Original Article

How Thick Peri-implant Tissue Affected Esthetic Satisfaction on Single Implant Restoration in Treated Periodontal Patients

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Abstract

To identify the factors affecting the esthetic outcome of implant-supported single crowns in periodontal patients, thirty-four periodontitis patients with implants were consecutively examined for esthetic outcomes. A questionnaire was used to measure the satisfaction of patients with peri-implant soft tissues, implant crown, smile, and total implant treatment using a visual analogue scale (VAS). Ten clinicians applied the Pink and White Esthetic Score (PES/WES) to each patient. The association between the clinical factors and the degree of patient satisfaction was analyzed using the Pearson chi-square test. The mean overall patient's satisfaction was 80.2 % and the mean PES/WES was 12.67. Peri-implant tissue biotype was significantly associated with the degree of patient satisfaction on papilla height, contour, color, and labial mucosa surface. A thick peri-implant tissue was the only significant factor in determining the degree of patients' satisfaction in periodontal patients. However, all patients reported acceptable esthetic outcomes.

Keywords: dental implant, esthetic, patient satisfaction, periodontitis, visual analogue scale

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Introduction

Peri-implant soft tissue and implant evaluation is commonly used to assess the esthetic outcomes of implant treatment.[1] However, most periodontal patients have an excessive exposed tooth length due to gingival recessions and alveolar bone loss. Therefore, these cases may be more challenging to obtain esthetic outcomes of a natural smile and beautiful teeth. Esthetic outcomes are directly affected by gingival recession, soft tissue

biotype, keratinized gingiva, and smile line. Several studies have demonstrated the influence of these factors on esthetics.[1-3]

The satisfaction of the patient should be considered as a very important success criterion for dental implant therapy. Although numerous studies[4-6] investigated patient satisfaction and the quality of life in those receiving dental implant treatments, there are limited studies addressing this aspect when evaluating the treatment outcomes of anterior single implants in periodontal patients. Esthetic satisfaction is the primary concern for anterior maxillary implants. An objective assessment can be performed by a clinician and is based on defined criteria for evaluating the natural appearance of the implant and restoration. In 2009, Belser et al.[7] modified a previously published Pink Esthetic Score (PES) and combined it with an implant restorative index to generate the Pink and White Esthetic Score (PES/WES). An overall score of 12 is defined as the threshold of clinical acceptability. Additionally, Cosyn et al.[8] presented data by ranking the degree of esthetic outcomes of the PES/WES. For example, the individual PES/WES score have been categorized into an almost perfect result (PES≥12, WES≥9) and unfavorable outcome (PES<8, WES<6). To accomplish successful long-term implant treatment outcomes, peri-implant esthetics must be considered and properly managed to avoid complications and a reduced quality of life for patients. However, the specific clinical factors which affect the satisfaction of patients on esthetic outcome is not well understood. Therefore, the aim of this study was to identify those factors affecting the satisfaction of periodontal patients with implant-supported single crowns.

Materials and Methods

The study protocol was approved by the Ethics Committee of the Faculty of Dentistry, Chulalongkorn University (HREC-DCU 2018-012). This cross-sectional clinical study retrieved data from a main survey of 200 dental implant patients who received endosseous dental implant treatment from 1996–2014. The patients were evaluated when they came for maintenance program visits at the Graduate Periodontics Clinic, Faculty of Dentistry, Chulalongkorn University. The patients were advised about the objective and process of the study before signing informed consent for participation. The participants in this study consisted of 34 consecutive periodontal patients with a single tooth implant placement in the esthetic zone, which was defined as the maxillary right canine to maxillary left canine. All 34 dental implants were in prosthetic function for at least one year. Inclusion criteria for all participants were: 1) Treated periodontal patients and 2) the presence of a single tooth implant placement in the esthetic zone defined as the maxillary right canine to maxillary left canine, which was functional for at least one year. Patients were excluded if presenting one or more of the following criteria: 1) Multiple implants or 2) Patients who had pseudo-papilla regeneration made of pink acrylic or porcelain to artificially create the interproximal papilla. Their demographic data and history of implant treatment were obtained from history taking, chart review, and dental examination.

Digital extraoral and intraoral photographs (Canon EOS 650 D, Japan with a 100 mm, Canon macro lens, and a ring flash) were taken with a digital camera. An extraoral photograph of each patient with a natural smile was taken. Standardized clinical photographs were taken according to previously published methods.[7] An alginate impression of the upper jaw was taken to fabricate a master model that was used in combination with the digital photographs by clinicians to assess implant esthetic outcomes.

The patient's degree of satisfaction with their dental implant treatment outcome was assessed using a visual analogue scale (VAS) questionnaire, which was modified from Belser et al.[7] (Table 1).

Table 1 *Patients satisfaction questionnaire.*

Variables		Questionnaire
Esthetic-related variables	Peri-implant mucosa	1. I am pleased with the position of the mucosa in the approximal embrasure (papilla height).
		2. I am pleased with the position of the labial surface of the peri-implant mucosa.
		3. I am pleased with the contour, color, and surface of the labial mucosa.
	Implant restoration	4. I am pleased with the shape and mesio-distal dimension of my crown.
		5. I am pleased with the surface, texture, translucency, and color of my crown.
Smile perception		6. I am pleased with my smile line.
Overall satisfaction		7. I am satisfied with the overall result.

The questionnaires were accompanied by simple and precise instructions.

Clinical and radiographic examinations were performed during one visit before receiving routine maintenance care. Periodontal care at the implant sites were performed according to the CIST protocol.[9] The clinical evaluation was performed by three examiners (NS, TT, and KS) who assessed the following clinical parameters:

• Modified plaque index (mPLI)[10]: scores were determined at the mesiobuccal, mid-buccal, distobuccal, and mid-lingual surfaces of each implant.

• Modified bleeding index (mBLI)[10]: scores were determined at the mesiobuccal, mid-buccal, distobuccal, mesiolingual, mid-lingual, and distolingual surfaces of each implant.

• Probing pocket depth: measurements were taken at the mesiobuccal, mid-buccal, distobuccal, mesiolingual, mid-lingual, and distolingual of each implant.

• Recession was the level of mucosal margin in relation to the restorative margin.

• Tissue biotype was classified as thin if the outline of the underlying periodontal probe could be seen through the buccal gingiva, and thick if the probe could not be seen.[11]

• Modified periodontal screening and recording (mPSR)[12]: scores were determined at six sextants of the mouth to assess the patient's periodontal status.

The measurement procedures were manually performed using a plastic periodontal probe (12-UNC COLORVUE®; Hu-Friedy, Chicago, IL, USA.) for the implants and a conventional manual University of North Carolina periodontal probe (UNC-15; Hu-friedy, Chicago, IL, USA.) was used for natural teeth. The distances were measured to the nearest millimeter.

The radiographic examination was performed using standardized periapical radiographs. Digital radiographs were then taken and was imported using dental software (Infinitt proprietary software v.2: Infinitt Co., Seoul, Korea) and evaluated on a computer screen. The distance from the implant shoulder to the alveolar bone crest was measured in millimeters at the mesial and distal aspect of each implant by one examiner (TS). The most severe bone level site was selected to represent the amount of bone loss. Due to different implant systems, a universal point of reference applicable to all implants could not be defined. Therefore, a suitable reference point at the fixture-abutment connection or abutment-crown connection was defined for each implant system.

Five prosthodontists and five periodontists performed the esthetic assessment. The clinicians, third-year residents, had not previously treated any of the participants. The clinicians assessed their degree of satisfaction with the dental implant treatment outcomes by examining the cast model and dental photographs. The standardized photographs were viewed using a PowerPoint program on a 14-inch notebook (Lenovo™ idealpad 710S Plus, Intel® Core™ i7-7500U). The clinicians scored the esthetic outcomes using the original PES/WES index by Belser *et al.*[7] Criteria of the peri-implant mucosa (pink esthetic) was used for evaluation of the soft tissue around single

implant crowns. The PES is based on five variables; 1) Mesial papilla 2) Distal papilla 3) Facial curvature 4) Level of facial mucosa and 5) Root convexity and color. Criteria of the implant crown was used (white esthetic) for evaluation of restoration. The WES is based on five variables; 1) Tooth form 2) Outline/volume 3) Color (hue/value) 4) Surface texture and 5) Translucency and characterization. Each variable is assessed with a 2-1-0 score, with 2 being the best and 0 being the poorest score. All variables are assessed by comparison with a natural reference tooth. An overall score of 12 is defined as the threshold of clinical acceptability. For study evaluation, the following variables were classified according to established definitions:

1) Implant survival: the implant with a restoration was present at the follow-up examination; however, its condition is not specified.[9]

2) Biological complications: disturbances in implant function by biological processes that affected the tissues supporting the implant.[13]

A. Peri-implant mucositis: presence of soft tissue inflammation with bleeding on probing at least one aspect of the dental implant (recorded from the mBLI) and no signs of supporting bone loss after initial bone remodeling.[14]

B. Peri-implantitis: presence of soft tissue inflammation with bleeding on probing at least one aspect of the dental implant (recorded from the mBLI) and bone loss around an osseointegrated implant beyond functional remodeling ≥ 2mm from the time of loading.[14] When there was no baseline radiograph, a threshold vertical distance of 2 mm from the expected marginal bone level was diagnosed as peri-implantitis.[15]

3) Smile type: the smile was defined as a high, average, or low smile by examining an extraoral photograph.[16]

Calibration

Prior to the study, the three examiners held intra- and inter-calibration sessions using five volunteer participants who had at least one dental implant restoration. An intra-class correlation coefficient was used to standardize data acquisition and the assessment of study variables. The mean intra- and inter-examiner calibration indicated an excellent agreement with intra-class correlation coefficient of 0.88 and 0.86, respectively. Intra-examiner calibration of radiographic bone level was analyzed before evaluating the implants of the study patient by assessing the bone loss on thirty randomly selected implants from the faculty database. The assessment was repeated one week later to evaluate the reproducibility of the results. An intra-class correlation coefficient of 0.86 was obtained.

Statistical analysis

The statistical software SPSS version 22.0 was used for data analysis. A normality test was used to determine a normal distribution of the study population. Descriptive analysis was used to evaluate the demographic data, implant characteristics, esthetic outcomes, and VAS scores. The VAS score of the satisfaction of patients was categorized into two groups using the non-excellent outcomes (score<90 %) and excellent outcome (score≥90 %) as a breaking point. The associations between the esthetic clinical variables and patients' satisfaction (non-excellent group versus excellent group) were analyzed using the Pearson Chi-square test. The effect of the speciality of the clinicians was performed using the Pearson correlation. For all statistical analysis, the $p<0.05$ was considered significant.

Results

Of the 200 patients participating in the survey, 47 patients had received dental implant therapy in the esthetic zone. Of these, 13 patients who did not meet the inclusion criteria were excluded. Finally, 34 participants with 34 maxillary single implants were examined. There were 15 males and 19 females, with an average age of 52.2 ± 13.3 years old. The mean follow-up period was 72 ± 52 months. Most of the patients (76 %) were treated using the delayed implant placement protocol. The overall mean distance from the implant abutment interface to the first bone-to-implant contact was 0.96 ± 1.13 mm. The implant survival rate was 100 %.

The demographic data at the participant and implant level is presented in Tables 2 and 3.

Table 2 Demographic data and clinical characteristics at participant level.

Subject Characteristic (N=34)		Number (%)
mPSR	Score 1 (bleeding)	4 (11.8 %)
	Score 2 (bleeding and calculus)	5 (14.7 %)
	Score 3 (probing depth 4-6 mm)	24 (70.6 %)
	Score 4 (probing depth >6 mm)	1 (2.9 %)
Smoking status	Former smoker	3 (8.8 %)
	Current smoker	1 (2.9 %)
	Non smoker	30 (88.3 %)
Smile line	Low smile line	7 (20.6 %)
	Average smile line	17 (50 %)
	High smile line	10 (29.4 %)

Table 3 Demographic data and clinical characteristics at implant level.

Implant characteristic (N=34)		Number (%)
Reason for tooth extraction	Tooth fracture	10 (29.4 %)
	Endodontic	5 (14.7 %)
	Periodontic	4 (11.8 %)
	Caries, Congenital Missing, Trauma, Non-restorable	15 (44.1 %)
Implant location	Central incisor	20 (58.8 %)
	Lateral incisor	11 (32.4 %)
	Canine	3 (8.8 %)
Implant system	Astra tech	13 (38.2 %)
	Straumann	10 (29.4 %)
	Paragon	4 (11.8 %)
	Others	7 (20.5 %)
Peri-implant status	Healthy	7 (20.6 %)
	Peri-implant mucositis	22 (64.7 %)
	Peri-implantitis	5 (14.7 %)
Probing depth	< 4 mm	15 (44.1 %)
	≥ 4 mm	19 (55.9 %)

Table 3 *Demographic data and clinical characteristics at implant level. (cont.)*

Implant characteristic (N=34)		Number (%)
Keratinized mucosa	MGJ ≤ 2 mm	3 (8.8 %)
	MGJ > 2 mm	31 (91.2 %)
Gingival recession	Recession	2 (5.9 %)
	No recession	32 (94.1 %)
Tissue biotype	Thick biotype	18 (52.9 %)
	Thin biotype	16 (47.1 %)
Shape of crown	Triangular shape	9 (26.5 %)
	Oval shape	12 (35.3 %)
	Square shape	13 (38.3 %)

About three-fourths of the participants (73.5 %) had a pocket depth of ≥ 4 mm (mPSR score of 3 & 4). Only 2.9 % of the patients were current smokers. Half of the participants had an average smile line (50 %). Tooth extraction due to periodontal disease was reported by 11.8 % of the patients. Out of the 34 implants, 20 (58.8 %), 11 (32.4 %), and 3 (8.8 %) were placed in the central incisor, lateral incisor, and canine region, respectively. The patients in this study had implants from various implant systems, the majority of which were AstraTech (38 %) and Straumann (29 %). The prevalence of peri-implant diseases was 64.7 % for peri-implant mucositis and 14.7 % for peri-implantitis. Nineteen (55.9 %) of the implants had a probing depth of ≥ 4 mm. Facial keratinized tissue of ≤ 2 mm was observed in 8.8 % of the cases. Nearly all implants had no mucosal recession (94.1 %). There were 16 (47.1 %) implants with a thin peri-implant biotype, whereas 18 (52.9 %) implants had a thick peri-implant tissue. Square-, triangular-, and oval-shaped implant restorations were observed in 38.3 %, 26.5 %, and 35.3 %, of the patients, respectively.

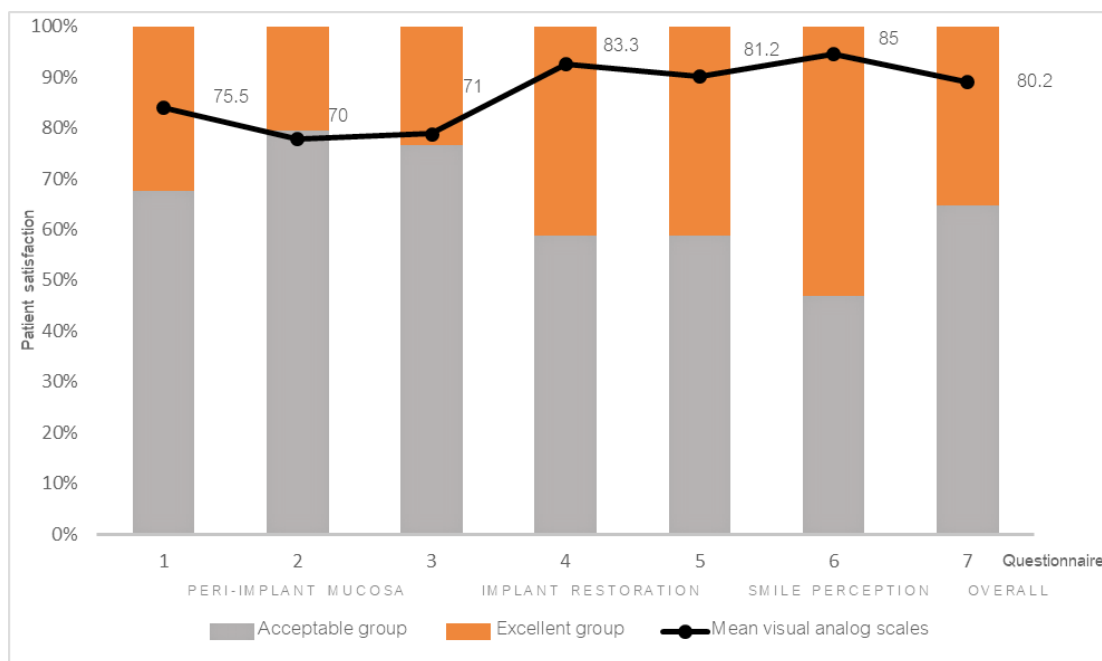The mean patient satisfaction based on VAS scores is illustrated in Figure 1.

Figure 1 *Mean visual analogue scale scores and categorical scores*

The patients gave a lower mean score for the peri-implant mucosa compared with the implant restoration (mean Q1-Q3: 70-75.5 % vs. mean Q4-Q5: 81.2-83.3 %). The overall mean of patient satisfaction was 80.2 %. To better understand the VAS score distribution, the VAS scores were classified into two groups: non-excellent outcome (score<90 %) and excellent outcome (≥90 %).

About one-third of the participants (35.3 %) reported excellent satisfaction with the overall treatment.

The peri-implant tissue biotype was significantly associated with the degree of patient satisfaction with the papilla height (Q1: p = 0.002), contour, color, and the labial mucosa surface (Q3: p = 0.025) (Fig. 2 and 3).
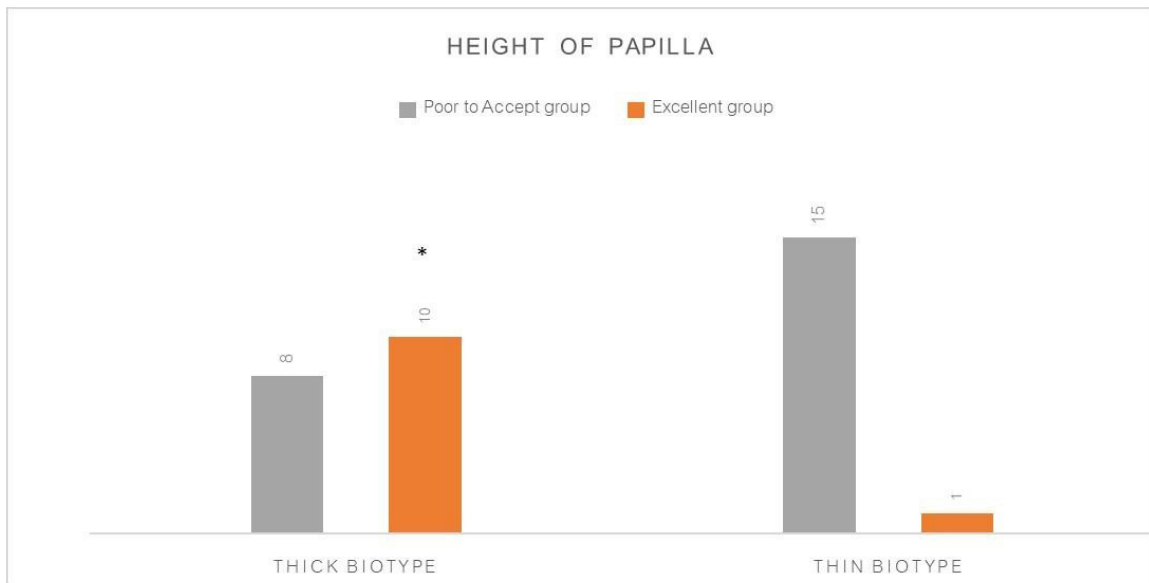

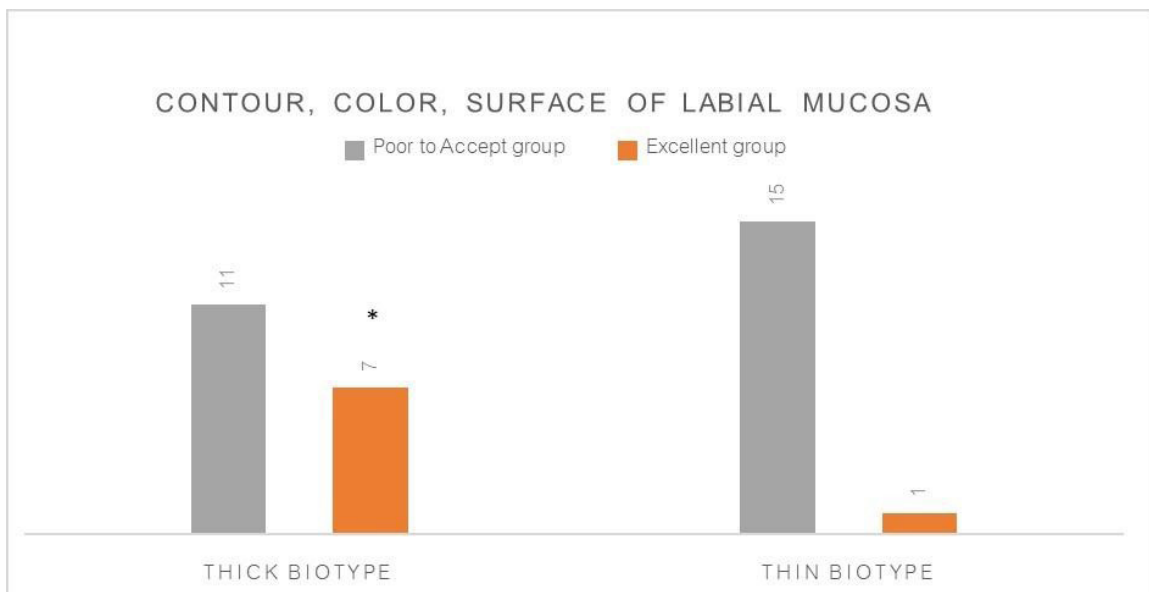*Figure 2* Esthetic-related variables: Questionnaire 1 (height of papilla)

Figure 3 Esthetic-related variables: Questionnaire 3 (contour, color, and surface)

In contrast, there was no association found between biological complications, probing depth, keratinized mucosa, mucosal recession, shape of crown, or smile line and the degree of patients' satisfaction.

Additionally, there were no sex or age differences in patients' satisfaction level.

The ten clinicians applied the PES/WES index for esthetic evaluation (Table 4).

Table 4 Mean PES and WES scores of the 34 dental implants determination based on speciality.

	5 Periodontal residents	5 Prosthodontics residents	Total 10	Pearson Correlation	*p*-value
Mean PES	5.54±1.93	6.77±2.79	6.2	0.820	0.000*
Mean WES	6.26±1.61	6.73±2.12	6.5	0.544	0.001*
Mean PES/WES	11.82±3.18	13.51±4.29	12.67	0.768	0.000*

*Significant correlation (p<0.05)

The mean PES, WES, and total PES/WES were 6.2, 6.5, and 12.67, respectively, which were all clinically acceptable. Further analysis of the effect of the speciality of the clinicians was performed using the Pearson correlation. The periodontist and prosthodontist residents had a significant positive correlation at a good level for the PES/WES evaluation (r=0.768, *p*=0.000). Although the periodontists gave lower scores, the difference was not significant.

Discussion

The results indicated that the patients' overall satisfaction level with implant therapy was generally high with a mean score of 80.2 %, which was comparable to other studies.[17,18] Moreover, approximately 36 % of the patients stated that the implant treatment met their high expectations of overall treatment outcome (VAS score ≥ 90 %). Similar results have been reported following implant treatment in healthy periodontal patients.[7,19]

Our questionnaire evaluated factors that were categorized as periodontal and prosthodontic clinical factors. We found that tissue biotype was the most important factor in determining the degree of patients' satisfaction in periodontal patients. These findings were similar to those of previous studies. Romeo *et al.*[20] showed that a thick biotype significantly correlated with the presence of an interproximal papilla. In addition,

Abrahamsson *et al.*[21] found that increased soft and hard tissue remodeling reestablished healthy peri-implant mucosa dimensions, especially in a thin biotype. In contrast, our study did not find that mucosal recession and keratinized gingiva had any impact on the degree of patients' satisfaction. Although many studies[1,2] demonstrated that mucosal recession occurred more frequently following implant placement in a thin tissue biotype, the present study observed only two cases (5.9 %) with a facial marginal mucosal level of ≥ 1 mm and three cases (8.8 %) with keratinized mucosa of ≤ 2 mm. The majority of patients had excellent quality peri-implant soft tissue, thus these factors did not have a significant effect on esthetic outcomes in this study.

There are numerous studies indicating that peri-implant diseases are affected by past periodontal history[13,22-24] The prevalence of peri-implant diseases in our cross-sectional study was 64.7 % for peri-implant mucositis and 16.7 % for peri-implantitis. However, we observed only one participant (2.9 %) with an mPSR score of 4 with a probing depth of more than 6 mm. The patients in the present study attended regular maintenance visits after implant therapy that may have contributed to our findings of periodontal disease control and minimal bone loss of 0.96 mm during the prolonged follow-up period of 72 months. Consequently, probing

depth and biological complications did not significantly impact the esthetic outcomes in periodontal patients as assessed by VAS scores in this study.

When a prosthodontic rehabilitation is planned, a variety of fundamental parameters for an esthetic smile including the position of the lips, gingival tissue condition, color, shape, and tooth position should be thoroughly considered.[25] However, this study found that the crown and smile line shape did not impact a patient's satisfaction scores. In contrast, Levi and colleagues[26] found that the restoration shape was critical for patients' overall acceptance of a dental implant treatment. These different outcomes may result from the dissimilarity of the participants and implant characteristics between studies. We observed equal proportions of implant restoration shapes with a mean VAS score above 80 %.

In the present study, the overall PES/WES was 12.7, which was clinically acceptable for periodontal patients. The mean PES and WES results were 6.2 and 6.5, respectively. These scores were slightly lower scores compared with a previous study by Belser et al,.[7] They evaluated the esthetic outcomes of maxillary anterior single tooth implants inserted using an early implant placement protocol and reported a higher mean PES than mean WES scores (7.8 vs. 6.9). Most of the patients (76 %) received delayed implant placement. This result was similar to a prior study, which reported that the esthetic scores in the delayed group were marginally lower compared with the immediate placement group.[27] Another important characteristic of the patients is having a history of or current periodontitis. Kolerman et al.[28] found that patients with severe or aggressive periodontitis were significantly associated with a low PES score. It was found that 20 % of the patients had a connective tissue graft or free gingival graft to improve soft tissue quality prior to implant surgery. Having this procedure may have positively influenced the esthetic outcome of their implant restorations.[3,29] Migliorati et al.[30] found a significantly higher PES in patients receiving a connective tissue graft. For the white esthetic score, this study had a mean WES score comparable to that of a previous study[31] because implant-supported prostheses fabrication and delivery were supervised by experienced prosthodontists. However, the use of titanium abutments and porcelain fused to metal restorations in the majority of cases in this study may have contributed to the low WES scores.

There were some limitations in this study. This study evaluated a limited number of maxillary single implants. This small sample size makes it difficult to draw any larger conclusions. Moreover, each variable was separately analyzed that could possibly affect the degree of patients' satisfaction in treated periodontal patients. However, the effect of each factor on the degree of patients' satisfaction are interrelated, and may have a synergistic rather than a cumulative effect. Therefore, a future prospective study with a larger number of dental implants is required to determine the clinical factors associated with the degree of patients' satisfaction. In addition, a complex relationship between each factor may also be resolved with a large sample size.

Conclusion

The degree of patients' satisfaction around single-tooth implant in the anterior maxilla was mainly influenced by the peri-implant biotype. It is recommended that treatment resulting in a thick mucosa is important to achieve an excellent degree of patients' satisfaction in periodontal patients. However, these patients reported acceptable esthetic outcomes that were comparable to general patients.

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