	Mesial papilla	-0.09	0.621
PES	Distal papilla	0.00	0.976
PES	Curvature of the facial mucosa	-0.30	0.075
PES	Level of the facial mucosa	0.00	>0.99
PES	Root convexity and soft-tissue color and texture	-0.04	0.550

None of the kappa coefficients demonstrated statistically significant agreement beyond chance.

Table 2. Distribution of responses to the six patient-satisfaction items.

Satisfaction item	Very low	Low	Moderate	High	Very high
Overall satisfaction	0 (0.0)	0 (0.0)	3 (15.0)	3 (15.0)	14 (70.0)
Crown color	0 (0.0)	0 (0.0)	2 (10.0)	6 (30.0)	12 (60.0)
Crown form	0 (0.0)	0 (0.0)	2 (10.0)	7 (35.0)	11 (55.0)
Crown size	0 (0.0)	0 (0.0)	4 (20.0)	3 (15.0)	13 (65.0)
Peri-implant gingival color	0 (0.0)	0 (0.0)	2 (10.0)	9 (45.0)	9 (45.0)
Peri-implant gingival form	0 (0.0)	0 (0.0)	1 (5.0)	8 (40.0)	11 (55.0)

Values are presented as n (%).

Table 3. Distribution of overall patient satisfaction according to sex.

Sex	Very low	Low	Moderate	High	Very high	Total
Women	0 (0.0)	0 (0.0)	2 (12.5)	2 (12.5)	12 (75.0)	16 (100)
Men	0 (0.0)	0 (0.0)	1 (25.0)	1 (25.0)	2 (50.0)	4 (100)
Total	0 (0.0)	0 (0.0)	3 (15.0)	3 (15.0)	14 (70.0)	20 (100)

Values are presented as n (%). Mann-Whitney U test: $p = 0.750$.

Discussion

In this preliminary study, patient-reported satisfaction was high across the six questionnaire items. Fourteen participants (70%) rated their overall satisfaction as very high, and no participant selected very low or low for any item. Peri-implant gingival color was the only item for which fewer than half selected the very high category, suggesting that soft-tissue color may remain a visible concern even when the restoration is accepted overall. The clinician-rated findings require a different interpretation. Kappa coefficients for the PES/WES parameters ranged from -0.30 to 0.29, and none showed statistically significant agreement beyond chance. This is not simply a matter of imprecise estimates; poor reproducibility prevents the scores from being used confidently to classify restorations or to examine their relationship with patient satisfaction. Accordingly, the present study cannot establish that professional esthetic assessments differed from patient perceptions. Such a conclusion would require a clinician-rated measure that first demonstrates acceptable reliability. The present results should instead be regarded as preliminary and hypothesis-generating evidence that can inform the design and calibration procedures of larger confirmatory studies.

Patient and professional evaluations nevertheless provide different types of information. Altay et al. reported that patients generally evaluated implant-supported crowns more favorably than clinicians [2]. Foong et al. also found that patients and dentists did not assess anterior implant-supported crowns in the same manner [4]. Fava et al. observed differences among evaluations made by patients, dentists, and laypersons [15]. Bonde et al. reported high long-term patient satisfaction even when professional examination identified esthetic or soft-tissue imperfections [16]. These findings support reporting patient and professional outcomes separately, but they cannot compensate for unreliable clinician ratings in the present study. Item-level responses also show why a single overall question may be incomplete. Satisfaction with peri-implant gingival color was lower than satisfaction with

most crown-related features. Siu suggested that crown color, papilla appearance, and soft-tissue characteristics may contribute differently to patient judgments [14]. Structured patient-reported measures should therefore capture both overall satisfaction and specific esthetic concerns. The poor reliability observed here does not show that PES/WES is unsuitable in every setting. It shows that the index was not applied reproducibly under the conditions of this study. Al-Dosari et al. found that esthetic ratings could vary among dental specialists assessing the same implant restorations [17]. Several factors may have contributed. Static two-dimensional photographs cannot fully reproduce contour, volume, or the appearance of a restoration during speech and smiling. The three-category scoring system may also be difficult to apply consistently when a feature falls between two categories. In addition, the evaluators did not undergo a documented formal calibration exercise before scoring. Future studies should calibrate evaluators with reference photographs before formal scoring and should confirm reliability in a pilot sample.

If agreement is inadequate, the scoring protocol should be revised before the index is used as an outcome measure. The reliability statistic and an acceptable threshold should also be specified in advance. Patient-reported outcomes should be assessed using validated instruments whenever possible. Afrashtehfar et al. emphasized the need to combine professional esthetic parameters with structured patient-perspective assessment tools [9]. Measures such as the Orofacial Esthetic Scale may provide broader assessment and improve comparability across studies. This study has several limitations. The planned sample size was 27 participants, but recruitment was restricted to 20 during the COVID-19 pandemic, reducing precision and statistical power. The cross-sectional design did not permit evaluation of changes in satisfaction or peri-implant appearance over time. These constraints reinforce the preliminary nature of the study and limit the extent to which its findings can be generalized. The questionnaire underwent assessment of face validity, content validity, and internal consistency, but it was not a widely standardized patient-reported outcome

measure. Responses were also concentrated in the highest categories, indicating a possible ceiling effect. The unequal sex distribution limited subgroup analysis. Only four men were included, so the nonsignificant sex comparison should not be interpreted as evidence of equivalent satisfaction. Important clinical factors, including smile line, lip mobility, gingival phenotype, implant position, prosthetic material, and pretreatment expectations, were not assessed. The principal limitation was the inadequate inter-rater reliability of PES/WES. This prevented meaningful interpretation of the clinician-rated scores and of any statistical relationships based on those scores. Future studies should use larger samples, calibrated evaluators, repeated reliability testing, and validated patient-reported outcome measures. Longitudinal designs would also help determine whether satisfaction changes as the restoration and peri-implant tissues age.

Conclusion

In this preliminary sample, patient satisfaction with single-tooth implant restorations in the maxillary esthetic zone was generally high. Fourteen of the 20 participants reported very high overall satisfaction, and no participant reported very low or low satisfaction for any questionnaire item. The PES/WES assessment did not demonstrate adequate inter-rater reliability. The clinician-rated scores therefore could not be used to classify esthetic outcomes or to evaluate their relationship with patient satisfaction. These preliminary findings support direct assessment of patient satisfaction in implant research but should be interpreted as hypothesis-generating rather than definitive. Future studies should combine validated patient-reported measures with clinician-rated indices that have demonstrated acceptable reliability.

Conflict of Interest

There is no conflict of interest to declare.

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