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Effects of Peri-implant Mucosal Characteristics on Clinical Peri-implant Parameters: A Retrospective Study

Peri-implant Mukoza Özelliklerinin Klinik Peri-implant Parametreler Üzerine Etkileri: Retrospektif Bir Çalışma

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Abstract

Objective: This study aimed to examine the effects of peri-implant keratinized mucosa (KM) width and thickness on peri-implant soft tissue health in functionally loaded implants and evaluate the factors affecting peri-implant health.

Materials and Methods: A total of 645 implants from 169 patients were evaluated in this study. The duration of the implant follow-up ranged from 12 months to 46 months. Clinical measurements such as plaque index (PI), gingival index (GI), bleeding on probing (BOP), probing depth (PD), clinical attachment loss (CAL), KM width, mucosal phenotype (MP), and buccal mucosal recession (MR) of peri-implant sites were performed. Peri-implant mucosa was classified as healthy, peri-implant mucositis, and peri-implantitis.

Results: It was determined that the thickness and width of the KM around the implant did not affect the peri-implant soft tissue health and PI, GI, and BOP scores. PD was found to be significantly lower in peri-implant regions with KM width <2 mm and thin MP. CAL was found to be significantly higher in peri-implant regions with KM width <2 mm and thin MP. Significantly less buccal MR was detected in peri-implant regions with KM width ≥2 mm and thick MP. The peri-implant regions treated with the overdenture were significantly less healthy.

Conclusions: It was determined that the CM width and thickness around the implant did not have a significant effect on soft tissue health in patients who could achieve plaque control. It is important to provide sufficient KM width and thickness in the peri-implant soft tissue, especially in esthetic areas.

Keywords: Keratinized mucosa width, mucosal phenotype, mucosal recession, peri-implantitis, peri-implant mucositis

Öz

Amaç: Çalışmanın amacı, fonksiyonel yükleme yapılmış implantlarda implant çevresi keratinize mukoza (KM) genişliğinin ve kalınlığının peri-implant yumuşak doku sağlığı üzerindeki etkilerini incelemek ve peri-implant yumuşak doku sağlığını etkileyen faktörleri değerlendirmektir.

Gereç ve Yöntemler: Çalışmada 169 hastaya ait toplam 645 implant değerlendirildi. İmplant takip süresi 12 ay ile 46 ay arasında değişmektedir. Peri-implant bölgelerin plak indeks (PI), gingival indeks (GI), sondalamada kanama (SK), sondalama derinliği (SD), klinik ataşman kaybı (KAK), KM genişliği, mukozal fenotipi (MF) ve bukkal mukozal çekilme (MÇ) miktarı gibi klinik ölçümleri yapıldı. Peri-implant mukoza sağlıklı, peri-implant mukozitis ve peri-implantitis olarak sınıflandırıldı.

Bulgular: İmplant çevresindeki KM kalınlığının ve genişliğinin peri-implant yumuşak doku sağlığını ve PI, GI, SK skorlarını etkilemediği belirlendi. SD değerleri, KM genişliği <2 mm ve MF'si ince olan peri-implant bölgeleride anlamlı düzeyde daha düşük bulundu. KAK değerleri, KM genişliği <2 mm ve MF'si ince olan peri-implant bölgelerde anlamlı düzeyde daha yüksek bulundu. KM genişliği ≥2 mm ve MF'si kalın olan peri-implant bölgelerde anlamlı olarak daha az bukkal MÇ tespit edildi. Overdenture ile tedavi edilen peri-implant bölgeleri anlamlı düzeyde daha az sağlıklıydı.

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Sonuç: Plak kontrolünü sağlayabilen hastalarda implant çevresi KM genişliği ve kalınlığının yumuşak doku sağlığı üzerine belirgin bir etkisinin olmadığı tespit edildi. Özellikle estetik bölgelerdeki peri-implant yumuşak dokuda yeterli miktarda KM genişliğinin ve kalınlığının sağlanması önemlidir.

Anahtar Kelimeler: Keratinize mukoza genişliği, mukozal fenotip, mukozal çekilme, peri-implantitis, peri-implant mukozitis

Introduction

The presence of adequate keratinized tissue width is thought to be essential for maintaining gingival health and preventing periodontal disease progression (1). However, studies evaluating the effect of peri-implant keratinized mucosa (KM) width on long-term implant success have encountered different clinical results (2,3). Costa et al. (3) claimed that the insufficiency of the keratinized tissue band causes mucositis, peri-implantitis and even implant loss, respectively. Similarly, Ueno et al. (4) emphasized that clinical parameters such as bleeding on probing (BOP), plaque index (PI) and probing depth (PD) increase in areas with peri-implant KM width <2 mm. However, there are also studies reporting that peri-implant KM width does not affect gingival index (GI) or BOP scores (5-8). While Bengazi et al. (9) reported that the presence of KM did not affect soft tissue recession in their observations 6-24 months after prosthetic loading, many clinical studies (2,5-7) showed that the amount of mucosal recession (MR) increased significantly in implant sites with narrow KM.

It is seen in the literature that there are conflicting results between peri-implant tissue health and the amount of keratinized tissue. There is only one study evaluating the effect of peri-implant mucosal phenotype (MP) on the amount of peri-implant MR and clinical attachment loss (CAL). Therefore, the main purpose of this retrospective study is to examine the effects of peri-implant KM width and thickness on peri-implant soft tissue health in functionally loaded implants and evaluate the factors affecting peri-implant health.

Materials and Methods

Approval was obtained from the İnönü University Scientific Research and Publication Ethics Committee for this study (protocol number: 2020/844, date: 14.07.2020). Written and verbal information about the purpose and method of the study were given to all patients, the information forms were read and consent forms were signed by the patients.

Patient Sample

Patients who underwent implant surgery at İnonu University Faculty of Dentistry, Department of Periodontology between March 2016 and December 2019 were included in this retrospective clinical study. All of the implants were placed by the same surgeon (M.Ö.U.) using a non-traumatic surgical technique. The inclusion criteria were as follows: patients older than 18 years and with complete radiographic and clinical records during implant placement, implants that have been in function for at least more than one year.

Pregnant women, those who used systemic antibiotics in the 6 weeks before the study, patients who needed prophylactic antibiotics, smokers and those with any systemic disease that may affect soft tissue and hard tissue health (such as hyperthyroidism, hyperparathyroidism and uncontrolled diabetes mellitus) were excluded from the study.

Clinical Measurements

PI, GI, BOP, PD and CAL measurements of all peri-implant sites were measured using a probe (Hu-Friedy Colorvue Periodontal Probe, Chicago, IL, ABD) at six points (mesiobuccal, mid-buccal, distobuccal, distolingual/palatinal, mid-lingual/palatinal and mesiolingual/palatinal) of each implant. PD was measured as the distance between the mucosal margin and the bottom of the pocket or sulcus. CAL was defined as the distance between the abutment-implant junction and the bottom of the pocket. BOP and suppuration were recorded as present or absent (+\-).

KM width, MP and MR amount were measured from the mid-buccal point using a Williams probe (Hu-Friedy, Chicago, IL, USA). KM width was determined as the distance between the mucosal margin and the mucogingival line. MP was measured for each dental implant from the buccal surface using the "probe method" (10). After the periodontal probe was placed in the peri-implant sulcus, it was checked whether the color of the probe was reflected from the peri-implant mucosa. The mucosa was recorded as thin when the color of the probe was reflected and thick when it did not. The amount of MR was determined as the distance between the abutment-implant junction and the mucosal margin. All clinical measurements were performed by a single investigator. PI, PD and MP measurements obtained from 10 patients who were not included in the study for intra-examiner calibration were repeated 1 week later, resulting in 95%, 90% and 90% agreement, respectively.

Standard periapical radiographs were taken from the patients using the parallel technique. Soft tissue around the implant was grouped as healthy, peri-implant mucositis and peri-implantitis (11). Implants were grouped according to their superstructure as a single crown, implant-supported crown-bridge restoration and overdenture. The implanted area and the duration of the implants in function were recorded. Straumann (Waldenburg, Switzerland), Astra Tech (Astra Tech AB, Mölndal, Switzerland), Nobel (Branemark, Sweden), Zinedent (Batı Group and Instradent, Turkey), MIS (MIS Implants Technologies Ltd, Shlomi, Israel) branded dental implants were included in this study.

Statistical Analysis

IBM SPSS Statistics 22 (IBM SPSS, USA) program was used for evaluation of statistical analyzes. The suitability of the parameters to the normal distribution was evaluated by Kolmogorov-Smirnov and Shapiro-Wilks tests and it was determined that the parameters did not show normal distribution. While evaluating the study data, in addition to descriptive statistical methods (mean, standard deviation, frequency), Mann-Whitney U test was used to compare quantitative data. Chi-Square test and Fisher-Freeman-Halton Exact test were used to compare qualitative data. Significance was evaluated at the $p<0.05$ level.

Results

In the study, 645 peri-implant area was evaluated in a total of 169 individuals, 88 (52.1%) men and 81 (47.9%) women. The duration of implant follow-up ranged from 12 months to 46 months, with a mean of 25.86±8.74 and a median of 26 months. The distribution of general information about the participants and implants is shown in Table 1.

Table 1. Distribution of general information on participants and implants

Distribution of information on participants		(n=169)	%
Gender	Male	88	52.1
	Female	81	47.9
Age	18-29	6	3.6
	30-39	18	10.7
	40-49	46	27.2
	50-59	54	32
	60-69	35	20.7
	70 and older	10	5.9
Keratinized tissue width	≥2 mm	496	76.9
	<2 mm	149	23.1
Mucosal phenotype	Thick	479	74.3
	Thin	166	25.7
	Healthy	433	67.1
Peri-implant tissue health	Peri-implant mucositis	138	21.4
	Peri-implantitis	74	11.5
Suppuration	No	627	97.2
	Yes	18	2.8
	Single crown	104	16.1
Type of restoration	Crown-bridge	500	77.5
	Overdenture	41	6.4

The rate of being healthy with peri-implants treated with overdenture was found to be statistically significantly lower than those treated with a single crown and crown bridge ($p1=0.000$; $p2=0.000$; $p<0.05$). There was no statistically significant difference in terms of healthy rates between peri-implant sites treated with a single crown and crown bridge ($p>0.05$) (Table 2).

There was no statistically significant difference in peri-implant tissue health, PI, GI and BOP levels between peri-implant sites with KM width ≥2 mm and peri-implant sites with KM width <2 mm and ($p>0.05$) (Table 2, 3). There was no statistically significant difference in peri-implant tissue health PI, GI and BOP levels between the peri-implant regions with thick MP and those with thin MP ($p>0.05$) (Table 2, 3).

Peri-implant sites with KM width ≥2 mm had significantly higher PD values and lower CAL and buccal MR amounts ($p<0.05$) (Figure 1). In peri-implant regions with thick MP, PD was significantly higher, and CAL and buccal MR were lower ($p<0.05$) (Figure 2).

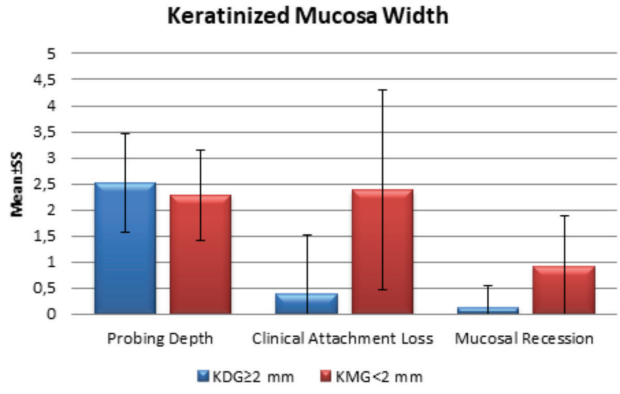

Figure 1. The relationship between peri-implant keratinized mucosa width and probing depth, clinical attachment loss and amount of mucosal recession

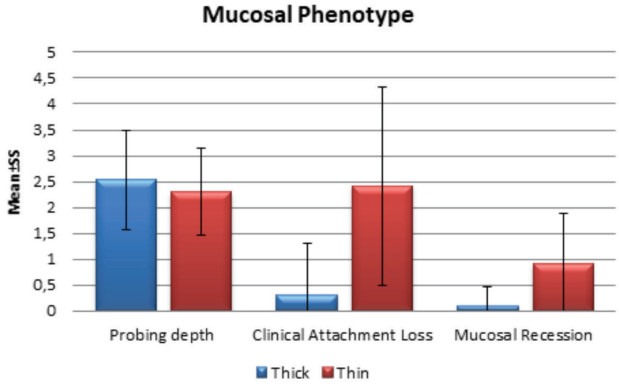

Figure 2. The relationship between peri-implant mucosal phenotype and probing depth, clinical attachment loss and amount of mucosal recession

Discussion

There are different opinions about the effect of the width and thickness of the keratinized tissue around the dental implant on the peri-implant soft tissue health. According to our study results, it was seen that the insufficiency in the thickness and width of the keratinized tissue around the implant did not negatively affect the clinical periodontal parameters such as PI, GI and BOP and the peri-implant soft tissue health. It is known that good oral hygiene is an important factor in reducing the risk of peri-implant disease and maintaining peri-implant health. It has been shown by some researchers that plaque accumulation, GI and BOP scores are higher in peri-implant areas with a narrow width of KM (2,5,12). However, some studies have reported that peri-implant keratinized mucosa width did not affect PI, GI and BOP scores (6,7). In their study, Buyukozdemir Askin et al. (13) found that the PI scores of the peri-implant regions with narrow KM were higher than the regions with wide KM and they showed that there was a significant improvement in PI scores after the gingival grafting procedure in the peri-implant regions with narrow KM. As a result of the study conducted by Schrott et al. (5), it was shown that the width of the KM in the buccal peri-implant regions has no effect on plaque accumulation. However, they found statistically significant higher plaque accumulation and bleeding scores in the lingual region with narrow KM (5). In their study, Schrott et al. (5) followed the patients for 60 months at 6-month intervals. During each visit, implant care was performed, which included debridement and oral hygiene instructions. In this study, the amount of KM in the buccal region may not have affected the PI scores, since plaque control was performed at regular intervals. We think that it is more important to provide plaque control rather than the

Table 2. Evaluation of peri-implant tissue health

		Peri-implant tissue health			
		Healthy	Peri-implant mucositis	Peri-implantitis	p-value
		n (%)	n (%)	n (%)	
Type of restoration	Single crown	74 (71.2%)	16 (15.4%)	14 (13.5%)	0.000*
	Crown-bridge	345 (69.0%)	105 (21.0%)	50 (10.0%)	
	Overdenture	14 (34.1%)	17 (41.5%)	10 (24.4%)	
Keratinized tissue width	≥2 mm	338 (68.1%)	104 (21%)	54 (10.9%)	0.562
	<2 mm	95 (63.8%)	34 (22.8%)	20 (13.4%)	
Mucosal phenotype	Thick	327 (68.3%)	100 (20.9%)	52 (10.9%)	0.546
	Thin	106 (63.9%)	38 (22.9%)	22 (13.3%)	

Chi-square test, *p<0.05

Table 3. Relationship between mucosal phenotype, keratinized tissue width and plaque index, gingival index and bleeding on probing

			Plaque index	Gingival index	Bleeding on probing, n (%)	
					No	Yes
Keratinized tissue width	≥2 mm	Min-max	0-3	0-3		
		Mean ± SD (median)	0.63±0.68 (1)	0.64±0.88 (0)	325 (65.5%)	171 (34.5%)
	<2 mm	Min-max	0-3	0-2		
		Mean ± SD (median)	0.58±0.69 (0)	0.69±0.87 (0)	94 (63.1%)	55 (36.9%)
		p-value	[1]0.432	[1]0.416	[2]0.585	
Mucosal phenotype	Thick	Min-max	0-3	0-3		
		Mean ± SD (median)	0.60±0.67 (1)	0.64±0.88 (0)	314 (65.6%)	165 (34.4%)
	Thin	Min-max	0-3	0-2		
		Mean ± SD (median)	0.66±0.71 (1)	0.69±0.86 (0)	105 (63.3%)	61 (36.7%)
		p-value	[1]0.455	[1]0.381	[2]0.592	

[1]Mann-Whitney U test, [2]Chi-square test, SD: Standard deviation, min-max: Minimum-maximum

amount of KM to protect the peri-implant soft tissue health. Therefore, in patients with good oral hygiene, it can be said that the soft tissue around the implant may be clinically healthy even when there is no keratinized tissue.

Studies have reported that soft tissue recession is common in implant-supported prostheses (14). In particular, the stability of the marginal mucosa of the implant restoration in the maxillary anterior region is important in determining the aesthetics. In most clinical studies, it has been shown that the amount of MR increased significantly in implant sites with narrow keratinized mucosa (2,5-7). However, in the study by Bengazi et al. (9), it was found that the lack of keratinized mucosa did not significantly affect the amount of marginal soft-tissue recession. In addition to KM width, soft-tissue phenotype affects the marginal mucosal level of implants. In a study evaluating the effect of peri-implant MP on periodontal parameters around the dental implant, it was reported that MR was twice as high in peri-implant regions with thin phenotype compared to peri-implant regions with the thick phenotype (6). Similar observations have been previously shown around teeth. Similar to the previous study, in our study, significantly higher CAL and MR were observed in areas where peri-implant MP was thin. Based on these findings, it is seen that insufficient keratinized mucosa in the peri-implant sites increases the amount of CAL and MR. Therefore, it is important to provide sufficient KM width and thickness in the peri-implant soft tissue in the aesthetic zone.

To our knowledge, there is only one study evaluating the relationship between peri-implant MF and CAL. In this study by Zigdon and Machtei (6), they reported that they found statistically significantly higher CAL scores in the peri-implant regions with thin MP. Mericske-Stern et al. (15) found significantly higher CAL scores in lingual peri-implant sites with narrow KM. However, they showed that the amount of peri-implant KM in the buccal region did not affect the CAL level. In our study, statistically significantly higher CAL scores were found in peri-implant regions with a KM width of <2 mm and a thin MP. In terms of this finding, the results of our study and the study by Zigdon and Machtei (6) are similar. However, the methods used in the determination of peri-implant MP in the study by Zigdon and Machtei (6) and our study are different. Zigdon and Machtei (6) used the camera to calculate the distance measured with a 27G needle while determining the MP in the buccal peri-implant region. In our study, the probe method was used to determine peri-implant MP.

In our study, 5 implants with 4 different surface properties were used. These are Straumann (Waldenburg, Switzerland) and Zinedent (Batı Group and Instradent, Turkey) roughened with sandblasted and large grit acid etched (SLA), Astra Tech (Astra Tech AB, Mölndal, Switzerland) roughened with fluorine modified, Nobel (Branemark, Sweden) roughened by anodization and MIS (MIS Implants Technologies Ltd, Shlomi, Israel) roughened with airborne-particle abraded-and-etched. As a result of a study, it has been shown that implant surface properties and design affect peri-implant soft tissue health and marginal bone level (7). Polizzi et al. (16) compared bone loss rates between minimally rough implants and moderately rough implants. They found no statistical difference in bone loss between the two surfaces. John et al. (17) investigated the initial biofilm formation on four titanium discs with different surface properties or chemical modifications. Samples were evaluated 48 hours after intraoral contact. It was concluded that discs with a machined surface showed slower biofilm formation and slower plaque maturation than a rough SLA surface. On the other hand, five-year clinical follow-up of partially roughened surfaces did not show an increased risk of peri-implantitis (18). However, studies investigating the effect of implant surface on peri-implantitis are limited and contradictory. While some studies have found a positive association between smooth surface and peri-implant health (19), some studies have found no correlation between the type of implant surface and marginal bone loss (20). Therefore, we think that direct comparisons should be made in order to determine the effect of the implant surface on the peri-implant tissues. Many factors such as previous periodontitis history, diabetes and smoking affect peri-implant soft tissue health.

Various methods have also been used in studies to determine peri-implant MP (14,21,22). Although none of these methods are seen as the gold standard today, each method has its advantages and disadvantages Gharpure et al. (21) used 12 color-coded probes to determine peri-implant MP. Peri-implant MP was categorized as thin and thick according to the visibility of the probe from the mucosa. In one study, an endodontic reamer was used to measure soft tissue thickness in the buccal region of implant-supported restorations (22). The endodontic reamer with a rubber stopper was inserted perpendicular to the gingiva until its contact with the alveolar bone was felt. Peri-implant mucosa thickness was determined by measuring the distance between the tip of the endodontic reamer and the rubber stopper with a caliper. Cardaropoli et al. (14) used a calibrated ultrasonic device to determine peri-implant mucosal thickness. The disadvantages of transgingival probing and endodontic reamer methods are that they are invasive procedures and require anesthesia. In addition, it is recommended to wait 20 minutes after the application of anesthesia in the transgingival probing method. In addition, it has been shown that reliable results are obtained with the probing method (10). De Rouck et al. (10) reported that the probe method is simple and reproducible. In our study, we preferred to use the probe method, which is a reliable and minimally invasive method that does not require the use of anesthesia, reproducible results can be obtained, in determining the phenotype. In addition, another advantage of my use of the probe method is that the required equipment is inexpensive.

In our study, the rate of the health of peri-implant areas restored with overdenture was found to be significantly

lower than those of peri-implant areas restored with a single crown and crown bridge. According to the results of a review, it was reported that the mean marginal bone loss in the mandible was 0.9 mm 10 years after rehabilitation of implants with a fixed prosthetic and 1.2 mm after 15 years (23). Another study found that the mean bone loss after 12 years was 1.7 mm around implants treated with overdentures in the mandible (24). These findings indicate that more bone loss occurs in implants treated with overdenture in the long term. It is known that overdenture restorations are preferred in completely edentulous advanced age group patients. In addition, studies have reported that the possibility of peri-implantitis is higher in patients older than 65 years of age (25). These results can be explained by the decrease in tooth brushing cooperation of patients due to aging. It is seen that the probability of developing the peri-implant disease is high with advancing age. Therefore, it is important to apply supportive periodontal and peri-implant treatment to patients in the advanced age group.

This study had some important limitations. The amount of peri-implant MR is affected by various factors such as KM width and thickness, crestal bone level, depth of the implant platform and buccal position of the implant. In our study, only the effect of peri-implant KM width and thickness on the marginal mucosal level was evaluated. The effect of the oral hygiene habits of the patients on the peri-implant tissues was not evaluated.

Conclusion

Within the limits of our study, it was found that KM width and thickness around the implant are not necessary for soft tissue health in patients who can provide plaque control. However, to reduce the risk of developing the peri-implant disease in patients who cannot provide adequate plaque control, the amount of keratinized soft tissue should be evaluated during implant planning.

Ethics

Ethics Committee Approval: Approval was obtained from the İnönü University Scientific Research and Publication Ethics Committee for this study (protocol number: 2020/844, date: 14.07.2020).

Informed Consent: Written and verbal information about the purpose and method of the study were given to all patients, the information forms were read and consent forms were signed by the patients.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: E.B., M.Ö.U., Concept: M.Ö.U., Design: M.Ö.U., Data Collection or Processing: E.B., Analysis or Interpretation: E.B., Literature Search: E.B., Writing: E.B., M.Ö.U.

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References

1. Lang NP, Löe H. The relationship between the width of keratinized gingiva and gingival health. J Periodontol 1972; 43: 623-7.
2. Adibrad M, Shahabuei M, Sahabi M. Significance of the width of keratinized mucosa on the health status of the supporting tissue around implants supporting overdentures. J Oral Implantol 2009; 35: 232-7.
3. Costa FO, Takenaka-Martinez S, Cota LO, Ferreira SD, Silva GL, Costa JE. Peri-implant disease in subjects with and without preventive maintenance: a 5-year follow-up. J Clin Periodontol 2012; 39: 173-81.
4. Ueno D, Nagano T, Watanabe T, Shirakawa S, Yashima A, Gomi K. Effect of the Keratinized Mucosa Width on the Health Status of Periimplant and Contralateral Periodontal Tissues: A Cross-sectional Study. Implant Dent 2016; 25: 796-801.
5. Schrott AR, Jimenez M, Hwang JW, Fiorellini J, Weber HP. Five-year evaluation of the influence of keratinized mucosa on peri-implant soft-tissue health and stability around implants supporting full-arch mandibular fixed prostheses. Clin Oral Implants Res 2009; 20: 1170-7.
6. Zigdon H, Machtei EE. The dimensions of keratinized mucosa around implants affect clinical and immunological parameters. Clin Oral Implants Res 2008; 19: 387-92.
7. Kim BS, Kim YK, Yun PY, Yi YJ, Lee HJ, Kim SG, et al. Evaluation of peri-implant tissue response according to the presence of keratinized mucosa. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2009; 107: e24-8.
8. Heckmann SM, Karl M, Wichmann MG, Winter W, Graef F, Taylor TD. Cement fixation and screw retention: parameters of passive fit. An in vitro study of three-unit implant-supported fixed partial dentures. Clin Oral Implants Res 2004; 15: 466-73.
9. Bengazi F, Wennström JL, Lekholm U. Recession of the soft tissue margin at oral implants. A 2-year longitudinal prospective study. Clin Oral Implants Res 1996; 7: 303-10.
10. De Rouck T, Eghbali R, Collys K, De Bruyn H, Cosyn J. The gingival biotype revisited: transparency of the periodontal probe through the gingival margin as a method to discriminate thin from thick gingiva. J Clin Periodontol 2009; 36: 428-33.
11. Caton JG, Armitage G, Berglundh T, Chapple ILC, Jepsen S, Kornman KS, et al. A new classification scheme for periodontal and peri-implant diseases and conditions - Introduction and key changes from the 1999 classification. J Periodontol 2018; 89 Suppl 1: S1-8.
12. Boynueğri D, Nemli SK, Kasko YA. Significance of keratinized mucosa around dental implants: a prospective comparative study. Clin Oral Implants Res 2013; 24: 928-33.
13. Buyukozdemir Askin S, Berker E, Akincibay H, Uysal S, Erman B, Tezcan İ, et al. Necessity of keratinized tissues for dental implants: a clinical, immunological, and radiographic study. Clin Implant Dent Relat Res 2015; 17: 1-12.
14. Cardaropoli G, Lekholm U, Wennström JL. Tissue alterations at implant-supported single-tooth replacements: a 1-year prospective clinical study. Clin Oral Implants Res 2006; 17: 165-71.

15. Mericske-Stern R, Steinlin Schaffner T, Marti P, Geering AH. Peri-implant mucosal aspects of ITI implants supporting overdentures. A five-year longitudinal study. Clin Oral Implants Res 1994; 5: 9-18.

16. Polizzi G, Gualini F, Friberg B. A two-center retrospective analysis of long-term clinical and radiologic data of TiUnite and turned implants placed in the same mouth. Int J Prosthodont 2013; 26: 350-8.

17. John G, Becker J, Schwarz F. Modified implant surface with slower and less initial biofilm formation. Clin Implant Dent Relat Res 2015; 17: 461-8.

18. Palmer RM, Palmer PJ, Smith BJ. A 5-year prospective study of Astra single tooth implants. Clin Oral Implants Res 2000; 11: 179-82.

19. Esposito M, Ardebili Y, Worthington HV. Interventions for replacing missing teeth: different types of dental implants. Cochrane Database Syst Rev 2014: CD003815.

20. Wennström JL, Ekestubbe A, Gröndahl K, Karlsson S, Lindhe J. Oral rehabilitation with implant-supported fixed partial dentures in periodontitis-susceptible subjects. A 5-year prospective study. J Clin Periodontol 2004; 31: 713-24.

21. Gharpure AS, Latimer JM, Aljofi FE, Kahng JH, Daubert DM. Role of thin gingival phenotype and inadequate keratinized mucosa width (<2 mm) as risk indicators for peri-implantitis and peri-implant mucositis. J Periodontol 2021; 92: 1687-96.

22. Migliorati M, Amorfini L, Signori A, Biavati AS, Benedicenti S. Clinical and Aesthetic Outcome with Post-Extractive Implants with or without Soft Tissue Augmentation: A 2-Year Randomized Clinical Trial. Clin Implant Dent Relat Res 2015; 17: 983-95.

23. Goodacre CJ, Bernal G, Rungcharassaeng K, Kan JY. Clinical complications with implants and implant prostheses. J Prosthet Dent 2003; 90: 121-32.

24. van Steenberghe D, Quirynen M, Naert I, Maffei G, Jacobs R. Marginal bone loss around implants retaining hinging mandibular overdentures, at 4-, 8- and 12-years follow-up. J Clin Periodontol 2001; 28: 628-33.

25. Marrone A, Lasserre J, Bercy P, Brecx MC. Prevalence and risk factors for peri-implant disease in Belgian adults. Clin Oral Implants Res 2013; 24: 934-40.