

# The Relationship Between the Amount of Peri-implant Keratinized Mucosa and Patient Satisfaction

Periimplant Keratinize Mukoza Miktarı İle Hasta Memnuniyeti Arasındaki İlişki

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## ABSTRACT

**Background:** The aim of this study was to evaluate the relationship between peri-implant soft tissue health, the amount of peri-implant keratinized mucosa (KMA), and the satisfaction of patients who applied to the Ankara University Faculty of Dentistry and had a fixed implant-assisted restoration in the premolar and/or molar region at least 1 year after the functional loading of implant treatment.

**Methods:** 40 implants from 40 patients, of which 24 were female and 16 were male, were included in our study. Peri-implant soft tissue health was objectively evaluated with clinical measurements and a radiographic examination. KMA around the implants was measured and recorded. Afterwards, the patients were asked to fill out a (subjective) questionnaire that included socio-demographic data and evaluated their satisfaction with their implants by VAS.

**Results:** All patients in the healthy group had keratinized mucosa (KM). In this study, a mean total VAS score of 8.40 out of 10 indicates that patients are satisfied with implant treatments. However, the relationship between chewing, speech, aesthetics, pain and discomfort, the presence of bleeding scores, and the total VAS score was statistically significant. There was a statistically significant difference between those without KM, those with insufficient KM, and those with present/sufficient KM in terms of speech VAS score ( $p=0.050$ ).

**Conclusion:** In our study, the presence of KM significantly affected VAS scores at the speech level.

**Keywords:** Dental implants, oral mucosa, patient satisfaction, implant success

## ÖZ

**Amaç:** Bu araştırmanın amacı; Ankara Üniversitesi Diş Hekimliği Fakültesi'ne başvuran, implant tedavisinin fonksiyonel yüklemesi üzerinden en az 1 yıl geçmiş, premolar ve/veya molar bölgede sabit bir implant destekli restorasyonu olan hastaların implant çevresi yumuşak doku sağlığı, keratinize mukoza (KMM) miktarı ve memnuniyetleri arasındaki ilişkiyi değerlendirmektir.

**Gereç ve Yöntem:** Çalışmamıza 24'ü kadın, 16'sı erkek olmak üzere 40 hastaya ait 40 implant dahil edildi. Peri-implant yumuşak doku sağlığı, klinik ölçümler ve radyografik inceleme ile objektif olarak değerlendirildi. İmplantların etrafındaki KMM ölçüldü ve kaydedildi. Daha sonra hastalardan sosyo-demografik verileri içeren ve implantlarından memnuniyetlerini VAS ile değerlendiren (sübjektif) bir anket doldurmaları istendi.

**Bulgular:** Sağlıklı gruptak tüm hastalarda keratinize mukoza (KM) vardı. Bu çalışmada ortalama toplam VAS skorunun 10 üzerinden 8,40 olması hastaların implant tedavilerinden memnun olduklarını göstermektedir. Ancak çiğneme, konuşma, estetik, ağrı ve rahatsızlık, kanama varlığı skorları ile toplam VAS skoru arasındaki ilişki istatistiksel olarak anlamlıydı. Konuşma VAS skoru açısından KM'si olmayanlar, KM'si yetersiz olanlar ve KM'si olan/yeterli olanlar arasında istatistiksel olarak anlamlı fark vardı ( $p=0,050$ ).

**Sonuç:** Çalışmamızda KM'nin varlığı konuşma düzeyindeki VAS skorlarını anlamlı olarak etkiledi.

**Anahtar Kelimeler:** Dental implantlar, oral mukoza, hasta memnuniyeti, implant başarıları

## INTRODUCTION

The presence of a sufficiently KM around dental implants is important for the maintenance of healthy peri-implant mucosa.<sup>1-4</sup> Compared to alveolar mucosa, KM is more resistant to damage caused by chewing.<sup>5,6</sup> The KM also reduces the negative effects of forces from the muscle connections and frenulum.<sup>7</sup>

If peri-implant KM is insufficient then lip, cheek, and tongue movements can cause tension in the tissues around the implant along with inadequate oral hygiene practices.<sup>8-11</sup> As a result, plaque accumulates around the implants and the susceptibility of peri-implant tissues to inflammation increases.<sup>12</sup> Furthermore, there are studies showing that inflammation increases in peri-implant tissues of implants without sufficient KM.<sup>13-15</sup>

The presence of a sufficient KM is important for the success of implants.<sup>11,16</sup> A thin band ( $\geq 0$  mm and  $\leq 2$  mm) of KM has been reported to maintain peri-implant tissue health.<sup>17</sup> However, the relationship between a sufficient ( $\leq 2$  mm) KM and the long-term success rate of implants has been discussed in the literature.<sup>18</sup> In order for implant treatments to be considered successful, the clinical and radiological success criteria of the implants determined by various authors and positive patient satisfaction must be matched. Since implant-supported

prostheses have advantages such as improved chewing, function, phonation, and aesthetics, the subjective criteria required in this evaluation re to provide sufficient function, comfort, and aesthetics.<sup>19</sup> There are now many studies in the literature on this topic due to the increased use of implant-supported prostheses. However, while various studies evaluate the degree of satisfaction of patients after implant treatment,<sup>20-22</sup> the number of studies associated with KMA is limited.

Our hypothesis was that the presence of KM around implants increases patient satisfaction. We designed a cross-sectional study in which we could establish a relationship between objective and subjective values. The purpose of this study was to evaluate the relationship between peri-implant soft tissue health, KMA, and the satisfaction of patients who applied to the Ankara University Faculty of Dentistry and had a fixed implant-assisted restoration in the premolar and/or molar region, at least 1 year after the functional loading of implant treatment.

## MATERIAL AND METHODS

This study was approved by the Clinical Research Ethics Committee of Ankara University Faculty of Dentistry (approval no. 36290600/22/2022). Patients who applied to the Ankara University Faculty of Dentistry with a fixed implant-supported restoration in the premolar and/or molar region at least 1 year after the functional

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loading of the implant treatment, were included in the study. The implants applied within the scope of the study were intraosseous implants. The main inclusion criteria were patients aged 18 years or older who did not have a systemic disease, did not use medication, and were not consumers of cigarettes or tobacco products.

The study excluded pregnant or breastfeeding women, patients with temporomandibular joint disorder, patients undergoing orthodontic treatment, or those with a severe orthodontic disorder. Our study included 40 implants in 40 patients (24 female and 16 male), who agreed to participate in the study. Written consent was obtained from the patients.

#### Sample size

The sample size to be used in the study was determined using a power analysis. The effect level was 0.50, the  $\alpha$  value was 0.05, and the power value (1- $\beta$ ) was calculated as 0.90. Accordingly, the number of samples was calculated as 34 in total. However, considering the possibility of missing data, it was decided that we include 40 patients in the study since it was recommended to obtain 10 % more observations.

#### Data collection

##### Clinical measurements and radiographic evaluation

The implant circumference was evaluated and soft tissue health determined by clinical and radiological methods. Clinical measurements were standardized by a single researcher specializing in the field. A Williams periodontal probe (Hu-Frider, Chicago, IL, USA) was used to measure four sites: the mesiobuccal, distobuccal, midfacial, and midpalatal/lingual regions of the implants. Measurements were recorded in index forms. All values were collected, divided by the number of regions measured, and the mean values were obtained. Periodontal clinical indices used in the study were peri-implant KMAs, Silness and Löe's (1964) plaque index (PI), gingival index (GI) of Löe and Silness (1965), bleeding on probing (BP), and probable pocket depth (PPD).

KMA (width) was obtained by measuring the distance from the free gingival margin to the mucogingival junction in the mid-buccal region of each implant, using a periodontal probe. The technique of folding the mucosa up to the adherent gingiva (rolling technique) was used to identify the mucogingival junction.<sup>23</sup> The differences in color and texture between the KM and the mucogingival junction were also noted. The peri-implant KMA measurement was recorded in the periodontal index form used for other clinical measurements. In our study, the implants were divided into three groups according to KMA as the width of the KM: present and sufficient ( $\geq 2$  mm), insufficient ( $< 2$  mm), and no KM (0 mm).<sup>24</sup> This value was recorded by measuring the same area each time. In cases where the probing values did not provide the exact value, the measurement was rounded to the exact value considered to be closest. We also took into account suppuration, mobility, fistula formation, swelling of the peri-implant mucosa, and hyperplasia as other clinical diagnostic parameters in peri-implant diseases, were taken into account.

Panoramic radiographs were used for radiographic evaluation. Accordingly, implants without bone loss, but with inflammation were categorized as mucositis; implants with exposed implant grooves and/or radiological bone loss were regarded as peri-implantitis; and implants without bone loss and without inflammation detected by clinical measurements were recorded as healthy.

After written informed consent was obtained from the participants in the study and the clinical measurements and radiologic evaluations were performed and recorded, participants were asked to fill out a 5 to 10-minute questionnaire. Two questionnaires were used as data collection tools (presented in supplementary materials).

#### Demographic characteristics questionnaire

This form contains questions about the patient's sociodemographic data (gender, age), dental implants (localization), how many years they have been using the prosthesis, how long they were toothless before the implantation, and the number of times they brush their teeth in a day.

Evaluation of the satisfaction of patients rehabilitated with dental implants using the questionnaire

A six-question VAS (visual analogue scale) was applied to measure the satisfaction associated with dental implants. For this purpose, patients were asked to score from 1 (lowest) to 10 (highest) whether they gained the expected functionality, if the implant met their aesthetic expectations, if their speech was affected, if they experienced pain and discomfort, the ease or difficulty of performing oral hygiene, and if they experienced bleeding.

#### Statistical analysis

The data were analyzed with SPSS 24.0 software and the results were evaluated at a 95% confidence level. In the study, kurtosis and skewness coefficients were calculated to determine the suitability of the data and other quantitative variables for a normal distribution. Accordingly, if the extreme values were determined, the extreme values were deleted. In the study, the Pearson correlation test was performed to examine the relationship between variables, and the t-test and ANOVA test were used to compare categorical variable groups in terms of quantitative variables.

## RESULTS

Of the 40 patients who participated in the study, 16 (40%) were male and 24 (60%) were female. The mean age of males was  $54.25 \pm 14.81$ , and the mean age of females was  $51.63 \pm 10.99$ . The 40 implants were classified as healthy (25%), having peri-implantitis (20%), or having mucositis (55%). By measuring the soft tissue around the implants, it was determined that the KMA varied between 0 and 5 mm. The mean KMA value was  $1.59 \pm 1.39$  mm.

By measuring KMA around the implants participating in the study, the patients were divided into three groups: no KM, insufficient KM, and present or sufficient KM (Figures 1-3).



Figure 1. No KM group



Figure 2. KM < 2 mm 2 (Insufficient group)

Accordingly, 22.5% of the patients did have no KM, 27.5% had insufficient KM <2 mm, and 50% had sufficient KM of ≥2 mm. Although 44.4% of the patients with no KM had peri-implantitis, 65.6% had mucositis, 27.7% of the patients with insufficient KM had peri-implantitis, 27.7% had mucositis, and 45.45% were healthy. Where KM was present in the sufficient group, 5% of the patients had peri-implantitis, 70% had mucositis, and 25% were healthy. KM was present in all patients in the group with healthy implants (Table 1).



Figure 3. KM ≥2 (Present/sufficient group)

Table 1. Evaluation of keratinized mucosa amount according to diagnosis

		Peri-implantitis		Peri-mucositis		Healthy		Total	
		N	%	N	%	N	%	N	%
KMA	No	4	44.4	5	65.6	0	0.0	9	22.5
	Insufficient	3	27.7	3	27.7	5	45.45	11	27.5
	Present/Sufficient	1	5.0	14	70.0	5	25.0	20	50.0

N: number of patients

62.5% of the patients participating in our study have been using prostheses for 1-5 years, 20 % for 6-10 years, and 17.5% for more than 10 years. In addition, 47.5% of the patients reported brushing their teeth twice a day, 52.5% once a day or occasionally (Table 2).

Table 2. Evaluation according to fixed prosthesis usage times and daily brushing habits

		Peri-implantitis		Mucositis		Healthy		Total	
		N	%	N	%	N	%	N	%
How many years have you been using prosthetics?	1-5 years	5	62.5	14	63.6	6	60.0	25	62.5
	6-10 years	2	25.0	6	27.3	0	0.0	8	20.0
	More than 10 years	1	12.5	2	9.1	4	40.0	7	17.5
Brushing habit	Twice a day	2	25.0	12	54.5	5	50.0	19	47.5
	Once a day/Sometimes	6	75.0	10	45.5	5	50.0	21	52.5

When evaluated according to the diagnostic parameters, 62.5% of participants diagnosed with peri-implantitis used their prostheses for 1-5 years, 63.6% of those diagnosed with mucositis used their implants for 1-5 years, and 60% of the healthy group used theirs for 1-5 years. According to their tooth brushing habits, 75% of participants diagnosed with peri-implantitis, 45.5% of those with mucositis, and 50% of the healthy group brushed their teeth once a day or occasionally. There were no patients in our population who never brush their teeth (Table 2).

According to the data obtained from the clinical measurements, the mean PI scores were 1.03±0.57, the mean GI scores were 1.34±0.50, and the mean PPD was 2.97±1.06 (Table 3).

Table 3. Evaluation of clinical measurements

	Min	Max	Mean	Sd
PI	0.00	3.00	1.03	0.57
GI	0.20	2.00	1.34	0.50
PPD	1.25	6.00	2.97	1.06

Min: minimum, Max: maximum, Sd: standard deviation

When we examined the relationship between implants with different diagnoses and patient age with clinical measurements, a statistically significant difference was found between peri-implantitis, mucositis, and healthy patients in terms of probable pocket depth (p=0.001). According to their mean values, the group with the highest pocket depth was those diagnosed with peri-implantitis, and the group with the lowest was the healthy group (Table 4).

Table 4. Evaluation of the relationship between different diagnostic areas and clinical measurements

	Peri-implantitis			Mucositis			Healthy			Kruskal Wallis	
	X	Sd	M	X	Sd	M	X	Sd	M	X <sup>2</sup>	p
PI	1.16	0.64	1.0	0.95	0.47	1.00	1.10	0.73	1.00	0.861	0.650
GI	1.38	0.58	1.25	1.45	0.43	1.50	1.07	0.52	1.00	3.872	0.144
PPD	4.16	1.26	4.63	2.88	0.66	2.75	2.23	0.88	2.00	13.766	0.001*
Age	56.75	12.22	58	53.36	12.66	55	47.90	12.26	46	2.455	0.293

\*p<0.05: significance, M: mean

When KMA and clinical measurements were compared, the results were not statistically significant. Plaque and gingival index scores were similar for all groups. Probable pocket depth was found to be 2.97 in patients without KM, 2.66 in those with insufficient mucosa, and 3.13 in those with sufficient mucosa (Table 5).

Table 5. Evaluation of the amount of keratinized mucosa in relation to clinical measurements

	KMA									Kruskal Wallis H Test	
	No			Insufficient			Present/Sufficient			X <sup>2</sup>	p
	X	Sd	Mean	X	Sd	Mean	X	Sd	Mean		
PI	1.06	0.30	1.00	1.02	0.68	1.00	1.03	0.62	1.00	0.781	0.677
GI	1.36	0.31	1.25	1.22	0.63	1.25	1.40	0.50	1.50	0.655	0.721
PPD	2.97	1.08	2.50	2.66	1.23	2.25	3.14	0.98	3.13	2.125	0.346

Evaluation of patient satisfaction with VAS revealed an average satisfaction value of patients with implant-supported prosthesis in terms of chewing as 8.63, speech was 6.83, aesthetic expectations was 8.18, and oral hygiene (ie, easy cleaning of implant-supported dentures) was 7.83. The satisfaction of the participants in terms of pain and discomfort was 8.65 and the presence of bleeding was 8.28. In our study, the mean total VAS score of 8.40 out of 10 suggests that the patients were satisfied with their implant treatments (Table 6).

Table 6. Evaluation of patients' satisfaction with implant treatments with VAS score

	Min	Max	Mean	Sd
Chewing	4	10	8.63	1.23
Speech	3	10	6.83	1.28
Aesthetics	3	10	8.18	1.39
Oral hygiene	4	10	7.83	1.50
Pain and discomfort	5	10	8.65	0.95
Presence of bleeding	5	10	8.28	1.34
Total VAS score	5.67	10.00	8.40	0.87

There was a statistically significant difference between those without KM, those with insufficient KM, and those with sufficient KM in terms of speech VAS score (p=0.050). According to the mean values, the group with the highest speech VAS score were those with a sufficient KMA, and the group with the lowest was those without KM. As KMA presence increases, the total VAS score (ie, the satisfaction of the patients), also increases. However, this result was not statistically significant (p=0.134; Table 7).

**Table 7. Evaluation of the VAS scores according to different amounts of keratinized mucosa**

	KMA									Kruskal Wallis H Test	
	No			Insufficient			Present/Sufficient			X <sup>2</sup>	p
	X	Sd	Mean	X	Sd	Mean	X	Sd	Mean		
Chewing	8.00	1.66	9	8.82	0.87	9	8.80	1.15	9	2.348	0.309
Speech	8.22	2.17	9	8.64	0.67	9	9.20	0.89	9	5.976	0.50*
Aesthetics	8.33	0.87	9	7.36	2.16	8	8.55	0.83	9	1.926	0.382
Oral hygiene	7.44	1.59	8	7.36	1.63	7	8.25	1.33	9	3.842	0.146
Pain and discomfort	8.67	0.50	9	8.55	1.04	9	8.70	1.08	9	0.430	0.806
Presence of bleeding	7.78	1.39	8	8.36	1.43	9	8.45	1.28	9	1.836	0.399
Total VAS score	8.07	1.00	8.50	8.18	0.85	7.83	8.66	0.77	8.75	4.014	0.134

\*p<0.05

There was also no statistical significance in terms of patients' age, clinical measurement values, or VAS scores according to the duration of prosthesis use (Table 8).

**Table 8. Evaluation of the duration of prosthesis use according to VAS scores**

	Duration of Prosthesis Use									Kruskal Wallis H Test	
	1-5 years			6-10 years			More than 10 years			X <sup>2</sup>	p
	X	Sd	Mean	X	Sd	Mean	X	Sd	Mean		
PI	1.02	0.56	1.00	0.88	0.27	1.00	1.25	0.80	1.00	1.147	0.564
GI	1.23	0.50	1.25	1.53	0.41	1.38	1.54	0.51	1.50	3.038	0.219
PDI	3.00	0.93	2.50	3.41	1.18	3.13	2.36	1.25	2.00	5.183	0.075
Age	52.60	13.51	54	50.63	11.30	51	55.29	11.43	54	0.511	0.774
How long did the patient live without teeth?	3.83	3.78	2	5.83	5.31	5	4.33	2.89	6	0.858	0.651
Chewing	8.40	1.38	9	9.13	0.99	9	8.86	0.69	9	2.601	0.272
Speech	8.68	1.41	9	8.88	1.36	9	9.29	0.49	9	1.595	0.450
Aesthetics	8.16	1.46	9	8.38	0.74	9	8.00	1.83	9	0.010	0.995
Oral hygiene	7.76	1.48	8	8.00	1.77	9	7.86	1.46	9	0.565	0.754
Pain and discomfort	8.80	0.65	9	8.13	1.73	9	8.71	0.49	9	0.359	0.836
Presence of bleeding	8.20	1.47	8	8.13	1.46	9	8.71	0.49	9	0.671	0.715
Total VAS score	8.33	0.95	8.50	8.44	0.82	8.58	8.57	0.64	8.67	0.355	0.838

In our study there was no statistically significant difference in clinical measurement values and VAS scores between patients who reported brushing twice a day, once a day, or brushing occasionally (Table 9).

**Table 9. Comparison of clinical measurement values and VAS scores obtained according to brushing habits**

	Brushing habits						Mann Whitney	
	Twice a day			Once a day/Sometimes			U Test	
	X	Sd	Median	X	Sd	Median		p
PI	0.83	0.34	1.00	1.21	0.67	1.00	143.000	0.093
GI	1.31	0.54	1.25	1.37	0.47	1.50	186.500	0.719
PPD	2.76	1.07	2.50	3.15	1.05	3.25	148.000	0.160
Age	49.21	11.44	47	55.81	12.94	56	137.500	0.093
How long did the patient live without teeth?	4.77	4.42	4	3.93	3.71	3	79.500	0.564
Chewing	8.79	0.98	9	8.48	1.44	9	179.500	0.563
Speech	8.89	0.99	9	8.76	1.51	9	195.500	0.906
Aesthetics	8.32	0.95	8	8.05	1.72	9	194.500	0.885
Oral hygiene	7.84	1.68	8	7.81	1.36	8	189.500	0.778
Pain and discomfort	8.58	1.22	9	8.71	0.64	9	185.000	0.658
Presence of bleeding	8.79	0.71	9	7.81	1.60	8	131.000	0.053
Total VAS score	8.54	0.76	8.67	8.27	0.95	8.50	178.500	0.532

**DISCUSSION**

The amount and necessity of KM for peri-implant health are controversial issues. Many studies suggest that peri-implant KM is essential for the health of implants.<sup>8,15,16,25</sup> Studies have shown that periodontal destruction can occur when plaque control cannot be performed properly in areas with insufficient KM.<sup>14</sup> Peri-implant KMA can also affect patients' satisfaction with their implants.

Insufficient KM leads to subgingival plaque accumulation due to the mobility of the free gingival margin.<sup>9</sup> Plaque deposition is an important clinical sign that results in increased inflammation in soft tissues.<sup>26,27</sup> In our study, there was no significant difference in the evaluation of gingival index and plaque scores according to KMA (Table 5). However, gingival index scores were higher in the peri-implantitis group than in the mucositis and healthy groups. Although all patients who participated in our study reported brushing their teeth, their mean plaque score was 1.03 (Table 3). These results show that KMA has little effect on soft tissue inflammation when patients observed good oral hygiene. Similar to our study, others have shown that KMA has no effect on mucosal bleeding tendency.<sup>11,28-30</sup> Insufficient KM in patients with poor oral hygiene might increase susceptibility to inflammation.<sup>31</sup> However, there are also studies showing that plaque accumulation around implants with KM <2 mm and bleeding symptoms on probing are significantly higher.<sup>4,32,33</sup>

When examining the relationship between implants with different diagnoses and patient age and clinical measurements, a statistically significant difference was found between peri-implantitis, mucositis, and healthy implants in terms of probable pocket depth (p=0.001). In our study, the pocket depth was 2.97 and 2.66 in those without KM and in those with insufficient KM, respectively. Furthermore, the probing depth was higher in those with sufficient KM and was found to be 3.13, which was not statistically significant (Table 5). Similarly, most studies have not shown a significant relationship between KMA and peri-implant probing depth.<sup>16,28,31-34</sup> However, similar to our results, probing depth was shown to be greater in areas with sufficient KM around the implant.<sup>35</sup> The authors of the study suggest that insufficient KM causes more soft tissue shrinkage in the implants resulting in less probable pocket depth.<sup>35</sup> Therefore, fewer pockets may form in areas with less KM. In contrast to our findings, Ueno et al.<sup>4</sup> reported that probing depth scores increased in areas where KMA was <2 mm.

In our study, the incidence of peri-implantitis was 12.5% in the KM  $\geq 2$  mm group, 37.5% in the KM  $\leq 2$  mm group, and 50% in the no KM group. In addition, KM was present in the group with a healthy diagnosis. This suggests that all implants caused peri-implantitis or mucositis in patients without KM (Table 1). Thus, our study revealed that the absence or insufficient KM increases the risk of mucositis and peri-implantitis. It has been reported previously that a sufficient KMA for peri-implant health is  $\geq 2$  mm, and when KM  $< 2$  mm, the lack of KM affects peri-implant health, which results in issues that can cause peri-implant mucositis/peri-implantitis.<sup>36-41</sup> In addition, studies have shown that the rate of mucositis development is higher in areas with less  $< 2$  mm of keratinized tissue band.<sup>30-32,42</sup> This is because a sufficient KM band facilitates oral hygiene, plaque control, and protects the epithelial attachment by keeping it away from the movements of the alveolar mucosa. In patients with good oral hygiene, peri-implant soft tissue has been reported to be clinically healthy even in the absence of KM.<sup>11</sup> However, it is difficult to ensure proper and accurate plaque control in areas without KM.<sup>43</sup> Studies have shown that periodontal destruction might occur when plaque control is not performed properly in areas with insufficient KM.<sup>14</sup>

In our study, patient satisfaction with implant prostheses was evaluated using the VAS assessment method, which is a practical and reliable method for recording patient satisfaction of chewing, speech, aesthetics, the applicability of oral hygiene, pain and discomfort, and the presence of bleeding. The VAS serves to measure a characteristic or attitude that is thought to change along a continuum of values and cannot easily be measured directly. It is often used in epidemiological and clinical research to measure the frequency of various symptoms. Additionally, VAS is a measurement tool that is easily understood by the patient.<sup>44</sup>

The greatest expectation of patients from implant treatment is to regain chewing function.<sup>45</sup> Restoring the loss of function caused by missing teeth is among the primary goals of most implant applications.<sup>46</sup> Implant prostheses are superior to removable and partial dentures in terms of chewing function,<sup>47,48</sup> which was reflected by the VAS score of the chewing function (8.63) obtained in our current study (Table 6). Furthermore, many studies have reported that implant-supported prostheses are accepted and positively evaluated by patients.<sup>21,49-51</sup> Similarly, the relationship between chewing function and total VAS score was statistically significant in our study. Nowadays, restoration of lost function is a major concern for all patients. Annibaldi et al.<sup>50</sup> reported that 94.2% of patients stated that their implant-supported prostheses were quite satisfactory in terms of chewing function, and 84.6% stated that they could chew all kinds of food with their implant-supported prostheses with no difference from their own teeth. Comfortable chewing function affects patients' overall satisfaction. Although our study was conducted with a small population, the patients were satisfied with their implant prostheses, and the total VAS score was 8.40 out of a maximum score of 10 (Table 6). Similarly, there are many studies in the literature showing that patients were satisfied with their implant treatment. In a study of 147 patients, they were asked questions about their chewing, speech functions, aesthetic results, and general satisfaction with their implant-supported prostheses, and it was found that the satisfaction rate was 91%.<sup>52</sup> Similar results were reported in similar studies.<sup>22,53-55</sup> Also, as in our study, high satisfaction rates have been obtained in patients who received implant treatment for the rehabilitation of single tooth deficiencies.<sup>69,56</sup>

According to our study results, dental implant applications were accepted as functional (mastication and speech) and aesthetic by the patients (mean=8.63; 8.83; 8.18; Table 6). As such, it can be said that dental implant applications are the ideal option for fixing tooth deficiencies. Similarly, in a study conducted by Moghadam et al.<sup>57</sup>, it was reported that patients' satisfaction rates with their implant-supported prostheses in terms of aesthetics, function, and comfort were between 85% and 96%.

Phonation is one of the issues that patients complain about after prosthetic treatment. Studies have reported that one of the most important criteria for patient satisfaction is the best possible restoration of speech function after prosthetic treatment.<sup>58,59</sup> Although our study was conducted in the posterior region, the satisfaction score of the patients in terms of speech function with their implant-supported prostheses was high with a value of 8.83 (Table 6).

Similarly, there are many studies in the literature reporting that patients found their speech function highly satisfactory after rehabilitation with implant-supported fixed prostheses.<sup>22,53-55,60</sup> According to other studies, it was found that patients rehabilitated with implant-supported prostheses improved their speech function with treatment. Furthermore, it was reported that patients' self-confidence also improved.<sup>61-65</sup>

When the mean VAS scores were evaluated, it was seen that aesthetic expectation was an effective factor in terms of treatment satisfaction for patients in this study (Table 6). Chang et al.<sup>66</sup> reported that the aesthetic results of implant-supported prosthesis applications in the treatment of single tooth deficiency was 94% as graded by the patients. This result shows that patients prefer implant prostheses, especially in single tooth deficiency, and find them aesthetic. In our study, the aesthetic VAS score was 8.18 out of 10. According to the results of similar studies, chewing functions, phonation, and patient satisfaction significantly increased after treatment in patients with implant-supported prostheses, and that they were satisfied with the aesthetic appearance of the prostheses.<sup>27,67</sup> It can be said that the aesthetic gain of implant applications in the premolar/molar regions is satisfactory for the patient. However, even if the concept of aesthetics is considered more important in areas within the boundaries of laughter or speech, in our study, it was considered as filling the missing tooth.

According to the scores obtained from our study group regarding satisfaction with implant treatment, the lowest VAS score was 7.83 out of 10 for oral hygiene, that is, their satisfaction with being able to clean their prostheses easily (Table 6). Similarly, a study by Annibaldi et al.<sup>50</sup> showed that 73.1% of patients stated that they had no difficulty cleaning their implant-supported prostheses. However, the lower score of ease of oral hygiene compared to other satisfactory factors in our study is related to the fact that the majority of individuals with a high degree of difficulty in denture cleaning have implant-supported fixed prostheses.<sup>20-22</sup> This lack of oral hygiene is due to the lack of motivation given to patients and the lack of production and planning of the cleaning tools needed.

In our study, there was a statistically significant difference between patients without KM, those with insufficient KM, and those with sufficient KM in terms of speech VAS score ( $p=0.050$ ). As KMA present increases, the total VAS score, that is, the satisfaction of the patients, also increases. However, this result was not statistically significant ( $p=0.134$ ). The presence of KM has a positive effect on peri-implant tissue health, contributing to overall patient satisfaction and comfort. In addition, speech function improves with implant prostheses. High satisfaction of speech function, which increases with the width of the KM, could be because the KM reduces tension by distancing the cheek movements away from the peri-mucosal tissues during speech and increases the width of the surface area required for voice formation. However, taking an impression from a fixed tissue, such as KM rather than mobile tissues, would clarify and facilitate the prosthetic impression stages. We can say that this improves speech function as it contributes positively to the output profile and health of the prosthesis.

The presence of KM has serious importance for the long-term success of implants, in creating a barrier against inflammation, and in ensuring the patient's oral hygiene. Patient satisfaction depends on the implants being functional, aesthetic, easy to clean, painless, and free from bleeding and infection in the long term. The necessity of keratinized tissue for implants is controversial, and there is no definitive conclusion. In order for this importance to be statistically reflected in studies, long term, multicenter, controlled clinical studies with large numbers of patients are needed. An increase in insufficient KM before or after implant surgery can be achieved by the effective application of mucogingival surgical methods. This will create a less risky environment for the long-term success of the implants. Before implant placement and planning, not only hard tissues but also soft tissues should be carefully evaluated for the long-term success of implants.

There were some limitations to this study. The implant brands used in this study were incomparably different and could not be standardized. In addition, since it was a post-implant study, the patients were not asked about the difficulties encountered during the treatment and their thoughts on the prices of the implants, considering they were

perennial implants. We believe that this research can be performed in larger populations and could include other factors, such as interface brushes and other developing technologies in hygiene.

#### CONCLUSION

According to the results of our study, implants were diagnosed as peri-implantitis or mucositis in patients with no KM. In the healthy group, KM was present in all patients. Evaluation of clinical measurements (plaque score and gingival index) according to the diagnosis shows that plaque scores were similar in all groups, whereas gingival index scores were higher in peri-implantitis patients compared to the mucositis and the healthy groups. In this study, a mean total VAS score of 8.40 out of 10 indicates that patients were satisfied with implant treatments. Additionally, total VAS scores increased significantly as the scores for chewing, speech, aesthetics, pain and discomfort, and bleeding increased. According to the analyses, there was no statistically significant difference in VAS scores between peri-implantitis, mucositis, and healthy patients ( $p>0.05$ ). As KMA presence increased, the total VAS score, that is, the satisfaction of the patients, also increased, however, these results were not statistically significant ( $p>0.05$ ). There was a statistically significant difference in speech VAS score between those without KM, those with insufficient KM, and those with sufficient KM ( $p=0.050$ ). Our hypothesis was that the presence of KM around the implants increased patient satisfaction. In our study, patients' satisfaction increased as KMA presence increased. However, this result was not statistically significant ( $p>0.05$ ).

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All co-authors have seen and agree with the contents of the manuscript and there is no financial interest to report. We certify that the submission is original work and is not under review at any other publication.

#### Değerlendirme / Peer-Review

İki Dış Hakem / Çift Taraflı Körleme

#### Etik Beyan / Ethical statement

Bu çalışma Ankara Üniversitesi Diş Hekimliği Fakültesi Klinik Araştırmalar Etik Kurulu tarafından onaylandı (onay no.36290600/22/2022)

Bu çalışma Erciyes Üniversitesi 2. Uluslararası Diş hekimliği Kongresinde Prof Dr Mehmet Yaşar Aykaç danışmanlığında 19.11.2022 tarihinde sunduğumuz/tamamladığımız İmplant Çevresi Keratinize Mukoza Miktarının Hasta Memnuniyeti ile İlişkisinin Değerlendirilmesi başlıklı yüksek lisans/doktora tezi esas alınarak hazırlanmıştır.

Bu çalışmanın hazırlanma sürecinde bilimsel ve etik ilkelere uyulduğu ve yararlanılan tüm çalışmaların kaynakçada belirtildiği beyan olunur.

This study was approved by the Clinical Research Ethics Committee of Ankara University Faculty of Dentistry (approval no. 36290600/22/2022)

This study was prepared based on the master's/doctoral thesis titled "Evaluation of the Relationship between the Amount of Keratinized Mucosa Around Implants and Patient Satisfaction" which we presented/completed under the supervision of Prof. Dr. Mehmet Yaşar Aykaç at the Erciyes University 2nd International Dentistry Congress on 19.11.2022.

It is declared that during the preparation process of this study, scientific and ethical principles were followed and all the studies benefited are stated in the bibliography.

#### Benzerlik Taraması / Similarity scan

Yapıldı - ithenticate

#### Etik Bildirim / Ethical statement

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#### Çıkar Çatışması / Conflict of Interest

Yazarlar çıkar çatışması bildirmemiştir. | The authors have no conflict of interest to declare.

#### Yazar Katkıları / Author Contributions

Çalışmanın Tasarlanması | Design of Study: MYA (%40), MMA (%30), SY (%30)

Veri Toplanması | Data Acquisition: JJ (%100)

Veri Analizi | Data Analysis: JJ (%40), ÖT (%30), SY (%30)

Makalenin Yazımı | Writing up: JJ (%50), SY (%50)

Makale Gönderimi ve Revizyonu | Submission and Revision: SY (%40), MYA (%20), MMA (%20), ÖT (%20)

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