

# SIGNIFICANCE OF THE WIDTH OF KERATINIZED MUCOSA ON THE HEALTH STATUS OF THE SUPPORTING TISSUE AROUND IMPLANTS SUPPORTING OVERDENTURES

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Our objective was to determine the association between keratinized mucosa width and the health status of the supporting tissue around implants supporting overdentures. Sixty-six functioning dental implants were examined. Periodontal parameters measured included gingival index, plaque index, bleeding on probing, probing depth, mucosal recession, periodontal attachment level, radiographic bone level, and width of keratinized mucosa. A negative correlation was found between keratinized mucosa width and mucosal recession and periodontal attachment level. When data were dichotomized by keratinized mucosa width, the mean gingival index score, plaque index score, and bleeding on probing were significantly higher for those implants with a narrow zone (<2 mm) of keratinized mucosa. A wider mucosal band ( $\geq 2$  mm) was associated with less mucosal recession and periodontal attachment loss compared with a narrow (<2 mm) band. The absence of adequate keratinized mucosa around implants supporting overdentures was associated with higher plaque accumulation, gingival inflammation, bleeding on probing, and mucosal recession.

**Key Words:** keratinized mucosa, dental implants, peri-implant tissues, overdenture, periodontal parameters

## INTRODUCTION

Implant-retained overdentures provide an effective treatment modality for edentulous patients and, particularly, for those who have persistent problems with the use of a conventional mandibular denture.<sup>1-6</sup> However, not all implants are successful and some fail as a result of bone loss and inflammatory reactions along the implant-tissue interface. In most cases, failure of

loaded implants is accompanied with a gradual process of breakdown of supporting soft and hard tissues. This process can be observed clinically at an early stage by decreasing health of the peri-implant mucosa.<sup>5</sup> Especially in the maxilla the possibilities for plaque control in patients having implants supporting overdentures are often limited due to an unfavorable implant position or to limitations of the prosthetic design. This may negatively influence the patient's capacity to clean the superstructures and the underlying permucosal portions of the implants. Also, in many cases tooth-brushing is painful for these patients because of the thin buccal mucosa, which is often formed after implant placement procedures.<sup>7</sup>

For many years the presence of an "adequate" zone of gingiva was considered critical for the maintenance of gingival health and prevention of periodontal disease progression. Friedman<sup>8</sup> stated

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that “inadequate” zone of gingiva would facilitate subgingival plaque formation because of improper pocket closure resulting from the movability of the marginal tissue. In an observational study, Lang and Loe<sup>9</sup> suggested a width of at least 2 mm of keratinized mucosa (KM), of which 1 mm was to be attached. However, several studies<sup>10–13</sup> have challenged this concept. Findings reported from controlled clinical trials demonstrated that it is possible to maintain clinically healthy marginal tissue even in areas with less than 1 mm of keratinized tissue.<sup>14</sup> However, it has been reported that in teeth with subgingival restorations a narrow zone of keratinized mucosa is associated with a higher chance of gingival inflammation.<sup>15</sup> Therefore, a wider zone of attached gingiva is needed around teeth that serve as abutments for fixed or removable partial dentures.

The anatomy and soft tissue support around implants is different than that around teeth.<sup>16–20</sup> It has been suggested that the attached mucosa adheres to the surface of the titanium implant by means of hemi-desmosomes.<sup>16</sup> However, no periodontal membrane or root cement is present. Therefore, a direct anchorage of connective tissue to the surface of the implant is not possible and the mechanical quality of this attachment is low.<sup>16–20</sup> This is especially important because the implant-supported restoration is located beneath the oral mucosa. These differences are important to the understanding of the susceptibility of implants to infection. Therefore, the necessity of a zone of keratinized tissue around the dental implants has been suggested. This zone can contribute to a high level of mechanical stability of peri-implant tissue.

The need for keratinized mucosa around endosseous implants is a controversial topic. Comparatively few studies are available examining the relationship between the width of KM and the health of peri-implant tissues. The aim of this study was to evaluate whether the width of the keratinized mucosa around implants supporting overdentures has a positive effect on the health of the surrounding soft and hard tissues.

## MATERIALS AND METHODS

### *Patient sample*

The patients for this study were treated at the Department of Periodontology, Isfahan University of Medical Science. Edentulous patients with maxillary and mandibular implants and overdenture prostheses were eligible if they had participated regularly in a maintenance care program after completion of

implant prosthodontic treatment. Their records and radiographs confirmed that the implants had been clinically successful for the entire time before the measurements took place. The implants served as overdenture anchorage either by means of a connecting bar or single spherical attachments. Patients were excluded from the study if they were: pregnant; used a systemic antibiotic within the past 6 weeks before the study; and had medical conditions that required prophylactic antibiotic coverage or systemic diseases that influenced bone and soft tissue metabolism (such as hyperthyroidism, hyperparathyroidism, and uncontrolled diabetes mellitus). Patients were classified according to smoking history as current smokers, never smokers, or former smokers (if they had quit smoking at least 1 year earlier). The procedures were explained to the patients both verbally and in written form, and were performed after the patient signed a consent form.

### *Clinical examination*

Patient examination and collection of all data were performed blind, by an independent and experienced clinician not involved in the treatment and unaware of group selection. The following data were recorded for each implant:

- Number and anatomic location of the implant.
- Plaque index (modified PI)<sup>21</sup>
- Gingival index (modified GI, defined)<sup>21</sup>
- Bleeding on probing (BOP)—used to examine the health status of the sulcular epithelium (scored as 0/1).
- Probing pocket depth (PPD)—measured in millimeters from the edge of the marginal gingiva and parallel to the long axis of the implant using a plastic periodontal probe with marked distances of 3, 6, and 9 mm. The measurements were performed twice at the mesial, buccal, distal, and palatal side by an experienced clinician using similar probing forces for all patients.
- Mucosal recession (MR)—measured from the mucosal margin to the implant abutment interface.
- Periodontal attachment level (PAL)—calculated by adding mid-buccal PPD to MR.
- Radiographic bone level (RBL)—measured by comparing the periapical radiographs obtained using the paralleling technique at the time of implant placement and with those obtained at the maintenance visit. Bone level was measured from a fixed reference point on the implant to the crestal bone level.
- KM width—measured by means of a calibrated probe. Each measurement was made from the gingival margin to the mucogingival junction. The

TABLE 1  
Descriptive statistics

Age (years)	63.1 ± 6.9 SD
Gender	Male: 12 (44%) Female: 15 (56%)
Arch type	Maxilla: 6 (22%) Mandible: 21 (78%)
Smoking status	Never smoker: 22 (81%) Former smoker: 2 (8%) Current smoker: 3 (11%)
Loading period (months)	25.40 ± 10.28 SD

mucogingival junction was identified by the rolling technique, wherein the mucosa was rolled until the nonmovable portion of the attached keratinized tissue was seen.

### Statistical analysis

Data were assessed with commercially available software (SPSS version 13.0 for Windows; SPSS, Inc, Chicago, Ill). The correlations between KM width and clinical and radiographic parameters were analyzed using Pearson's correlation coefficient test. Width of KM was dichotomized using 2 mm as a cutoff point. Group A consisted of implants where the width of the KM was  $\geq 2$  mm, and group B comprised implants where the width of the KM was  $< 2$  mm. The comparisons between dichotomized widths of KM were made using Mann-Whitney *U* test. *P* values of  $< .05$  were regarded as statistically significant.

### RESULTS

Altogether, 27 edentulous patients with a mean age of 63.1 (SD  $\pm$  6.9) years and with 66 restored dental implants were included in the study. Most of the patients were nonsmokers (Table 1). A total of 24 implants (36%) were located in the maxilla and 42 implants (64%) in the mandible. Implant lengths ranged from 8 to 14 mm, and diameters ranged from 3.3 to 4.1 mm.

TABLE 2  
Periodontal and radiographic parameters

	Mean	SD( $\pm$ )
Plaque index	1.34	0.64
Gingival index	0.85	0.69
Bleeding on probing	0.34	0.28
Probing pocket depth	3.12	0.71
Mucosal recession	0.79	0.85
Periodontal attachment level	3.04	1.00
Radiographic bone level	1.25	0.64
Keratinized mucosa width	2.5	1.5

TABLE 3  
Correlation between keratinized mucosa width and periodontal and radiographic parameters

Variance	<i>P</i>	<i>r</i>
Plaque index	0.61	0.038
Gingival index	0.31	0.114
Bleeding on probing	0.49	0.241
Probing pocket depth	0.08	0.44
Mucosal recession	0.01*	-0.45
Periodontal attachment level	0.03*	-0.37
Radiographic bone level	0.09	0.68

\*Statistically significant.

Relatively low PI, GI, PPD, and MR were recorded (Table 2). The mean RBL was  $1.25 \pm 0.64$  mm with a range of 0.78 mm to 3.11 mm. KM width ranged from 0 to 6 mm (mean  $2.5 \pm 1.5$ ). The correlations between KM width and periodontal and radiographic parameters around implants are presented in Table 3. A negative correlation was found between KM width and MR (*P* = .02) and PAL (*P* = .03).

Of the 66 implants, 36 implants had  $\geq 2$  mm of keratinized tissue (group A); whereas 30 implants were found to have a keratinized mucosa of  $< 2$  mm (group B). There was no statistical difference between the two groups with respect to PPD. The means for group B were significantly higher than group A for the following parameters: PI, GI, BOP, MR, and PAL (Table 4).

### DISCUSSION

The evaluation of soft tissue is primarily concerned with the treatment planning of overdenture prostheses, which gain dual support from implants and edentulous ridge. In a study by Kaptein et al,<sup>7</sup> they concluded that implants supporting overdentures had

TABLE 4  
Periodontal and radiographic comparison between wide ( $\geq 2$  mm) and narrow ( $< 2$  mm) keratinized mucosa

	KM width $\geq 2$ mm		KM width $< 2$ mm		<i>P</i>
	Mean	SD	Mean	SD	
Plaque index	1.20	0.71	1.87	0.59	0.02*
Gingival index	1.01	0.67	1.65	0.78	0.01*
Bleeding on probing	0.38	0.34	0.49	0.30	0.04*
Probing pocket depth	2.98	0.51	3.11	0.56	0.115
Mucosal recession	0.55	0.49	0.85	0.79	0.03*
Periodontal attachment level	2.95	0.89	3.21	1.01	0.04*
Radiographic bone level	1.12	0.75	1.24	0.91	0.07

\*Statistically significant.

a higher risk for bone loss, based on the worse peri-implant tissue health. They also showed that mean peri-implant probing depth and gingiva index in overdentures is significantly higher than fixed bridges. To the best of our knowledge, this is the first time that association between width of KM around implants supporting overdentures and the soft peri-implant tissue has been explored.

There are varying opinions concerning the influence of a zone of keratinized attached mucosa surrounding dental implants. Several authors<sup>22-25</sup> reported that, in good oral hygiene conditions, the marginal gingiva around implants were clinically healthy, even when no keratinized mucosa was present. On the other hand, other investigators<sup>26-29</sup> reported an association between implant survival and width of keratinized gingival.

In the current study, a negative correlation was found between KM width and MR and PAL. These findings are in accordance with other investigators<sup>28,30</sup> who found a negative correlation between KM width and MR, and between KM width and GI. This study showed that implants with narrow zones of keratinized tissue (<2 mm) had significantly more plaque and signs of inflammation than those with wider zones of keratinized gingiva ( $\geq 2$  mm). These findings are supported by previous studies<sup>27,28</sup> that demonstrated that the absence of adequate keratinized mucosa in endosseous dental implants, especially in posterior implants, was associated with higher plaque accumulation and gingival inflammation. In addition, a recent study showed that areas lacking keratinized gingiva had a higher susceptibility to tissue breakdown due to plaque accumulation.<sup>29</sup> In fact, good oral hygiene is very difficult to achieve around dental restorations without the protection of a band of keratinized gingival tissue. Therefore, in order to achieve long-term stable peri-implant health, it is important to achieve an adequate soft tissue seal around dental implant/restorations.<sup>31</sup> Han et al<sup>32</sup> have shown the use of free soft tissue grafts to augment keratinized gingiva before or following the restoration of an implant. The rationale for performing the procedures include making plaque control more effective, facilitating impression taking by the restorative dentist and dissipating muscular and frenal pull, and possibly preventing further recession.<sup>33,34</sup>

In our findings, implants with narrow zones of keratinized gingiva had more bleeding on probing. In the peri-implant sulcus, the collagen fibers are orientated parallel to the implant surface, in contrast to the collagen fibers adjacent to the natural teeth, which are perpendicularly orientated and anchored in

the cementum. The absence of these horizontal collagen fibers will result in less resistance on probing. This will lead to a local tissue trauma and some bleeding, even in clinically healthy peri-implant tissue.<sup>34</sup> To avoid false bleeding on probing data, modest probing forces were used and we ignored small point bleeding in clinically healthy situations.

We did not find any correlation between KM widths and PPD. Our finding is supported by previous studies<sup>28,29,35</sup> that showed that KM width was positively correlated to PPD. It was reported that at sites with healthy mucosa or mucositis, the tip of the probe may identify the location of the apical level of the barrier epithelium.<sup>36</sup> At sites with peri-implantitis, however, the probe will penetrate apical to the epithelium and reach the base of the inflammatory lesion at the alveolar bone crest. Consequently, an increased probing depth will result. Schou et al<sup>36</sup> reported that probing depth measurements at implant and teeth yielded different information, and small alterations in probing depth at implants may reflect changes in soft tissue inflammation rather than loss of supporting tissues.

Although the mean bone loss was higher for implants with narrow zones of keratinized mucosa, this difference was not significant. Thus, width of keratinized mucosa appears to have no significant impact on the alveolar bone loss around implants supporting overdentures. In accordance to our findings, other investigators reported no association between the width of keratinized mucosa and alveolar bone loss around dental implants.<sup>27</sup> Also, recent longitudinal studies<sup>37,38</sup> have demonstrated that loss of alveolar bone may be almost absent or minimal in well-maintained patients. However, it is important to realize that this retrospective cross-sectional study only suggests explorative evidence; also, it lacks data on the baseline KM width. Also, determination of the alveolar bone loss was made through comparison of nonstandardized radiographs at two different points in time. Yearly measurements of bone loss over time on standardized radiographs possibly would have allowed a calculation of rate of bone loss per year. Therefore, a prospective longitudinal study will be required to further establish these results.

## CONCLUSION

The results of this study show that there is a significant influence of width of keratinized mucosa on health of the peri-implant tissues. The absence of adequate keratinized mucosa around implants supporting overdentures was associated with higher plaque accumu-

lation, gingival inflammation, bleeding on probing, and mucosal recession.

#### NOTE

The authors report no conflicts of interest related to this study.

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