

Research Article

Significance of Width of Keratinized Mucosa on Peri-Implant Tissue Health: A Cross-Sectional Study

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Abstract

Objective: Impact of the width of keratinized mucosa on peri-implant health is controversial. Thus, the aim of this study is to determine the impact of the width of keratinized mucosa on the health status of the peri-implant tissue.

Methods: Thirty-nine patients with one hundred fifty-seven dental implants with loading time ranged between 1 to 9 years were recruited. Clinical examinations included plaque index (PI), bleeding on probing (BOP), probing pocket depth (PPD), the width of keratinized mucosa (WKM), buccal mucosal recession (MR) and radiographic bone loss (RBL). Statistical analysis was accomplished with bivariate Pearson correlation test and chi-square test. The result was considered statistically significant when the p-value was ≤ 0.05 .

Results: The mean PI, BOP, MR and RBL were significantly higher for those dental implants with < 2 mm keratinized mucosa compared to those with more than 2 mm WKM. While there was no significant relation between PPD and WKM, statistically significant association between WKM and PI, BOP and MR were found, whereas, no significant relations were detected between WKM and PPD and RBL.

Conclusions: A significant association between WKM and peri-implant tissue health was found. Dental implants with a sufficient WKM > 2 mm facilitate better oral hygiene measures and better peri-implant health. The augmentation of mucosal tissue for those dental implants with insufficient WKM can provide better prognosis and may extend the life expectancy of the implant.

Keywords: *Width of keratinized mucosa, Peri-implant health.*

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Introduction

Today, dental implant is the most favorable and accepted treatment for replacing missing teeth; it provides functional and esthetic demand of patients. Adequate health and esthetic of peri-implant tissue are essential criteria for successful dental implant⁽¹⁾. A successful dental implant is the one with stability and immobility of the implant within the jaw, lack of radiographic evidence of bone loss, presence of sufficient zone of keratinized and attached mucosa around the implant⁽²⁾.

In natural dentition, free and attached gingiva form the keratinized gingiva that extends from the gingival margin to the mucogingival junction⁽³⁾. Teeth with at least 2 mm of keratinized gingiva (1 mm being attached) compared with teeth with less than 2 mm keratinized gingiva have better periodontal health as found by Lang and Loe 1972⁽⁴⁾. For the maintenance of gingival health around the natural teeth and to impede the progression of periodontal disease, the presence of an adequate zone of attached gingiva was considered important for natural dentitions⁽⁵⁾.

A study reported that subgingival plaque formation was shown to be facilitated by an inadequate zone of attached gingiva, which results from mobile gingival margin of improperly closed pocket⁽⁵⁾. Moreover, another study showed that teeth with the subgingival restoration with a narrow zone of keratinized gingiva have a higher chance of gingival inflammation; this is important because implant-supported restoration locates beneath oral mucosa⁽⁶⁾.

A similar debate also presents on the importance of the amount of keratinized mucosa around the implant. The keratinized mucosa around an implant is firmly bonded to the underlying bone and provides a functional barrier between the oral environment and osseointegrated dental implants^(1,7). There are differences in anatomy and soft tissue around teeth such as the attached mucosa adheres to the dental implant titanium using hemidesmosomes, there are not root cementum and periodontal ligament, this makes the mechanical quality of this attachment that surrounds the implant to be weaker than in natural dentition^(8,9). That is why more tissue destruction around dental implants are happening than around natural teeth when induced by ligatures⁽¹⁰⁾.

Important of the WKM around the dental implant is still controversial. Many studies reported that the health of peri-implant tissue could be maintained regardless of the presence or absence of keratinized mucosa, providing that the patient can have good plaque control measures^(11,12). On the other hand, others found a relation between the survival of an implant and WKM⁽⁵⁾. Studies

showed significantly higher PI^(5,13,14) and gingival index^(13,15) of peri-implant soft tissues of narrow keratinized mucosa, furthermore, shallower PPD at implants with ≥ 2 mm WKM were reported^(1,13). Maintaining good oral hygiene around dental implant is difficult to be achieved without the presence of a band of keratinized mucosal tissue⁽¹⁵⁾. Therefore, the presence of a layer of keratinized mucosa is essential for maintaining good oral hygiene and preserving the health of peri-implant tissue. Different measures and treatment procedures should be considered for long-term health maintenance of dental implants, including specific oral hygiene instruction, widening of keratinized tissue by increasing vestibular depth⁽¹⁶⁾. However, if the relation was not found, those surgical procedures may cause discomfort and challenge for the patient. Therefore, the purpose of this study is to determine the importance of WKM in peri-implant tissue health.

Patients and methods

Patient's recruitment

This study was approved by the Research Ethics Committee of the Kurdistan Board for medical specialties (number: 645). Participants were recruited from patients attended Shorish Dental Teaching Hospital for periodic checkup of their dental implants between April and October 2018. Inclusion criteria: patients over 20 years, with at least one loaded dental implant for a period not less than one year, no history of any systemic diseases or received any antibiotic for at least six weeks before or any other medications that might interfere with the outcome of this study. Exclusion criteria are smokers and patients had scaling and polishing. Patient information sheet and written consent were provided for subjects that willing to take part in the study.

Clinical evaluation parameters

The following clinical parameters were examined and recorded for all patients recruited for this study by a calibrated examiner:

1. Number and location of the dental implant.
2. Modified plaque index (scored as 0/1)⁽¹⁷⁾ for the presence or absence of dental plaque. Clinical parameters were evaluated at distobuccal, midbuccal, and mesiobuccal points by plastic explorer probe walked on the buccal surface of the dental implant.
3. Modified bleeding on probing (scored as 0/1)⁽¹⁷⁾, which performed to assess health or disease status of the sulcular epithelium around the implants by specialized

plastic William's periodontal probe on distobuccal, midbuccal, and mesiobuccal points.

4. PPD determined from marginal gingiva to the base of sulcus using plastic William's periodontal probe on distobuccal, midbuccal, and mesiobuccal points.

5. MR was estimated by measuring the distance from the mid-buccal mucosal margin to the implant abutment interface. The examination was performed using plastic William's periodontal probe⁽¹⁸⁾.

6. WKM measured by a digital Vernier from the mid-buccal mucosal margin to the mucomucosal junction (Figure 1A).

7. RBL was determined on standardized periapical radiograph from the crest of the interseptal bone to the shoulder of the dental implant (Figure 1B).

Statistical analysis

The normality test (Shapiro-Wilk test) for continuous data was performed and the data were then subjected to an appropriate test. The relation between WKM and PI, BOP, MR and RBL were examined by chi-square test. Statistical significance was defined as $p\text{-value} \leq 0.05$ and all calculations were conducted using the SPSS software package (version 21; SPSS Inc., Chicago, IL, USA).

Results

Thirty-nine subjects (24 female, 15 male) with a mean age of 42.5 years (ranged between 20-65 years) were recruited. A total of 157 dental implants with loading time ranged between 1-9 years. A total of (101) implants (65%) were located in the maxilla and (56) implants (35%) in the mandible. Fifty-seven dental implants were in premolars area, 57 in molars area, 21 in the canine area and 22 in incisors area.

The WKM varied between 0 to 7 mm, from those 157 dental implants 99 implants were found to have ≥ 2 mm keratinized mucosa (63%), whereas 58 implants with < 2 mm keratinized mucosa (37%). All the clinical parameters (PI, BOP, MR and RBL) were significantly higher in dental implants with less than 2 mm keratinized gingiva.

Plaque index was positive in 92 dental implants (59%) in which 56 of them were associated with less than 2 mm WKM (Table 1). Bleeding on probing were observed on 66 dental implants (42%) in which 41 of them were associated with less than 2 mm keratinized mucosa (Table 2). The mucosal recession was associated with 41 (26%) dental implants in which 35 of them were associated with less than 2 mm keratinized mucosa (Table 3). Furthermore, 46 dental implants (29%) experienced bone loss of more than 1 mm, in which 24 of them were associated with less than 2 mm keratinized mucosa (Table 4). Probing pocket depth ≥ 4 mm were found in 8 dental implants (5%) in which 2 of them were associated with less than 2 mm keratinized mucosa (Table 5).

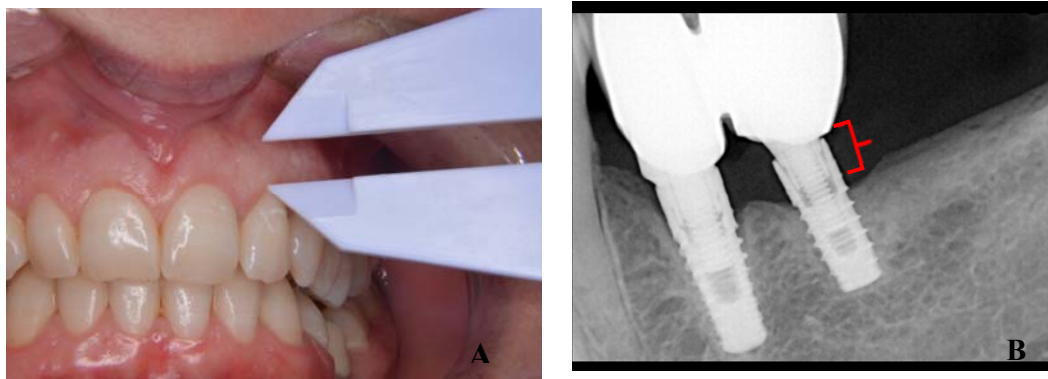


Figure 1: **A**, WKM measured by digital Vernier, **B**, RBL measures on radiograph.

Table 1: Relation between WKM and PI.

WKM		PI				Total
		No plaque	Mild plaque *	Moderate plaque **	Sever plaque ***	
	0	1	3	9	16	29
	1	1	4	11	13	29
	2	19	2	3	4	28
	3	15	9	1	1	26
	4	15	7	0	1	23
	5	9	3	0	0	12
	6	3	4	0	0	7
	7	2	1	0	0	3
Total		65	33	24	35	157
p-value		0.001				

*Mild plaque= plaque accumulation on one side of mesial, mid buccal or distal side. **Moderate plaque= plaque accumulation on two sides of mesial, mid buccal and/or distal side. ***Sever plaque= plaque accumulation on mesial, mid buccal and distal sides.

Table 2: Relation between WKM and BOP.

WKM		BOP				Total
		No bleeding	Mild bleeding *	Moderate bleeding **	Sever bleeding ***	
	0	8	3	6	12	29
	1	9	4	6	10	29
	2	15	4	3	6	28
	3	9	13	3	1	26
	4	12	9	1	1	23
	5	6	5	0	1	12
	6	5	2	0	0	7
	7	2	1	0	0	3
Total		66	41	19	31	157
p-value		0.001				

*Mild bleeding= bleeding on probing one side of the mesial, mid buccal or distal side. **Moderate bleeding= bleeding on probing on two sides of mesial, mid buccal and distal side. ***Sever bleeding= bleeding on probing on mesial, mid buccal and distal sides.

Table 3: Relation between WKM and MR.

WKM		MR					Total
		0	1	2	3	4	
	0	9	7	9	4	0	29
	1	14	8	4	1	2	29
	2	28	0	0	0	0	28
	3	21	5	0	0	0	26
	4	22	1	0	0	0	23
	5	12	0	0	0	0	12
	6	7	0	0	0	0	7
	7	3	0	0	0	0	3
Total		116	21	13	5	2	157
p-value		0.001					

Table 4: Relation between WKM and RBL.

WKM		RBL											Total
		0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	6	
	0	8	1	7	2	0	4	4	0	1	2	0	29
	1	14	0	4	0	1	3	1	2	2	0	2	29
	2	25	0	0	0	1	1	0	1	0	0	0	28
	3	17	0	3	2	0	1	0	1	1	0	1	26
	4	13	0	2	2	3	1	2	0	0	0	0	23
	5	8	0	1	0	0	0	1	2	0	0	0	12
	6	5	0	0	0	0	1	0	0	1	0	0	7
	7	3	0	0	0	0	0	0	0	0	0	0	3
Total		93	1	17	6	5	11	8	6	5	2	3	157
p-value		0.01											

Table 5: Relation between WKM and PPD.

WKM	PPD		Total
	Healthy	Unhealthy	
0	29	0	29
1	27	2	29
2	28	0	28
3	25	1	26
4	23	0	23
5	11	1	12
6	6	1	7
7	3	0	3
Total	152	5	157
p-value	0.34		

Discussion

In natural dentition, adequate width of keratinized gingiva has shown to be valuable to maintain the gingival health and prevent loss of periodontal attachment. Lang and Loe (1972)⁽⁸⁾ reported that 80% of teeth with more than 2mm WKM are healthy, whereas those with < 2mm WKM showed various degree of inflammation. Moreover, Tenenbaum (1982)⁽¹⁹⁾ stated that there is a correlation between gingival recession and width of attached gingiva. Stetler and Bissada (1987) studied the difference in response of gingiva to restoration; they found higher gingival inflammation score in teeth with narrow keratinized gingiva. Thus, it is recommended that it would be better to augment or increase keratinized tissue when subgingival restoration

margin to be placed on teeth with insufficient keratinized gingiva or when plaque control cannot be optimally performed⁽⁶⁾.

The same concept has been applied to peri-implant keratinized tissue; numerous studies were conducted to determine the effect of the width of WKM on peri-implant health status, some showed a correlation between them, while others reported no relation^(1,7,13,20,21). The current study revealed that the presence of adequate WKM might be beneficial in decreasing plaque accumulation, tissue inflammation, gingival recession and loss of alveolar bone. This study showed that implants with narrow zones of keratinized gingiva ≤ 2 mm had more plaque score than those with wider zones of keratinized gingiva > 2 mm (p-value <

0.001) (Table 1). Other studies support our findings that the absence of adequate WKM interfere with plaque control, this may be due to inadequate room for insertion and manipulation of the brush, pain from the brush, facilitating impression taking, dissipating muscular and frenal pull, movability of peri-implant soft tissue that facilitate introduction of microorganisms and/or inadequate protection from mechanical trauma during tooth brushing^(5,7,12,13,16,21-23). On the other hand, other studies reported that there was no significant difference in PI with the presence or absence of keratinized mucosa and they showed no relation between oral hygiene maintenance and movability of peri-implant soft tissue or resistance of keratinized mucosa to mechanical trauma from brushing^(14,20,24-26).

Also, this study showed that implants surrounded by ≤ 2 mm keratinized gingiva have an increased amount of BOP (p-value < 0.001) (Table 2). Which indicates active inflammation in the soft tissue around dental implants and this might result in subsequent attachment loss and bone loss, then leading to failure of the implant. The orientation of collagen fibers around dental implants is vertical rather than horizontal and not engaged to the results of the implant in less resistance on probing. This makes the tissue to be more fragile and leads to local tissue trauma and some bleeding, even in clinically healthy peri-implant. This finding is in supported by the meta-analyses from systematic reviews^(21,27) and by other studies^(5,13,14,21-23).

Mucosal recession around the dental implant is of great value, especially in the anterior maxilla. However, the studies reported that soft-tissue recession at dental -implants was commonly found⁽²⁸⁻³⁰⁾. Crestal bone level, depth of the implant, the soft tissue biotype, and buccal position of the implant are some other factors that affect the level of mucosal margin^(25,31) (Table 3). Our data showed MR increased at dental-implant with narrow WKM and this result is in line with other studies^(5,16,20,25). On the other hand, a study showed lack of keratinized gingiva did not significantly affect the marginal tissue recession⁽²⁸⁾.

The long-term outcome and stability of the dental implant mainly depend on the peri-implant bone level. A study reported that the mean bone loss around the dental implant for the first year was 1.5 mm, followed by 0.1 mm annually⁽¹¹⁾. Whereas, another study reported that dental implant is considered successful with 0.2 mm bone loss annually after first year loading⁽³²⁾. In the present study, amount of bone loss was statistically higher around implants with a narrow width of keratinized mucosa (p-value < 0.1) (Table 4) and our result were consistent with studies investigated the relation between the amount of WKM and bone loss around dental implants^(20,22,33-35). On the other hand,

some other studies found no significant relation between the amount of RBL and WKM^(5,7).

Finally, no statistically significant correlation was found between peri-implant PPD and WKM as other studies also suggested this relation^(5,7,20,21,36) (Table 5). However, another study reported that dental implants with wider keratinized mucosa are presented with higher probing depth⁽²⁵⁾. These controversies in the results of published studies to determine a relation between WKM and other clinical and radiographic parameters require conducting longitudinal studies.

It is important to acknowledge that the current study conducted on relatively a small group of patients with various socioeconomic and educational level. These patients received a different level of postoperative instructions for plaque control and how to maintain their implants. Therefore, longitudinal studies with larger sample size and more objective standardization such as post-implant insertion instruction are necessary to determine the exact impact of WKM on peri-implant health.

Conclusion

Within the limitation of the study, a significant association between the WKM and the health of the peri-implant tissues was found. The outcomes of this study verify that narrow keratinized gingiva around dental implants significantly associated with higher plaque accumulation, bleeding on probing, gingival recession and marginal bone loss.

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