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Original Article

Evaluating the Effect of Attached Gingiva Height on Pre-implant Tissue

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Abstract

Background: Many patients refer to their load implants while there is no attached gingiva in the area of prosthetic implants – unlike the attached gingivae found with natural teeth. The important role played by gingiva in comforting the patient and preventing gingival inflammation has not been fully appreciated yet. This study aimed to evaluate the association between the attached gingival height with gingival inflammation and patients' comfort.

Methods: This retrospective cohort study was conducted to examine 80 implants (Dio uf) placed in 63 patients. At least two months had passed since the patients had had implant crown. The patients were divided into three groups: attached gingiva, gingival up to 2 mm, and at least 2 mm of attached gingiva. Indices such as bleeding on probing (BOP), the amount of plaque, gingival index and patient comfort during brushing and chewing were evaluated. Statistical data were analyzed using the Kolmogorov–Smirnov test, Levene's test and independent t-test.

Results: By increasing the height of attached gingiva, decreases were observed in probing depth (*P* value = 0.004), BOP (*P* value = 0.001), the degree of plaque index (*P* value = 0.006), and gingival index (*P* value = 0.003); and this association was statistically quite significant. By increasing the attached gingiva height, furthermore, the patients felt less discomfort when brushing and chewing; however, the findings were not statistically significant in terms of patients' comfort during chewing (*P* value = 0.364).

Conclusions: Increasing the height of attached gingiva reduced the symptoms of gingival inflammation, but increased patients' comfort when chewing and brushing.

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Background

The gingiva is the part of oral mucosa that forms a covering over the alveolar mucosa and the area around the collar of the teeth. In adults, the normal gingiva covers the alveolar bone and the tooth root to a more correct coronal extent than the area between the enamel and the cemented. The gingiva is anatomically divided into three parts: marginal gingiva, attached gingiva, and interdental gingiva (papilla). Although various parts of the gingiva – based on their functional needs – show significant differences in their differentiation, histology, and thickness, all parts are specifically organized to act properly against mechanical and microbial damage. In other words, the specialized and differentiated structure of the gingiva is a reflection of its effectiveness as a barrier against the penetration of harmful microbes into the deeper tissues.

The width of the attached gingiva is considered as another important clinical factor, which is equal to the distance between mucogingival junction and projection on the external surface of the bottom of the sulcus or periodontal pocket. This distance should not be confused with the width of the keratinized gingiva, since keratinized gingiva width also includes the marginal gingiva.

Highlights

- By increasing the height of attached gingiva, BOP, plaque index, gingival index were decreased.
- Increasing the height of attached gingiva, increased patients' comfort when chewing and brushing.
- Increasing the height of attached gingiva reduced the symptoms of gingival inflammation
- gingival augmentation surgical procedures is useful when the attachment level of the gingiva is zero

Using dental implants is increasing on a daily basis. This increase in the need and application of implant-based therapy is due to several factors such as the effect of aging on edentulous state, the complications of removable and fixed prostheses, the psychological consequences of edentulous state, the predictable results of implants, and the improvement of public awareness (1,2).

Nowadays, the number of elderly people is increasing all over the world and, at the same time, there is an increase in the size of population with partial and complete edentulousness. Therefore, the use of prostheses has become a significant part of dental treatments. The first permanent teeth to appear are the molar ones, which are lost due to decay, incomplete endodontic treatments,

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and fractures. In order for maintaining dental arch and proper occlusion, replacement of these teeth is required. Edentulousness has several consequences for soft and hard tissues (1,2).

Dehiscence occurs when the supporting tissues are damaged or lost. Dehiscence is a common complication that occurs following an implant restoration and should be anticipated, especially in cases where the soft tissues are thin and do not have a good support. In patients with a high smile line or with high aesthetic expectations, this occurrence is considered a treatment failure. Periodontal tissues consist of circumferential and transseptal fibers, which are inserting into the cementum located in the upper part of the crestal bone. Therefore, marginal gingiva and interdental papilla are reinforced even when the periodontal tissues are very thin. However, pre-implant soft tissues strongly rely on the surrounding bones for support, where there are no connective fibers inserting into the supracrestal region to support the soft tissue around the implant. As a result of this, the height of the soft tissue around the implant does not usually exceed 3 to 4 mm, and the bone resorption around the implant results in dehiscence (3).

There is disagreement regarding the adequate width of the attached gingiva. Some consider the width of 1 mm as the adequate or sufficient dimension, while others believe that 3 mm is the adequate dimension of the gingiva. From the viewpoint of some other experts, any dimension of gingiva which is compatible with gingival health and prevents marginal gingiva from stretching during the mucosa movement is considered to be sufficient (4).

Lin et al conducted a systematic review on the effect of the dimension of attached gingiva around the implant on parameters such as bleeding on probing (BOP), plaque index, gingival inflammation, and so forth. Eleven articles were selected and, according to the results, plaque index, gingival inflammation, and dehiscence reported in implants with a sufficient attached gingiva had a better result, however, the amount of BOP, probing depth, and bone resorption in radiography showed no significant difference (5).

In a study by Kim et al, 100 patients received 276 implants. Then the researchers did their first follow-up after 13 months, and evaluated plaque depth, plaque amount, the amount of bone resorption, and the degree of gingival inflammation. They found no difference in plaque depth, plaque amount, and the degree of gingival inflammation in the presence or absence of the keratinized gingiva; however, bone resorption and dehiscence were detected to be higher in the group with no keratinized gingiva (6).

If the amount of keratinized mucosa has a significant effect on the implant health, special measures (e.g., health training and surgical procedures to increase keratinized tissue and vestibular depth) should be taken for patients with insufficient keratinized mucosa during the maintenance phase of treatment (7).

If the difference between the soft tissues around the implant and natural teeth is considered significant, the question is whether the keratinized gingiva around the implant is essential or, at least, beneficial for the health of the soft tissue around the implant or 2 mm keratinized gingiva– which is recommended for natural teeth – is acceptable for dental implants (7).

Gingival health can be maintained regardless of its dimension. In addition, findings from experimental and clinical studies have revealed that in the presence of plaque, regions with thin and narrow gingiva have the same resistance to attachment loss as the regions with thick and wide gingiva. The old viewpoint on the need for widening the gingival tissue to prevent joint collapse is not scientifically supported (4).

Cross-sectional studies have shown that there is an interrelationship between the periodontal defects and the height of the gingiva, which means that having thin and narrow gingiva is an effective factor in the development of soft tissue resorption. Bearing in mind the fact that information obtained from the given studies cannot prove or disprove the cause-and-effect relationship in this case, therefore, the information should be interpreted (4).

Methods

Our study population included the patients referring to the periodontics and prosthodontics department of Hamedan Dental School and private clinics to follow up on their implant therapy, and having had dental implant crowns for at least two months.

Stratified random sampling method was adopted in this study. First, by examining the data from the files of patients who had referred for implant therapy, all patients were divided into three groups: patients with marginal gingiva, patients with attached gingiva which has a maximum height of 2 mm, and patients with attached gingiva which has a minimum height of 2 mm. Then, 20 patients were randomly selected from each group. Following the previous studies, the sample size was determined to be 80 patients for this study (6).

Clinical examination was conducted on patients. When performing the examination for each implant, patient information such as age, gender, and length of time they had dental implant crowns were recorded, and each patient was given a code. Then, the position of the implant for each patient was determined. Using a Hu-friedy plastic probe, the height of the attached gingiva was measured. The probing depth in three points (mesiobuccal, mid-buccal, and distobuccal) was also measured using the same probe. Finally, the average of these three points was calculated and recorded in the patient form.

In the next step, the patient's BOP was checked and recorded on the patient's file if it was positive. Then,

patients were given a disclosing agent which are in the form of solutions or tablets and stain the bacterial biofilm on the surfaces of the teeth, tongue and gums, causing the biofilm of the plaque, tongue, lips and fingers to stain. After chewing the disclosing agent, the total plaque index of the mouth and implant was calculated and recorded. Finally, the degree of gingival inflammation around the implant was assessed.

Inclusion Criteria

1. Korean dental implants were selected for this study (Dio uf);
2. Only those cases in which the implants were placed submerged during surgery were included in the study;
3. The two-stage surgical approach was used;
4. At least two months had already passed since the implant crown had been placed in all patients;
5. The soft tissue was attached or non-attached (three groups).

Exclusion Criteria

1. Subjects with history of systemic problems (e.g., diabetes, pregnancy);
2. Those having diseases and conditions affecting the clinical appearance of gingiva (e.g., smoking);
3. Subjects having been taking antibiotics or corticosteroids for 2 weeks before the examination;
4. Patients with a history of soft tissue transplantation.

Statistical Analyses

The obtained data were analyzed using SPSS software version 21. Descriptive statistics methods and statistical tests, including the Kolmogorov-Smirnov test, Levene test, independent *t* test, and logistic regression were also adopted to analyze the data.

Results

In this study, 80 samples were selected using random sampling. As for the gender division of the study population, 43.8% of the participants were women and 56.2% were men. Moreover, 55% of the implants were in the maxilla and 45% of the implants were in the mandible. As for implants' location, 38.75% of the implants were located in the anterior region and 61.25% of them were located in the posterior region. Among 80 implants examined in the study, 28.8% had the attachment level of 0 mm, 30% had the attachment level of 0-2 mm, and 41.2% had the attachment level of >2 mm.

The mean age of patients and the standard deviation were 50.56 years and 11.99, respectively. The minimum and maximum ages were 21 and 83 years, respectively.

The mean duration of implantation was 16.21, and the standard deviation was 8. Furthermore, the minimum and maximum durations were 6 and 36 months, respectively.

The probing depth for three surfaces with the attachment levels of 0, 0-2, and >2 had a mean of 2.493, 1.625, and 1.747, respectively. The standard deviation for these three surfaces was determined as 0.192, 0.188, and 0.160, respectively. These numbers revealed that with an increase in the attachment level of the gingiva, there was a decrease in the probing depth. According to the study results, there was a significant statistical difference between the mean probing depth of different surfaces and their attachment levels (P value = 0.004), indicating that there was a statistical relationship between the attachment level of gingiva and the probing depth.(Table 1)

In addition, a difference was detected between the mean probing depths in attachment levels of 0, 0-2 (P-value = 0.007), and >2 (P-value = 0.01); however, no significant difference was found regarding the mean probing depths for attachment levels of 0-2 and >2 (P value = 0.992).

The highest percentage of bleeding (bleeding point index (8)) was observed in patients with the attachment level of 0, and the lowest percentage of bleeding was detected in patients whose gingiva had the attachment level of >2. It could be stated that the percentage of bleeding in patients with the attachment level of 0 was significantly higher than the other patients from two groups (Table 2).

Plaque amount (O'Leary plaque index (9)) around the dental implant for the attachment levels of 0, 0-2, and

Table 1. One-Way Variance Analysis: Assessment of the Effect of the Attachment Level of the Gingiva on the Probing Depth

Attachment Level of Gingiva (mm)	Mean ± Standard Deviation	Test Results
0	2.493 ± 0.192	F = 5.113, *df* = 2 *P* value <0.001
0-2	1.652 ± 0.188	
> 2	1.747 ± 0.160	

Table 2. Frequency Distribution of Individuals at Each Level of the Gingival Attachment Based on BOP

Total		Yes	No	Total
Attachment level of gingiva	0	19 (82.6%)	4 (17.4%)	23 (28.8%)
	0-2	11 (45.8%)	13 (54.2%)	24 (30%)
	>2	10 (30.3%)	23 (69.7%)	33 (41.2%)
Total		40 (50%)	40 (50%)	80 (100%)

Results of chi-square test: P value = 0.001, df = 2, $\chi^2 = 0.070$

>2 had the mean value (standard deviation) of 31.212 (1.622), 25.729 (1.584), and 24.080 (1.342), respectively, indicating that with an increase in the attachment level of the gingiva, the plaque amount decreased. A difference was also detected between the mean value of the plaque amount for the attachment level of 0 and that of >2 (*P* value = 0.005); however, no differences were found between the attachment level of 0-2 and that of >2 (*P* value = 1), as well as between the attachment level of 0 and that of 0-2 (*P* value = 0.066) in terms of the mean value of the plaque amount (Table 3).

Moreover, participants with the attachment level of the gingiva >2 showed a higher frequency of plaque index compared to those from other two groups.

The gingival index grade G1 had the highest percentage in the group with an attachment level of 0. On the other hand, the gingival index grade G0 had the highest percentage in the other two groups with attachment levels of 0-2 and >2 (Table 4).

The possibility of the increase in gingival index was statistically significant in those having no attached gingiva, compared to those with an attachment level of more than 2 mm (*P* value <0.0001).

The possibility of the increase in gingival index was not statistically significant in participants having an attachment level of 0-2 (*P* value = 0.091) compared to those with an attachment level of more than 2 mm.

In all three groups, no problem associated with attachment was discovered during tooth-brushing for the highest percentage of participants. This difference was statistically significant (*P* value = 0.031). It could be stated that the percentage of people with problems in the attachment level of >2 was less than that in other two groups (Table 5).

According to our study results, the highest percentage of patients had no problems during tooth-brushing regarding the attachment level of the gingiva. In all three group members, furthermore, no one complained of having problems while chewing. The difference among the study groups in this regard was not statistically significant. (Table 6).

Table 3. One-Way Variance Analysis: Assessment of the Effect of Attachment Level of Gingiva on the Plaque Amount Around the Implant

Attachment Level of Gingiva (mm)	Mean ± Standard Deviation	Test Results Obtained From Variance Analysis
0	31.212 ± 1.662	F = 5.553, df = 2 *P* value = 0.006
0-2	25.729 ± 1.584	
> 2	24.08 ± 1.342	

Discussion

It has been proven that the biological width is formed around the implants (1,11). In addition, it has been argued that the presence of keratinized gingiva plays a pivotal role in the success of dental implants (11,12).

The keratinized tissue around the implant is an issue on which there is still lack of consensus. Torkzaban et al have argued that at least 2 mm of keratinized gingiva and 1 mm of attached gingiva are required for maintaining the gingival health (1). As schropp has put it, however, insufficient keratinized tissue and attached tissue do not endanger the long-term health of hard and soft tissues if the patients maintain good oral health (11,12).

A systematic review study by Thoma et al has found that soft tissue transplantation methods to obtain keratinized tissue results in a significant improvement in gingival indices compared to the control group (13).

If the amount of keratinized mucosa has a significant

Table 4. Frequency Distribution of Individuals at Each Level of the Gingival Attachment Based on the Degree of Gingival Index (10).

		Degree of gingival index				Total
		G0	G1	G2	G3	
Attachment level of gingiva	0	4 (17.4%)	14 (60.9%)	5 (21.75%)	0 (0%)	23 (28.8%)
	0-2	12 (50%)	9 (37.5%)	3 (12.5%)	0 (0%)	24 (30%)
	>2	23 (69.7%)	9 (27.3%)	1 (3%)	0 (0%)	33 (41.2%)
Total		39 (48.8%)	32 (40%)	9 (11.2%)	0 (0%)	80 (100%)

Results of chi-square test: *P* value = 0.003, *df* = 4, $\chi^2 = 15.760$

Table 5. Frequency Distribution of Individuals at Each Level of the Gingival Attachment Based on the Patience Compliance During Tooth-Brushing

Brushing		Patience Compliance During Tooth			Total
		With No Problem	Relatively Difficult	Hardly Doable	
Attachment level of gingiva	0	19 (82.6%)	3 (13%)	1 (4.3%)	23 (28.8%)
	0-2	18 (75%)	6 (25%)	0 (0%)	24 (30%)
	>2	32 (97%)	1 (3%)	0 (0%)	33 (41.2%)
Total		69 (86.2%)	10 (12.5%)	1 (1.2%)	80 (100%)

Results of chi-square test: *P* value = 0.031, Fisher's exact test = 8.204

Table 6 . Frequency Distribution of Individuals at Each Level of the Gingival Attachment Based on the Patience Compliance While Chewing

		Patience Compliance While Chewing			Total
		With No Problem	Relatively Difficult	Hardly Doable	
Attachment level of gingiva	0	20 (78%)	(13%)3	0 (0%)	23 (28.8%)
	0-2	22 (91.7%)	(8.3%)2	0 (0%)	24 (30%)
	>2	32 (97%)	1 (3%)	0 (0%)	33 (41.2%)
Total		74 (92.5%)	10 (7.5%)	0 (0%)	80 (100%)

Results of chi-square test: *P*-value = 0.364, Fisher's exact test = 1.966

impact on the tissue health around the implant, special measures such as health training and surgical procedures to increase keratinized tissue and vestibular depth should be proposed for patients with insufficient keratinized mucosa during the maintenance phase of treatment (7).

Despite what was stated above, there is still debate over the role of attached gingiva in the long-term success of implants (6,14).

The present study, therefore, examined 80 implants in 63 patients to evaluate the effect of the height of attached gingiva on the probing depth, BOP, plaque amount around the implant, degree of inflammation, and patients' comfort when tooth-brushing and chewing. All patients were divided into three groups as follows: patients with marginal gingiva, patients with attached gingiva which had a maximum height of 2 mm, and patients with attached gingiva which had a minimum height of 2 mm.

Out of 80 implants examined in this study, 23 implants (28.8%) had an attachment level of 0 mm, 24 ones (30%) had an attachment level of 0-2 mm, and 33 ones (41.2%) had an attachment level of >2 mm.

With an increase in the attachment level of the gingiva, a decrease in probing depth was observed. There was a significant difference in the probing depth of surfaces with different attachment levels, meaning that there was a statistical relationship between the attachment levels and probing depth. The two groups with the attachment level of more than zero had lower mean value in the probing depth than that in the group with the attachment level of 0. No significant difference was observed in the probing depth of surfaces with the attachment levels of 0-2 and >2.

Chung et al placed 339 implants in 69 completely edentulous patients and measured the width of attached gingiva, keratinized mucosa, plaque amount, the degree of inflammation, bleeding, probing depth, and the rate of bone resorption over three years. They found no difference between the group with keratinized gingiva and the group without keratinized gingiva regarding the rate of bone resorption. However, the degree of inflammation and plaque amount were higher in implants with smooth surfaces than those with rough surfaces. In addition, the degree of inflammation and plaque amount in implants with keratinized gingiva of <2 mm and attached gingiva of <1 mm were more than implants with keratinized gingiva of >2 mm and attached gingiva of >2 mm (15).

Therefore, it seemed that the presence of attached gingiva with at least the attachment level of 1 mm was essential for preventing plaque formation and maintaining the gingival health around the implant. Chackartchi et al concluded that a sufficient width of the keratinized gum resulted in softer and harder tissue stability, less plaque accumulation, limited soft tissue resorption, and less mucositis around the implant (16).

According to the results from this study, the highest percentage of bleeding was recorded for the patients with an attachment level of 0, and the lowest one was reported for those with an attachment level of >2. The systematic review study by Thoma et al found that soft tissue transplantation methods did not lead to a significant improvement in bleeding index, but marginal bone loss gradually decreased compared to the control group (13).

In a study conducted by Schrott et al, plaque formation and gingival bleeding were reported to increase in the group with the keratinized gingiva of <2 mm than the group with that of > 2 mm; however, the width of keratinized gingiva had no effect on plaque formation and buccal bleeding (7).

With an increase in the attachment level of the gingiva, a decrease was discovered in the plaque amount. The two groups with an attachment level of >0 had a lower mean value in plaque amount than the group with an attachment level of 0. However, the difference between 0-2 and >2 was not statistically significant. This result could be attributed to the fact that when the gingiva had the minimum attachment level of 1 mm, patients demonstrated more ability in cleaning it; and when the attachment level of the gingiva was 0, this could be considered as a plaque retentive factor.

According to our study results, the highest percentage of people with the attachment level of 0 had the inflammation degree G1; however, in the other two groups with the attachment levels of 0-2 and >2, the highest percentage of participants had the inflammation degree G0. The possibility of inflammation was increased in the group with no attached gingiva than the group with an attachment level of >2. This difference was statistically significant. However, the difference between 0-2 and >2 was not statistically significant.

In a study performed by Crespi et al (17), the plaque amount, the degree of inflammation, BOP, and dehiscence

were higher in the group with the keratinized gingiva of <2 mm than the one with the keratinized gingival of >2 mm.

As for the attachment level of the gingiva, the highest percentage of patients in all three groups had no problems while brushing their tooth. In the group with the attachment level of 0, one patient complained of a problem when tooth-brushing; while in other two groups, no complaint was reported in this regard.

The percentage of patients having problems in the group with the attachment level of <2 was less than that in other two groups. In other words, the absence of the attached gingiva had rarely caused problems to maintaining oral health, and patients provided with enough information regarding oral health could maintain good oral health even in regions with no attached gingiva.

In all three groups, the highest percentage of participants had no problem while chewing, and no one complained of a serious difficulty in chewing. Although the statistical test showed no significant difference in the frequency, the number of patients without problems during chewing was discovered to be more in the group with an attachment level of >2 than in the groups with the attachment levels of 0 and 0-2. When asking this question(do you have trouble chewing), an attempt was made to exclude patients who complained of chewing due to food impaction or open embrasures. Investigating this issue was perhaps the most challenging one and, therefore, an attempt was made to interpret the results more cautiously.

Chung et al have reported that if the dimension of keratinized gingiva is appropriate, the rate of alveolar bone resorption does not significantly decrease, but the degree of inflammation and plaque amount decreases significantly (6, 15).

Wennström et al (18) and Bengazi et al (19) have also shown that the width of attached gingiva and soft tissue movement are not necessary to control plaque and mucosal health around implants because they do not anticipate the risk of future dehiscence. In other words, these researches have demonstrated that the lack of movable gingiva has no adverse effect on the health of the gingiva near the implant and the soft tissues around the implant (6).

According to the overall results from this study, although gingival augmentation surgical procedures such as free gingival graft were associated with problems posed for patients, but this surgery seemed that is useful when the attachment level of the gingiva is zero and is essential for the maintenance of long-term health of the implant and the surrounding tissues. These surgical procedures could be implemented before or after the placement of the implant. Some sources, however, have demonstrated more preference of the correction of soft tissue over the correction of bone defects (3).

Conclusions

According to our study results, with an increase in the height of the attached gingiva, decreases were observed in probing depth, BOP, implant plaque index, full-mouth plaque index, and degree of inflammation. Moreover, as the height of the attached gingiva increased, patients felt less discomfort when tooth-brushing and chewing. Taking our study results into account, therefore, surgical procedures such as FGG are recommended to correct mucosal defects, as well as to increase the width of the attached gingiva around the implants.

Conflict of Interest Disclosures

The authors declare that they have no conflict of interests.

Ethical Statement

The present retrospective cohort clinical study was approved by the University Ethics Committee (p/16/35/9/5426) and was performed in accordance with the Declaration of Helsinki. Moreover, all patients expressed their willingness to participate in this study.

Authors' Contribution

Both authors equally contributed in to the design and implementation of the research, analysis of the results and wrote the article.

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