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Review Article

Significance of the width of keratinized mucosa on peri-implant health

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Abstract

In implant therapy, the adequate state of peri-implant tissue health and soft-tissue aesthetics is the essential criterion of restorative success. The need for keratinized mucosa for the maintenance of peri-implant health and soft-tissue integration remains a debated issue. The aim of this paper is to provide a narrative review of the current literature concerning the significance of keratinized mucosa with respect to the clinical parameters of monitoring oral hygiene practice and tissue status. The published studies revealed that there were conflicting results with regard to the influence of keratinized mucosa on plaque score and soft-tissue inflammation. Most studies showed that the amount of soft-tissue recession was significantly increased at implant sites with narrow keratinized mucosa, but the amount of keratinized mucosa had little effect on deepening of peri-implant pockets. The evidence related to the effect of keratinized mucosa on the changes of attachment or bone levels is limited, and conclusions could not be drawn at present. Further, this review found that a band of keratinized mucosa was not absolutely necessary for the maintenance of peri-implant tissue, whereas lack of adequate keratinized mucosa around the implant might impede proper oral hygiene performance and compromise the aesthetic results. In conclusion, because there is a wide variety of clinical features in patients pursuing implant therapy, individual consideration of treatment strategies for the patient with minimal keratinized mucosa is recommended.

Keywords: clinical parameters; dental implants; keratinized mucosa; peri-implant soft tissue

1. Introduction

The peri-implant keratinized mucosa is firmly bound to the underlying bone and constitutes a functional barrier between the oral environment and underlying dental implants. However, after teeth are extracted, the resorption of surrounding bone and keratinized gingiva occurs, which may result in deficiency of keratinized mucosa during subsequent implant placement.

The need for keratinized mucosa around dental implants has been widely discussed. During the early development of endosseous dental implants, the establishment of a dense connective tissue around the implant collar for long-term implant stability was repeatedly addressed.[1–3] Nevertheless, a number of subsequent studies showed that implants had a high survival rate irrespective of the presence or absence of keratinized mucosa.[4–6] Nowadays, in addition to achieving high implant survival following implant therapy, maintenance of functionally loaded implants in an adequate status of health and aesthetics had become a prerequisite for long-term success of implant restoration. The need for keratinized tissue around the dental implant to maintain health and tissue stability is therefore becoming of increasing concern.

In the beginning years of implant dentistry, few comparative studies investigated the relationship between the width of keratinized mucosa and the health of peri-implant tissues. In

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animal studies, it was found that deficiency of keratinized mucosa around ligated implants in monkeys demonstrated more soft-tissue recession, greater loss of attachment,[7] and increased depth of angular bony defect.[8] Nevertheless, Strub et al[9] reported no significant differences in peri-implant soft-tissue recession or bone loss between sites with narrow or wide keratinized mucosa following plaque-induced breakdown in dogs. Among recent clinical studies, the number of works focusing on peri-implant keratinized tissues has dramatically increased. However, the need for keratinized mucosa for maintaining the stability of peri-implant tissues was controversially illustrated. The aim of this review was to summarize these clinical findings and assess the current evidence regarding the role of keratinized mucosa in maintenance of dental implants.

2. Influence of keratinized mucosa on oral hygiene practice

Good oral hygiene is believed to be an important factor in maintaining peri-implant health and reducing the risk of peri-implant disease.[10–12] Several studies showed that plaque accumulation was higher around implants with keratinized mucosa measuring <2 mm.[13–16] However, some other studies revealed there was no significant difference in plaque score with the presence or absence of keratinized mucosa and indicated that the width of masticatory mucosa and movability of the peri-implant soft tissue were not essential for the plaque control (Table 1).[17–21]

It is difficult to simply draw a conclusion about whether lack of keratinized mucosa is detrimental to plaque removal, because other factors, such as implant position, implant surface texture, prosthesis design, and patients' dental hygiene skills may influence the effectiveness of plaque control. When implants are surrounded by alveolar mucosa, the lining mucosa with a movable soft-tissue border may impede proper oral hygiene performance, especially in sites with severe bone and soft-tissue resorption or in areas with difficult access for oral hygiene. One long-term study demonstrated that in patients receiving regular maintenance for an implant-supported fixed prosthesis, the width of keratinized mucosa had no effect on plaque accumulation on buccal sites, but significantly higher plaque accumulation was noted in implants on lingual sites where the width of keratinized mucosa was <2 mm.[22] In addition, Buyukozdemir Askin et al[23] found that implant sites with narrow keratinized mucosa (≤2 mm) had higher plaque score than did sites with wide keratinized mucosa (>2 mm), and they showed that the group with narrow keratinized mucosa had significant improvement of plaque index after gingival grafting procedure. These studies indicated that the presence of keratinized mucosa is not absolutely necessary for plaque control of the implant, but the existence of a band of keratinized mucosa provides a favorable environment to perform daily oral hygiene, which is advantageous for the patients with reduced manual dexterity.

3. Influence of keratinized mucosa on soft-tissue status

Peri-implant soft-tissue inflammation, marginal tissue recession, probing depth, and attachment level are the clinical parameters commonly used for monitoring soft-tissue status of dental implants.[24] The clinical signs of bleeding on probing, mucosal recession, increasing probing depth, and loss of attachment level are always present with peri-implant disease.[12]

Table 1
Plaque index at implant sites with varying widths of keratinized mucosa.

Study	Year	Follow-up period	No. of patients/implants	PI		
				KMW ≥2 mm		KMW <2 mm
Chung et al[13]	2006	8 y	69/339	1.3		1.5* ($p < 0.05$)
Bouri et al[14]	2008	4.5 y	76/200	1.3		1.8* ($p < 0.001$)
Adibrad et al[15]	2009	2 y	27/66	1.2		1.9* ($p = 0.02$)
Mericske-Stern et al[19]	1994	5 y	33/64	B	0.4	0.5
				L	0.7	0.5
Schrott et al[22]	2009	5 y	58/307	B	0.3	0.2
				L	0.4	0.7* ($p = 0.001$)
Kim et al[18]	2009	1 y	100/276	0.7		0.7
				KMW ≥2 mm		KMW ≤1 mm
Mericske-Stern[20]	1990	6–66 mo	62/137	B	0.6	0.6
				L	0.8	1.1
				KMW >1 mm		KMW ≤1 mm
Zigdon and Machtei[21]	2008	3 y	32/63	Insignificant correlation		
				KM presence		KM absence
Boynueğri et al[16]	2013	1 y	15/36	0.3		0.6* ($p < 0.05$)
Krekeler et al[17]	1985	1.7 y	26/98	PI: 0	8%	13%
				PI: 1	20%	19%
				PI: 2 and 3	72%	68%

B = buccal; KM = keratinized mucosa; KMW = keratinized mucosa width; L = lingual; PI = plaque index.
* Statistically significant difference.

The associations between the width of keratinized mucosa and these clinical parameters have been addressed as follows.

3.1. Soft-tissue inflammation

Soft-tissue redness, swelling, and bleeding are regarded as signs of peri-implant inflammation.[12] Qualitative change of soft tissue, gingival index (GI), bleeding index (BI), or bleeding on probing were used to determine the status of soft-tissue inflammation. Several clinical studies[13–16] reported higher scores of GI in implants with narrow keratinized mucosa (<2 mm). Furthermore, some investigations[14,15] revealed that implant sites with narrow keratinized mucosa (<2 mm) had a significantly higher chance of bleeding than did sites with wide keratinized mucosa (≥2 mm). However, other studies showed that the width of keratinized mucosa around implants had no impact on GI[18,21,25] or bleeding tendency of mucosa[13,16,17,19–21,25] (Table 2).

The findings of those studies regarding the effect of the width of keratinized mucosa on soft-tissue inflammation are controversial, and impaired oral hygiene may play a role in the manifestation of mucosal inflammation around implants with minimal keratinized tissue. Several authors reported that significant elevation of GI and BI scores was accompanied by compromised plaque control at sites with narrow keratinized mucosa.[13–16] In cases with comparable plaque scores between the sites with narrow and wide keratinized mucosa, negligible difference of GI or BI score between both groups was noted.[18,19,21] These results demonstrated that the amount of keratinized mucosa has little influence on soft-tissue inflammation in the presence of good oral hygiene. However, suboptimal oral hygiene due to difficulty in access for plaque control in the areas of minimal keratinized mucosa may lead to greater tissue damage. For the maintenance of soft-tissue health of dental implants, the capability to access oral hygiene at implant sites is more important than the width of keratinized mucosa.

3.2. Soft-tissue recession

The dimensional change of peri-implant soft tissue is a matter of great concern for implant therapies. Especially in the maxillary anterior zone, marginal mucosa stability strongly determines the aesthetic outcome of implant restoration. However, it is worth noting that soft-tissue recession at implant-supported prosthesis was commonly reported,[26–30] and whether the width of keratinized mucosa had effects on soft-tissue recession at implants is still under debate. Most clinical studies[15,18,21,22] showed that the amount of recession was significantly increased at implant sites with narrow keratinized mucosa, and Bengazi et al[28] reported that lack of keratinized mucosa did not significantly affect the amount of marginal tissue recession (Table 3).

In addition to the width of keratinized mucosa, the soft-tissue biotype, crestal bone level, depth of implant platform, and buccal position of implant were proved to influence the marginal mucosal level of implants.[21,31] Consequently, the soft-tissue recession around dental implant could not be interpreted independently with respect to the width of keratinized mucosa.

3.3. Probing depth and attachment level

It has been postulated that a band of keratinized mucosa, which provides a dense connective tissue collar at the site of

Table 2
Gingival index and bleeding index or bleeding on probing at implant sites with varying widths of keratinized mucosa.

Study	Year	Follow-up period	No. of patients/implants	GI		BI/BOP		
				KMW ≥2 mm	KMW <2 mm	KMW ≥2 mm		KMW <2 mm
Chung et al[13]	2006	8 y	69/339	0.8	0.9* ($p < 0.05$)	BI	0.5	0.4
Bouri et al[14]	2008	4.5 y	76/200	1.3	1.8* ($p < 0.001$)	BOP	71%	89%* ($p < 0.01$)
Adibrad et al[15]	2009	2 y	27/66	1.0	1.7* ($p = 0.01$)	BOP	0.4	0.5* ($p = 0.04$)
Mericske-Stern et al[19]	1994	5 y	33/64			BI	B0.1	0.2
							L0.4	0.2
Wennström et al[25]	1994	5–10 y	39/171	GI: 0	71% 60%	BOP	54%	69%
				GI: 2 and 3	4% 6%			
Kim et al[18]	2009	1 y	100/276	0.4	0.4			
						KMW ≥2 mm		KMW ≤1 mm
Mericske-Stern[20]	1990	6–66 mo	62/137			BI	B 0.6	0.9
							L 0.7	0.8
				KMW >1 mm	KMW ≤1 mm	KMW >1 mm		KMW ≤1 mm
Zigdon and Machtei[21]	2008	3 y	32/63	Insignificant correlation		BOP	Insignificant correlation	
				KM presence	KM absence	KM presence		KM absence
Boynueğri et al[16]	2013	1 y	15/36	0.1	0.6* ($p < 0.05$)	BOP	0.2	0.4
Krekeler et al[17]	1985	1.7 y	26/98			BI: 0	13%	13%
						BI: 1	50%	50%
						BI: 2 and 3	33%	33%

B = buccal; BI = bleeding index; BOP = bleeding on probing; GI = gingival index; KM = keratinized mucosa; KMW = keratinized mucosa width; L = lingual.
* Statistically significant difference.

Table 3
Amount of marginal tissue recession at implant sites with varying widths of keratinized mucosa.

Study	Year	Follow-up period (y)	No. of patients/implants	Marginal tissue recession (mm)	
				KMW ≥ 2 mm	KMW < 2 mm
Adibrad et al[15]	2009	2	27/66	0.55	0.85* ($p = 0.03$)
Kim et al[18]	2009	1	100/276	0.32	0.72* ($p < 0.01$)
Schrott et al[22]	2009	5	58/307	0.08	0.69* ($p < 0.001$)
Bengazi et al[28]	1996	2	40/158	Insignificant correlation	
				KMW > 1 mm	KMW ≤ 1 mm
Zigdon and Machtei[21]	2008	3	32/63	0.27	0.90* ($p = 0.001$)

KMW = keratinized mucosa width.
* Statistically significant difference.

implant penetration, may establish a more efficient sealing of soft tissue around implants.[7,32,33] In addition, the effect of the width of keratinized mucosa on deepening of peri-implant pockets and loss of attachment level has drawn great attention in clinical research.

The majority of studies[13–16,18,19] failed to find an association between keratinized mucosa width and peri-implant probing depth; however, the study by Zigdon and Machtei[21] showed that implants with wider mucosal band presented with higher mean probing depth than those with narrower band of keratinized mucosa (3.1 mm vs. 2.7 mm; Table 4). They considered that shallower probing depth at implants sites with narrow keratinized mucosa might be related to soft-tissue recession. Therefore, less pocket formation may be more common in areas with less keratinized mucosa.[21]

The correlations between the width of keratinized mucosa and attachment level around implants are presented in Table 5. Mericske-Stern et al[19] compared the attachment level between implants with narrow keratinized mucosa (<2 mm) and wide keratinized mucosa (≥2 mm). The results revealed that significantly more loss of attachment was only found at lingual sites with narrow keratinized mucosa, whereas there was no difference at buccal sites. In addition, Zigdon and Machtei[21] and Adibrad et al[15] reported that narrow keratinized mucosa was associated with more loss of attachment. However, the differences in attachment loss between narrow and wide keratinized mucosa were small and could be clinically insignificant.

4. Influence of keratinized mucosa on hard-tissue status

The stability of peri-implant bone level is crucial to long-term outcome of implants (Table 6). Adell et al[34] reported that the mean bone loss for implants was 1.5 mm for the 1st year, followed by a mean bone loss of 0.1 mm annually. Further, Albrektsson et al[35] claimed that the bone loss was <0.2 mm annually after the 1st year of prosthetic loading in successful cases.

The radiographic alveolar bone level for implants with different keratinized mucosa widths was compared in several articles. Studies by Adibrad et al[15] and Chung et al[13] failed to reveal significant difference in crestal bone loss between groups with narrow and wide keratinized mucosa. Conversely, Bouri et al[14] and Kim et al[18] found that the mean bone loss was higher for implants with narrow band of keratinized mucosa.

Caution should be exercised when interpreting the association between bone level and width of keratinized mucosa. The marginal bone level around a dental implant is affected by multiple factors, including patient's smoking habit, implant design, quality and quantity of surrounding soft and hard tissues, surgical procedures, occlusal loading, and patient's

Table 4
Probing depths at implant sites with varying widths of keratinized mucosa.

Study	Year	Follow-up period (y)	No. of patients/implants	Probing depth (mm)		
				KMW ≥ 2 mm		KMW < 2 mm
Mericske-Stern et al[19]	1994	5	33/64	B	2.8	2.5
				L	3.1	2.9
Chung et al[13]	2006	8	69/339		2.9	2.9
Bouri et al[14]	2008	4.5	76/200		3.7	3.9
Adibrad et al[15]	2009	2	27/66		3.0	3.1
Kim et al[18]	2009	1	100/276		2.8	2.6
				KMW > 1 mm		KMW ≤ 1 mm
Zigdon and Machtei[21]	2008	3	32/63		3.1	2.7* ($p = 0.04$)
				KM presence		KM absence
Boynueğri et al[16]	2013	1	15/36		1.9	1.7

B = buccal; KM = keratinized mucosa; KMW = keratinized mucosa width; L = lingual.
* Statistically significant difference.

Table 5
Attachment level at implant sites with varying widths of keratinized mucosa.

Study	Year	Follow-up period (y)	No. of patients/implants	Attachment level (mm)		
				KMW ≥ 2 mm		KMW < 2 mm
Mericske-Stern et al[19]	1994	5	33/64	B	3.3	3.2
				L	3.2	3.7* ($p < 0.05$)
Adibrad et al[15]	2009	2	27/66		3.0	3.2* ($p = 0.04$)
				KMW > 1 mm		KMW ≤ 1 mm
Zigdon and Machtei[21]	2008	3	32/63		2.7	3.3* ($p = 0.019$)

B = buccal; KMW = keratinized mucosa width; L = lingual.
* Statistically significant difference.

Table 6
Marginal bone loss at implant sites with varying widths of keratinized mucosa.

Study	Year	Follow-up period (y)	No. of patients/implants	Marginal bone loss (mm)	
				KMW ≥ 2 mm	KMW < 2 mm
Bouri et al[14]	2008	4.5	76/200	1.24	1.72* ($p < 0.001$)
Kim et al[18]	2009	1	100/276	0.41	0.65* ($p = 0.019$)
Chung et al[13]	2006	8	69/339	0.11	0.11
Adibrad et al[15]	2009	2	27/66	1.12	1.24

KMW = keratinized mucosa width.
* Statistically significant difference.

plaque control status, as well as other diverse factors.[36] It is hard to draw a definitive conclusion regarding the effect of keratinized mucosa on peri-implant bone level because most previously mentioned studies presented the cross-sectional data with a retrospective evaluation. Further prospective longitudinal studies with adjustment of the related confounding variables are needed to clarify this question.

In conclusion, there are conflicting results in the current literature with regard to the significance of keratinized mucosa in peri-implant health. Several studies indicated that a band of keratinized mucosa is not indispensable for the maintenance of peri-implant tissue. However, in clinical situations in which adequate plaque control is not feasible or patients' aesthetic demand is extremely high, the preservation or the reconstruction of keratinized mucosa is beneficial for effective oral hygiene procedures and maintenance of soft-tissue stability around dental implants. There is a great variety of clinical features and treatment needs in implant patients. To achieve long-term stable outcomes for implant therapies, individual consideration of treatment strategies for the patient with minimal keratinized mucosa is recommended.

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