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Aesthetics and Gingival Harmony in Fixed Prosthetic Dentistry

Sabit Protetik Diş Tedavilerinde Estetik ve Diş Eti Uyumu

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ABSTRACT

Objectives: The aim of this study was to evaluate the PES and WES values of fixed metal ceramic restoration treatments according to gingival phenotype in a certain population.

Materials and Methods: Pre- and post-treatment conditions of metal-ceramic restorations containing 263 anterior and premolar teeth in 63 patients were evaluated photographically. PES/WES scores were used for an objective aesthetic evaluation. Gingival phenotypes were classified as 'thin' and 'thick'. All values were examined statistically.

Results: While the average of PES was found to be 11.36, the average of WES was 5.41. The 'thick' phenotype constituted the majority with 80.3% whereas the 'thin' phenotype constituted 19.7% of cases. No significant relationship was observed between PES and WES values for either 'thin' or 'thick' phenotypes.

Conclusion: No significant relationship has been observed between the initial aesthetic values of metal-ceramic restorations and the gingival phenotype when the correct treatment protocol is followed, but further and longer follow-up studies are needed.

Keywords: *Aesthetics, Periodontal indexes, Permanent dental restorations*

ÖZET

Amaç: Bu çalışmada belirli bir populasyonda sabit metal seramik restorasyon tedavilerinin PES, WES değerlerinin diş eti fenotipine göre değerlendirilmesi amaçlanmıştır.

Gereç ve Yöntemler: 63 hastada 263 anterior ve premolar dişleri içeren metal seramik restorasyonların tedavi öncesi ve sonrası durumu fotoğrafik olarak değerlendirildi. PES/WES skorlamaları objektif bir estetik deeğerlendirme için kullanıldı. Diş eti fenotipleri 'ince' ve 'kalın'olarak sınıflandı. Tüm değerler istatistiksel olarak incelendi.

Bulgular: PES ortalama 11,36 WES ortalama 5,41 bulunmuştur. Kalın" fenotipi %80,3 ile çoğunluğu oluştururken, "İnce" fenotipi vakaların %19,7'sini oluşturmuştur. İnce ve kalın fenotipler için PES ve WES değerleri arasında anlamlı bir ilişki gözlemlenmemiştir.

Sonuç: Doğru tedavi protokolü izlendiğinde metal-seramik restorasyonların başlangıç estetik değerleri ile dişeti fenotipi arasında anlamlı bir ilişki gözlenmemiştir ancak daha ileri ve uzun takip çalışmalarına ihtiyaç vardır.

Anahtar kelimeler: *Estetik, Periodontal göstergeler, Kalıcı diş restorasyonları*

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Introduction

The use of appealing and aesthetically pleasing restorations that closely resemble the original tooth structure, particularly in the anterior region, is an essential aspect of modern dentistry.[1] The color, shape, size, and other aesthetic aspects of the restoration, among others, should all be considered. Orofacial aesthetics is based on the harmony of the grin and smile lines when they are in line with the facial features.[2] The needs of patients in terms of aesthetics have recently taken center stage.

In contemporary times, the most common treatment approach for producing fixed prosthodontic restorations is metal-ceramic restorations which involve the use of metal-ceramic materials as substructures. Ensuring sufficient mechanical resistance against occlusal forces is one of the key characteristics that influences the long-term prognosis of fixed prosthodontic restorations. However, due to the limited resistance of delicate and fragile feldspathic porcelain against stress, especially in posterior restorations, it is recommended to restore such areas with metal or highly durable ceramic substructures. Metal-ceramic systems offer some advantages such as durability and support for ceramics. Among the frequently used options for metal substructures, Ni-Cr alloys offer advantages such as high tensile strength, high hardness, low cost, and low density.[4]

Technology has advanced in response to the growing demand from patients for aesthetic dental care and as a result of dentists' shift toward dental and restorative materials that mimic the visual characteristics of real teeth.[5]

Traditionally, dentists often primarily focus on the tooth when addressing patient's aesthetic demands, frequently neglecting the gum tissue and the surrounding soft tissues. However, up to now, attention must also be given to these aspects in order to achieve superior aesthetic outcomes and to address conditions that naturally exist or develop over time due to wear, attrition, and erosion within the oral cavity. Frequently, the pink component or soft tissue component can be compromised due to various factors such as gum and periodontal surgical procedures, trauma, resorption, traumatic incidents, or trauma resulting from occlusion.[6,7] Furhauser et al.[8] introduced a valuable index called the Pink Aesthetic Score (PES) for evaluating the soft tissue surrounding implant-supported crowns, which can serve as a valuable index for observing soft tissue changes over an extended period. Belser et al.[9] later introduced the White Aesthetic Score (WES) to specifically focus on the visible portion of implant-supported restorations. Lanza et al.[1] confirmed the validity of PES and WES evaluations for both natural teeth and implant restorations. Numerous studies have reported that the PES/WES scoring system can function as a standard objective assessment tool. The conducted studies claim that PES/WES analysis satisfies criteria for reliability, reproducibility, and validity.

Lanza et al.[1] confirmed the validity of PES and WES evaluations for both natural teeth and implant restorations. The PES/WES scoring system has been shown in numerous research to be a useful standard objective assessment instrument.[10] According to the studies, PES/WES analysis meets standards of validity, repeatability, and reliability.[11]

PES is based on seven variables: mesial papilla, distal papilla, soft tissue level, soft tissue contour, alveolar process, soft tissue color, and texture. Additionally, WES is based on five variables: tooth form, outline and volume, color, surface texture, and translucency. Accordingly, each variable is assessed with a 2-1-0 score, where two is the best and zero is the worst score, resulting in a maximum possible score of 14 for PES and 10 for WES.

'Dental phenotype' is a term that defines the combination of three-dimensional gingival volume and bone. For its measurement, a standardized and repeatable assessment of periodontal phenotype is recommended using a periodontal probe. To achieve this, the periodontal probe should be placed into the sulcus and the gingival tissue should be observed transparently. Therefore, it is assumed that the probe will be visible when the periodontal phenotype is thin (≤1 mm) and not visible when it is thick (>1 mm).[12] Studies have reported a relationship between tooth shapes and dental phenotype. Specifically, teeth with long crowns and short contact surfaces are associated with thin gingival architecture and maxillary alveolar bone, while teeth with square crowns and long contact surfaces are associated with thick gingival architecture and maxillary alveolar bone. Considering the phenotype is important during treatment planning because a thin gingival margin is more prone to gum recession and may result in a higher failure rate and less stability with prosthetic margins after periodontal treatment.[13]

While studies assessing implant restorations using PES/WES analysis and gingival phenotype are

present in the literature[14-19], no study has been found that includes the evaluation of PES / WES analyses of fixed metal-ceramic restorations on natural teeth together with gingival phenotype. The aim of the study is to determine the aesthetic results of metal-ceramic restorations on natural teeth in the anterior and premolar regions and their relationship with gingival phenotypes. Our null hypothesis is that there is no correlation between PES/WES values of restorations and gingival phenotype.

Materials and Methods

Our study was conducted with the approval of the Hamidiye Scientific Research Ethics Committee of the University of Health Sciences, numbered 2023/2. The assessment of PES and WES values was performed on the initial and final photographs of 63 patients, 263 teeth who applied to the University of Health Sciences Faculty of Dentistry for metal-ceramic restoration treatments. The patients gave their consent in accordance with the ethical permission. Additionally, for the determination of dental phenotype, measurements were taken using a periodontal probe based on the transparency of the gingiva in the photographs, and the gingival phenotypes were classified as 'thick' and 'thin'. The photographs were taken using a single iPhone 13 Pro device. The evaluation of the photographs was conducted by a prosthodontist and periodontist.

The sample size for this study was calculated based on the primary outcome of measuring the agreement between the probe visibility method and clinical measurements. Lee et al. 20 found a kappa value of 0.17 (95% CI: 0.06-0.28) for incisors, 0.19 (95% CI: 0.03-0.36) for canines, and 0.20 (95% CI: 0.10-0.31) for premolars. In this study, the sample size calculator developed by Arifi was used.[21,22] When the minimum acceptable kappa value is used as 0.4 and the expected kappa value is taken as 0.2, the significance level (α) is adjusted as 0.05 and the significance power as 90%; the sample size for this study was calculated to be a minimum of 221 samples.

For each type of data used in the study, the necessary descriptive statistics (mean, standard deviation, minimum, maximum, median, frequencies, and percentage values) were calculated. The normality of quantitative variables was examined using the Shapiro-Wilk test. Non-normally distributed quantitative variables were compared between two groups using the Mann-Whitney U test. While Pearson's correlation analysis was used to examine relationships between quantitative variables that were regularly distributed, Spearman's correlation analysis was used to examine relationships between non-normally distributed quantitative variables. The logistic regression model is used to predict the binary categorical dependent variable based on several predictor variables. SPSS® 26 (IBM® Corp. Released 2019. IBM® SPSS® Statistics for Windows, Version 26.0. Armonk, NY: IBM® Corp) was used for all statistical evaluations in the study.

Results

The PES variable exhibited an average value of 11.36 with a standard deviation of 1.55, while the median was 12, ranging from six to 14. For the WES variable, the mean was 5.41, accompanied by a standard deviation of 2.01. The median was five, spanning from zero to 10. In the categorical data, the "Thick" phenotype constituted the majority at 80.3%, while the "Thin" phenotype accounted for 19.7% of the cases (Table 1).

Table 1. Distirbution of the variables.

		Mean+SD	Med (Min-Max)
Pes		11.36±1.55	12- (6-14)
Wes		5.41±2.01	5- (0-10)
		N	**%**
Phenotype	**Thin**	52	19.7%
	Thick	212	80.3%

Both z-scores are close to zero, indicating that the medians of the two groups were not significantly different. The p-values for both tests were relatively high (0.969 and 0.750), suggesting that there was no statistically significant difference between the groups in both cases (thin and thick). This means that, based on these tests, there is insufficient evidence to reject the null hypothesis that the distributions of the two groups are similar for the given variables (Table 2, Figure 1).

Table 2. Comparisons according to phenotype.

	Thin Phenotype Mean+SD Med (Min-Max)	Thick Phenotype Mean+SD Med (Min-Max)	z	p
Pes	11.29±1.71 12- (6-14)	11.38±1.52 12- (6-14)	-0.038	0.969
Wes	5.44±2.15 5- (2-10)	5.4±1.98 5- (0-9)	-0.318	0.750

Mann-Whitney U test

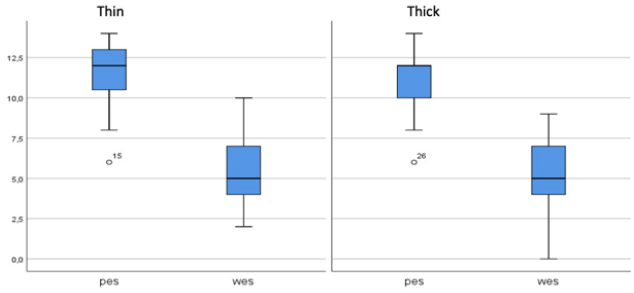

Fig 1. Comparisons according to Phenotype.

There was no strong evidence to suggest a significant monotonic relationship between the PES and WES variables for either the "thin" or "thick" phenotypes, as well as when considering both phenotypes together (Table 3, Figure 2).

Table 3. Correlation analysis.

		Pes		
		Thick Phenotype	Thick Phenotype	Total
Wes	**r**	-0.076	-0.047	-0.050
	p	0.592	0.499	0.418

Spearman's rho test

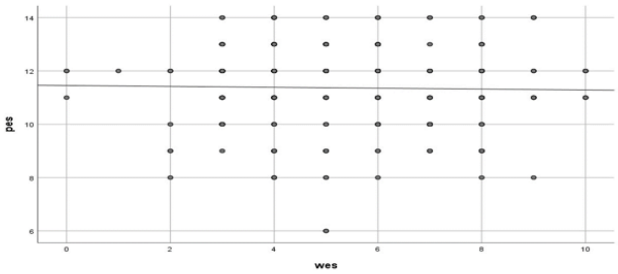

Fig 2. Correlation Analysis.

In the Logistic Regression Analysis, phenotype was taken as the dependent variable and PES, WES as independent variables. Since Hosmer-Lemeshow p=0.006<0.05, the model was not appropriate for interpretation and p=0.918>0.05 the model was not statistically significant (Table 4).

Table 4. Logistic regression analysis

	p	OR	Lower %95 CI	Upper %95 CI
Pes	0,699	1,039	0,856	1,262
Wes	0,889	0,989	0,851	1,150

For either the "thin" or "thick" phenotypes, as well as when taking both phenotypes into account, there was no strong evidence to support a substantial monotonic association between the "Pes", "Wes", and "Age" variables. (Table 5).

Table 5. Correlation between age, Pes, and Wes (Overall and by phenotype).

Phenotypes		Age Thin	Thick	Total
Pes	**r**	-0,114	0,047	0,016
	p	0,419	0,496	0,797
Wes	**r**	0,243	0,082	0,116
	p	0,082	0,233	0,060

Spearman's rho test

There was a significant difference between males and females in terms of Pes in Thick phenotypes ($p<0.05$). The mean of males was found to be higher than females. There was a significant difference between males and females in terms of Wes in Thin phenotypes ($p<0.05$). The mean of males was found to be higher than females. There was a significant difference between males and females in terms of Wes in overall ($p<0.05$). The mean of males was found to be higher than females (Table 6).

Table 6. Comparisons between gender, Pes and Wes (Overall and by phenotype).

		Male Mean+SD Med (Min-Max)	Female Mean+SD Med (Min-Max)	z	p
Pes	Thin	11,41±1,12 11- (9-13)	11,23±1,94 12- (6-14)	-0,179	0,858
	Thick	11,69±1,51 12- (8-14)	11,19±1,49 11- (6-14)	-3,300	0,001
	Overall	11,64±1,45 12- (8-14)	11,2±1,59 12- (6-14)	-1,866	0,062
Wes	Thin	6,94±2,59 6- (2-10)	4,71±1,47 4- (2-8)	-2,124	0,034
	Thick	5,58±2,24 6- (0-9)	5,28±1,8 5- (2-9)	-1,468	0,142
	Overall	5,81±2,34 6- (0-10)	5,16±1,74 5- (2-9)	-2,758	0,006

Mann-Whitney U test

Discussion

The null hypothesis was accepted and no significant relationship between dental phenotype and PES/WES values of restorations was found at the conclusion of the study. Among the participants, 80.3% had a thick phenotype, while 19.7% had a thin phenotype. The average PES value was observed to be 11.36 ± 1.55, and the average WES value was observed to be 5.41 ± 2.01.

Lanza et al.[1] observed the initial and final PES/WES values in a case study of aesthetic restorations in the maxillary anterior region and reported an increase in values in the restoration. Chen et al.[23] conducted a photographic analysis for 306 natural teeth and observed the mean PES and WES values to be 12.92 and 8.75, respectively. In addition, 47 male and 55 female ranging from 18 to 53 years old patients were observed in their studies; reported that PES and WES values were higher in male patients. They also observed higher PES/WES values in younger patients in their study. However, the age range of the patients in our study ranged between 17 and 70 years. Age: No statistically significant correlation was found between PES WES values and gingival phenotype. In our study, 39 female and 24 male patients were examined, and the PES and WES values of males were statistically higher than females. This difference may be due to the number of subjects in our study and the observed tooth numbers.

Wadigal et al.[14] evaluated PES and WES values by examining images of immediately placed implants in the anterior maxilla. In their study involving 53 patients, the reported mean PES value was 8.63 ± 2.4, and the mean WES value was 6.92 ± 1.67. Björn et al. 16 observed PES and WES values over a five-year follow-up in single implant treatments. The initial and final total PES values were reported as 9.61 and 11.49, respectively, and the average WES was reported as 6.48. In a similar study involving 45 patients, the PES/WES values were observed to be 14.7 ± 1.18 and 6.9 ± 1.47.9 The PES and WES values in these studies are generally comparable to our study results. Vanlıoğlu et al.[19] (47 patients) evaluated PES and WES values for 55 maxillary anterior region implants placed in patients with metal-ceramic restorations over a period of two to four years. Overall aesthetic outcomes were achieved in their study, with WES values reported to surpass PES values. Similarly, satisfactory aesthetic results were obtained in our study. However, in our study, PES values yielded higher results than WES values. These disparities may stem from our focus on supra-restorations rather than implant-supported restorations, as in the mentioned studies. Given the limited number of studies that have conducted PES/WES evaluations on natural tooth restorations, we also compared our results with implant-supported restoration studies. Furthermore, our study examined a greater number of cases compared to similar studies, although a long-term follow-up study was not conducted. Bernal et al.[15] assessed PES/WES values and dental phenotype on images taken before and after single implant placement in the anterior maxilla for 25 patients. They reported no statistically significant relationship between WES values and dental phenotype. Bittencourt et al.[17] In

their studies, they evaluated 26 implant-supported crowns with metal-ceramic and zirconia-ceramic frameworks using ceramic and titanium abutments. They focused on the correlation between PES and WES scores, dental phenotype, and the correlation between PES score and dental phenotype. They obtained statistically significant results between PES values and dental phenotype, reporting higher PES values in cases with thick phenotypes. Tatum et al.[18] evaluated PES and WES scores and periodontal phenotype assessment during immediate single implant placement in 41 patients. They stated that there was no significant difference between thick and thin phenotypes when the correct treatment protocol was followed. In the present study, no statistically significant results were found between PES, WES values, and dental phenotype. This discrepancy may be related to the nature of our study involving natural teeth and the absence of a long observation period for cases, relying on evaluation based on photographs taken at the completion of the procedure. Despite the limited number of studies that have examined PES and WES values on natural teeth,[1,20] there is no study that has evaluated dental phenotype in restorations on natural teeth. Hence, we could not fully compare our results statistically in terms of dental phenotype.

The limitations of the study include the fact that immediate post-treatment images were obtained and analyzed, and long-term outcomes were not considered. Additionally, numerous restorations, including anterior and premolar teeth, were included in the evaluation in the same patient, rather than just one tooth group, and a variety of age groups were evaluated in the study.

Conclusion

Initial aesthetic values (PES/WES) of metal aesthetic restorations made on natural teeth were within acceptable values. There was no statistically significant relationship between initial aesthetic values of restorations and gingival phenotype. It is thought that this study will contribute to physicians' understanding of the aesthetic results of the planning and finishing stages of routine metal-ceramic restoration treatments in the clinic. More detailed and long-term controlled clinical studies are needed on this subject.

Conflict of interest

None of the authors of this article has any relationship, connection or financial interest in the subject matter or material discussed in the article.

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