



# The association of buccal keratinized tissue width and periodontal biotype on soft tissue surrounding dental implant

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## Abstract

**Objectives:** To compare clinical outcomes surrounding dental implants between narrow and wide buccal keratinized tissue and between thin and thick periodontal biotype.

**Materials and methods:** Fifty one patients recruited from the patient's bank of Oral medicine and Periodontology, Faculty of dentistry, Mahidol University. Eighty two functioning dental implants were examined. All implants mucosa were divided into 2 categories: 1) keratinized mucosal width was divided into wide ( $\geq 2$  mm) and narrow ( $< 2$  mm), 2) keratinized mucosal thickness was divided into thick and thin. Clinical parameters included gingival index (GI), plaque index (PI), bleeding index (BI), probing depth (PD), buccal mucosal recession and periodontal attachment were determined. Peri-implant crevicular fluid was collected for measurement by periotron.

**Results:** The implant areas that had thick or wide mucosa showed more probing depth than those that had thin or narrow mucosa, significantly ( $P=0.001$ ,  $P=0.008$ , in order). The periotron value in thin or narrow mucosa had significantly greater than thick or wide mucosal sites ( $P=0.016$ ,  $0.042$  orderly). There was no correlation between keratinized tissue thickness or width and GI, BI and PI. Thin mucosa tend to occur buccal recession than thick mucosa, but not significant though.

**Conclusion:** The finding of this study showed that keratinized mucosal thickness and width surrounding implants affected the peri-implant soft tissue status.

**Key words:** implants, mucosal thickness, mucosal width, peri-implant inflammation, peri-implant soft tissue, periodontal parameters

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## Introduction

The preservation of healthy tissues surrounding dental implant is one of the crucial factors for the success rate of the treatment in longstanding period.<sup>1</sup> It has been controversy for the necessity of adequate peri-implant keratinized mucosa to promote long term prognosis.<sup>2</sup> Although not justified, it has usually been considered that inadequate keratinized mucosa interferes proper oral hygiene and offers deficient protection of the tooth and implant-supporting tissues to injury caused by friction forces encountered during mastication and tooth brushing, or injury caused by bacterial plaque load.<sup>3</sup>

From the affirmation of Friedman's study, absence of keratinized gingiva would promote the formation of subgingival plaque from the mobility of the marginal tissue which results inappropriate pocket closure.<sup>4</sup> Corresponding to an observational study, Lang and Loe stated that the movability of the soft tissue margin at inadequate keratinized mucosa areas (<1 mm) may assist the subgingival plaque formation and cause the supporting tissues more susceptible to destruction.<sup>5</sup> Moreover, there was a retrospective study that investigated the association between keratinized mucosa width and peri-implants clinical index. It revealed that two times greater of peri-implant mucosal recession was presented in a narrow keratinized mucosa band ( $\leq 1$  mm).<sup>6</sup> From the above studies, a wider zone of keratinized tissue is needed around teeth and dental implants.

On the other hand, several observations have challenged this impression. Experimental study in dogs showed no difference in the progression of gingival disease in the narrow keratinized mucosal band areas.<sup>7</sup> The longitudinal clinical studies of former inadequate keratinized gingival areas which augmented by free gingival graft were also rejected the protective role respecting the maintenance of periodontal

attachment levels.<sup>8-10</sup> The optimal plaque control was the crucial factor to remain the periodontal attachment levels over of the keratinized gingival.<sup>8,10</sup>

To maintain the healthy tissues around dental implant, another factor that has also been considered was the tissue thickness. The dimension of the soft tissue attachment to the implant abutment surface was measured significant for the preservation of peri-implant mucosal health and for the aesthetics outcome of the restoration.<sup>11</sup> The biological width concept has been applied to explain a normal dimension of dento-gingival junction surrounding natural teeth and restorations for a while.<sup>12</sup> In dog model, Berglundh and Lindhe stated that comparable persistent dimension of gingiva was also noticed in peri-implant soft tissue.<sup>13</sup> In this experimental observation, the authors demonstrated that bone remodeling would subsequently happen later on the surgically decreasing of the gingival flap thickness.<sup>13</sup> This occurrence would happen afterward for the re-formation of the biological width of the peri-implant soft tissue.<sup>13</sup> The clinical implication from this finding was the justification for soft tissue placement in stable and correct position should be done with carefully.<sup>13</sup> The esthetic outcomes of immediate implant placement were observed by Evan and Chen.<sup>14</sup> This study demonstrated that patients with thin biotype slightly had mucosal recession greater than patients who had thick biotype, though, this was not statistically significant.<sup>14</sup> Moreover, the result of the previously observations by Claffey and Shanley, the development of gingival recession prone to happen in thin gingiva<sup>15</sup> while the forming of significantly greater pocket depth in the natural dentition was observed in thick gingival biotype.<sup>16</sup>

A certain minimum biological width of mucosa surrounding dental implants may be desired and the bone remodeling may occur to

form a required soft tissue attachment dimension. Corresponding to a study by Linkevicius et al. 2010, they compared platform switching implants and conventional implant-abutment connection placed in thin mucosal areas.<sup>17</sup> This study found a similar consequence of marginal bone loss. The magnitude of bone loss in thin mucosa is terminated to the healing period after surgical procedure and the formation of required biological width of peri-implant soft tissue attachment.<sup>17</sup>

From the above data, the necessity of keratinized mucosa around endosseous implants and tissue thickness are interesting information to obtain. This study aims to compare clinical outcomes surrounding dental implants between wide and narrow buccal keratinized tissue and between thin and thick biotype. This study may give more information whether wider keratinized tissue or thick biotype is able to maintain soft tissue health around dental implants.

## Materials and methods

This study was designed as a cross sectional clinical study. Initially, the study was approved by Institutional Review Board Faculty of Dentistry/Faculty of Pharmacy, Mahidol University. All participants had to sign the inform consent before starting the study.

### Patient sample

The subjects suitable for the study were recruited from a population in the patient's bank of Oral medicine and Periodontology, Faculty of dentistry, Mahidol university. The following inclusion criteria were: 18 years of age or older, having implant-supported fixed restorations that have been in place for a minimum of 12 months. Patients were included only if the dental implant and its restorations were still in place. Subjects were excluded from

the study if they were: pregnant; using systemic antibiotic within the past 6 weeks before the study and having medical conditions that required prophylactic antibiotic coverage or systemic diseases that influences soft tissue and bone metabolism (e.g. uncontrolled diabetes mellitus, hyperparathyroidism and hyperthyroidism).

The medical and dental history were collected. The data of smoking habits was obtained and categorized as never smokers, current smokers or former smoker (if they had quit smoking more than 1 year).

### Clinical examination

Clinical measurements were made at the areas surrounding each dental implant and a mean value was used. All of these clinical measurements were recorded by a single observer including:

1. The soft tissue condition which followed the criteria of Gingival index system. (Scored as 0-3) (GI, Loe & Silness 1963)<sup>18</sup>
2. The presence of plaque at implant-supported restoration sites used 15 UNC/CP periodontal probe (Hu-Friedy, Chicago, IL, USA) running along the crown surface and determined according to Plaque index system. (Scored as 0-3) (PI, Silness & Loe 1964)<sup>19</sup>
3. Bleeding index (BI) – recorded the bleeding following probing 10 seconds. (scored as 0/1) (BI, Ainamo and Bay 1975)<sup>20</sup>
4. Probing depth (PD) measures to the nearest millimeter using a 15 UNC/CP periodontal probe (Hu-Friedy, Chicago, IL, USA) at the mid buccal aspect and interproximal surfaces of each implant.
5. Mucosal recession – measured from the mucosal margin to the implant abutment interface.
6. Periodontal attachment was calculated by adding mid-buccal pocket depth (PD) to mucosal recession (MR) by using 15 UNC/CP

periodontal probe (Hu-Friedy, Chicago, IL, USA).

7. Keratinized mucosal width– measured at the mid – buccal aspect of each implant to the nearest half –millimeter with a 15 UNC/CP periodontal probe (Hu-Friedy, Chicago, IL, USA). Each measurement was made from the gingival margin to the mucogingival junction. The mucogingival junction was identified by the rolling technique, wherein the mucosa was rolled until the non-movable portion of the attached keratinized tissue is seen.

8. Tissue biotype was considered as being thick or thin base on Kan et al. 2003 criteria<sup>21</sup>:

Thin tissue: a 15 UNC/CP periodontal probe (Hu-Friedy, Chicago, IL, USA) could be seen through the mucosal tissue when placed into the labial gingival; the tissue was determined as being thin

Thick tissue: a 15 UNC/CP periodontal probe (Hu-Friedy, Chicago, IL, USA) tip was not visible; the tissue was determined as being thick.

9. Peri-implant crevicular fluid sampling was collected from the mid buccal of each implant. The areas were isolated with gauze and air dried, paper stripes (PerioPaper Strips, Oraflow Inc., Plainview, NY, USA) were placed within the mucosa crevices until encountered mild resistance and waited for thirty seconds. The volume of peri-implant crevicular fluid was determined by Periotron model 6000 (Dental product division Winnipeg, Manitoba, Canada). All implants mucosa were divided into 2 categories:

1. Keratinized mucosal width was divided into wide ( $\geq 2$  mm) and narrow ( $< 2$  mm).

2. Keratinized mucosal thickness was divided into thick and thin.

All subjects were provided with full mouth cleaning and personal oral hygiene instruction after all data were obtained at examination visit.

### Statistical analysis

SPSS version 16.0 for window statistical

software was used to analyze data. The descriptive statistics were employed to identify the implants and the subjects. The Fisher’s exact test was used to determine the association between qualitative data, including GI, PI and BI. The Mann- Whitney U test was used to test the difference in quantitative clinical parameter (i.e., PD, mucosal recession, periodontal attachment, periotron value) and dichotomized of keratinized mucosal tissue width and thickness. The level of significance was set at  $P < 0.05$ .

The clinical parameters in this study were measured by single examiner. The intraclass correlation coefficient (ICC) was used for the estimation of the intra-observer reliability in each parameter measurement. In this study, the reliability of intra-observer was determined by second measurements of two quantitative parameters (probing depth and keratinized tissue width) with 1- week interval. The Intra-observer reliability value for probing depth and keratinized tissue was 0.88 and 0.92 respectively as shown in Table 1.

### Results

The population of this study consists of 51 patients, there were 36 females (70.6 %) and 15 males (29.4%). The mean age was 50 years. (range 33-71 years old). Most of them, 48 patients (94.1%) had never smoked, while one of them was former smoker and others two were current smokers. 82 functioning dental implants were examined. All of these dental implants were restored with fixed prosthesis, including of single crown, bridges and fixed partial denture. The average loading period was

**Table 1** The Intra-observer reliability values (ICC) of observations

Parameters	ICC
Probing depth	0.88
Keratinized tissue width	0.92

42 months (range 12-120 months). The demographic data was shown in Table 2.

The differences between clinical parameters and dichotomized thickness of keratinized mucosal tissue are showed in Tables 3 and 4. There were 44 implants determined the tissue thickness as thick and 38 implants determined the tissue thickness as thin. There was no significant difference between thick and thin keratinized mucosal thickness and GI (P = 0.275), PI (P = 0.239), BI (P = 0.491) and mucosal recession (P = 0.095). On the other hand, the results showed that thick keratinized mucosa presented more PD and periodontal attachment than thin keratinized mucosa significantly (P= 0.001 and P = 0.005, respectively), while thin keratinized mucosa showed periostion value more than thick keratinized mucosa significantly (P = 0.016).

The differences between clinical parameters and dichotomized width of keratinized mucosal tissue (data were divided in <2 mm and  $\geq$  2 mm) are showed in Tables 5 and 6. There were 23 implants determined the width of keratinized mucosal tissue as narrow (<2 mm) and 59 implants determined the width of keratinized mucosal tissue as wide ( $\geq$  2 mm). Wide keratinized mucosa tissue ( $\geq$  2mm) had no statistical difference with narrow keratinized mucosal tissue (< 2 mm) on GI (P = 1.000), PI (P = 0.747), BI (P = 0.521), periodontal attachment (P=0.053) and mucosal recession (P = 0.124). On the other side, the data revealed that wide keratinized mucosal tissue had PD more than narrow keratinized mucosal tissue statistical significance(P = 0.008), while narrow keratinized mucosa showed periostion value more than wide keratinized mucosa significantly (P = 0.042).

**Table 2** The demographic data

Demographic	Number (%)
Gender	
- Females	36 (70.6%)
- Males	15 (29.4%)
Smoking	
- Never smoker	48 (94.1%)
- Former smoker	1 (2.0 %)
- Current smoker	2 (3.9 %)

**Table 3** Comparison of periodontal indices between thick and thin keratinized mucosa

Parameters	Thick (n=44)	Thin (n=38)	P-value
Gingival index (GI)			
0	38 (86.4%)	36 (94.7%)	0.275
1	6 (13.6%)	2 (5.3%)	
Plaque index (PI)			
0	34 (77.3%)	34 (89.5%)	0.239
1	10 (22.7%)	4 (10.5%)	
Bleeding index (BI)			
0	18 (40.9 %)	12 (31.6%)	0.491
1	26 (59.1%)	26 (68.4%)	

**Table 4** Comparison of clinical parameters between thick and thin keratinized mucosa

Parameters [median (min,max)]	Thick (n=44)	Thin (n=38)	P-value
Probing depth (mm)	3 (2,5)	2 (1,4)	0.001*
Mucosal recession (mm)	0 (0,0)	0 (0,2)	0.095
Periodontal attachment (mm)	3 (2,5)	2 (1,5)	0.005*
Periotron value	22 (2,128)	28.5 (1,127)	0.016*

\* Statistical significant (P &lt; 0.05)

**Table 5** Comparison of periodontal indices between narrow (< 2 mm) and wide (≥ 2 mm) keratinized mucosa

Parameters	Wide (n=59)	Narrow (n=23)	P-value
Gingival index (GI)			
0	53(89.8%)	21 (91.3%)	1.000
1	6 (10.2%)	2 (8.7%)	
Plaque index (PI)			
0	48 (81.4%)	20 (87.0%)	0.747
1	11 (18.6%)	3 (13.0%)	
Bleeding index (BI)			
0	22 (37.3%)	8 (34.8 %)	0.521
1	37(62.7%)	15 (65.2%)	

**Table 6** Comparison of clinical parameters between narrow (< 2 mm) and wide (≥ 2 mm) keratinized mucosa

Parameters [median (min,max)]	Wide (n=59)	Narrow (n=23)	P-value
Probing depth (mm)	3 (1,5)	2 (1,4)	0.008*
Mucosal recession (mm)	0 (0,1)	0 (0,2)	0.124
Periodontal attachment (mm)	3 (1,5)	2 (1,5)	0.053
Periotron value	25 (1,128)	28 (12,103)	0.042*

\* Statistical significant (P &lt; 0.05)

## Discussion

There were some studies revealed the negative association between mucosal recession and keratinized mucosal thickness surrounding dental implant. The greater recession tend to present in the thin gingival region. One of this study's purposes was to determine mucosal recession surrounding dental implants between thin and thick periodontal biotype. The effect of the

dimensions of keratinized mucosa around implants on clinical parameters was observed by Hadar Zigdon et al. in 2008.<sup>6</sup> They reported that the effect of thin mucosa (< 1 mm) was associated with mucosal recession two times greater than thick mucosa (≥ 1 mm) (0.9±1.05 vs 0.45±0.79; P=0.04).<sup>6</sup> Furthermore, from the studied of Nisapakultorn et al. 2010 in forty anterior maxillary single-tooth implants, they stated that thin biotype was significant

correlated with increasing facial mucosal recession risk.<sup>22</sup> Resemble in the examination of Evans and Chen in 2008, they demonstrated that patients with thin biotype slightly had greater mucosal recession than those patients who had thick tissue biotype ( $1.0 \pm 0.9$  mm vs.  $0.7 \pm 0.57$  mm, respectively); however, this was not statistically significant ( $P = 0.187$ ).<sup>14</sup> Similar to this study, when data was dichotomized by thickness, there was no correlation between mucosal thickness and mucosal recession ( $P = 0.095$ ). However, from this present observation found buccal tissue recession in all sites of those patients who had thin peri-implant mucosa, while buccal recession was not found in patients who had thick mucosa. Therefore it might conclude that thin keratinized mucosa had tendency to have recession more than thick keratinized mucosa.

In this study, there was a statistically significant difference between mucosal thickness and probing depth. Similar to the examination of Muller et al. 2000, the study stated that patients who had thick gingiva had a remarkably greater periodontal pocket depth in natural teeth.<sup>16</sup> They suggested that the fact of thicker tissue may result in greater probing depth due to inter-individual variation of the biological width.<sup>16</sup> A comparable distinction in pocket depth by Olsson et al., they found that shallower pockets may be supposed in patients with thin biotype and that deeper pockets can be met in patients with a thick biotype.<sup>23</sup> In the same way, other observations which stated that the thick gingival tissues typically resistant to recession due to a thick, broad band of attached gingiva.<sup>21,24,25</sup> Furthermore, the studies revealed that nature of thin biotype is quite friable, so the gingival recession was more frequently detected than thick biotype.<sup>21,24,25</sup> In accordance with this current observation, we found that patient who had thick biotype had more probing depth than patient who had thin

biotype. We might summarize that soft tissue surrounding dental implant had the same characteristic as natural tooth. In thick keratinized mucosa had tendency to occur deep probing depth while in thin keratinized mucosa tend to appear mucosal recession.

There were some data that supported the effect of keratinized mucosal width on recession of soft tissue surrounding dental implants. In animal observation, ligated implants with minimal or lack of keratinized mucosa exhibited more significantly recession than the area which surrounded with keratinized mucosa.<sup>26,27</sup> In the same way, the findings of other studies suggested that the existence of keratinized mucosa surrounding dental implants is significantly correlated with soft tissue status.<sup>28,29</sup> In accordance with the prospective studied in 164 implants from 29 patients of Crespi et al. 2010. They found that sites of implants which lack of keratinized mucosa ( $<2$ mm) had significantly greater recession than adequate keratinized mucosa ( $\geq 2$ mm) sites ( $1.3$  mm vs.  $0.2$  mm;  $P < 0.01$ ).<sup>30</sup> Moreover, the study of Artzi et al. in 2006 presented that the mucosal recession and marginal bone resorption had statistically significant increases in the group of deficient keratinized mucosa.<sup>31</sup> On the other hand, Strub et al. (1991) did not find the differences in peri-implant soft tissue recession between area with or without keratinized mucosa following plaque-induced breakdown in animal models.<sup>32</sup> In addition, comparison of buccal implant area in narrow keratinized mucosa ( $<2$  mm) and wide keratinized mucosa sites found no significant difference in recession.<sup>33</sup> In accordance with this current study, when grouped together, a wide keratinized mucosa ( $\geq 2$  mm) had no significant difference with narrow keratinized mucosa ( $<2$  mm) when concerned with mucosal recession of soft tissue surrounding dental implants. Therefore, the

information of association between the keratinized mucosal width and its effect on soft tissue recession were still controversy both in natural teeth and implants.

In this study found the significant difference between keratinized mucosal width and probing depth. The wide keratinized mucosa ( $\geq 2$  mm) showed a higher mean probing depth than narrow keratinized mucosa ( $< 2$  mm). This finding was in accordance with observation of Hadar et al. in 2008 and Roos-Jansaker et al. in 2006, they demonstrated that the presence of keratinized mucosa was correlated with a greater probing depth in that area. Therefore it might be simplify the relationship of width of keratinized mucosa with deep probing depth.<sup>6,34</sup>

There are some observations reported that the dimension of the absence or presence of keratinized mucosa at implant sites influence oral hygiene measurement. The longitudinal prospective 4 year-study in the anterior jaw region of Crespi et al. 2010, showed the significant difference in plaque index, bleeding index and gingival index between the sites of keratinized mucosa  $< 2$  mm and  $\geq 2$  mm.<sup>30</sup> In the same way, the cross-sectional studies revealed that narrow keratinized mucosa ( $< 2$  mm) had higher scores of plaque index, bleeding index and gingival index than wide keratinized mucosa ( $\geq 2$  mm) significantly.<sup>35,36</sup> However, these studies were not provide the information which regard to instructions in oral hygiene or supportive care. In contrast, the cross-sectional study in 46 implants supported mandibular overdentures showed no significant difference in bleeding index and plaque index between implants with or without keratinized mucosa sites.<sup>37</sup> Similar to this study, we found negative correlation between keratinized mucosal width and thickness on plaque index, bleeding index and gingival index. The possible explanation might be that patients in this

observation were recruited from a population in the patient's bank of Oral medicine and Periodontology, Faculty of dentistry, Mahidol university. All of the patients were well-instructed in oral hygiene, and almost of them had good oral hygiene. Therefore there was low PI ( $< 1$ ) in the beginning. This PI was not powerful enough to reach the statistically significant. Hence the correlation between width and thickness of keratinized mucosa compared to PI, BI, GI was still controversy.

The presence and volume of gingival crevicular fluid (GCF) can be indicative of changes to periodontal tissues that are the consequence of inflammatory reactions of the host.<sup>38</sup> The volume of GCF measured on Periotron was reported on periotron value. From this present observation found that thick biotype had significantly lower periotron value than thin biotype ( $P=0.016$ ). Similar to the result when grouped the data by mucosal width, wide keratinized tissue had lesser periotron value than narrow keratinized mucosa, significantly ( $P=0.042$ ).

Within the limitation of the current study, the following conclusions may be drawn: the implant sites which had thick or wide mucosa presented more probing depth than those that had thin or narrow mucosa significantly. The periotron value in thin mucosa had significantly greater than wide or thick mucosal areas. In contrast, there was no correlation between keratinized tissue width or thickness and GI, BI and PI.

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