Original Research Article

Efficacy of Collagen Matrix (Mucograft® and Mucoderm®) Versus Free Gingival Graft to Enhance the Width of Keratinized Tissue Around Implants

İmplantlarının Etrafındaki Keratinize Dokunun Genişliğini Arttırmak İçin Kullanılan Kolajen Matriks Türevleri (Mucograft® ve Mucoderm®) ile Serbest Dişeti Greftinin Etkinliğinin Karşılaştırılması

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ABSTRACT

Aim: The purpose of this study was to test collagen matrices in order to increase keratinized tissue around dental implants when compared with free gingival graft.

Material and Methods: A total of 18 patients with 36 implants were included in this study. Participants were divided randomly into three groups; Plaque Index, Gingival Index, Bleeding On Probing, Probing Depth, The Width of the Keratinized Mucosa and Thickness of Keratinized Mucosa at Augmentation Site were measured at baseline and then 1st, 3rd and 6th months following the surgery.

Results: Clinical parameters of the augmentation area within and between groups showed a statistically significant difference between the baseline values of the augmentation site when compared to values of the 1st, 3rd and 6th months ($p<0.05$). Peri-implant keratinized gingiva increased in thickness compared to the baseline values. However, there were no major differences observed between autogenous and porcine collagen graft materials.

Conclusions: Collagen matrices were useful in increasing the keratinized gingiva in terms of improving gingival health in all the groups.

Keywords: Dental implant; Keratinized gingiva; Periodontal surgery; Porcine collagen matrix

ÖZET

Amaç: Bu çalışmanın amacı, implantların etrafındaki keratinize dokuyu arttırmayı amaçlayan kolajen matriks türevlerini serbest dişeti grefti ile karşılaştırmaktır.

Gereç ve Yöntem: Çalışmaya 36 implantı olan 18 hasta dahil edildi. Katılımcılar rastgele üç gruba ayrıldı: Plak indeksi, gingival indeks, sondlamada kanama, cep derinliği, keratinize mukozanın genişliği ve keratinize mukoza kalınlığı başlangıçta, ameliyattan sonra 1., 3. ve 6. aylarda ölçüldü.

Bulgular: Ogmentasyon alanının klinik parametreleri, grup içi ve gruplar arasında başlangıç değerlerine göre 1., 3. ve 6. aylarda istatistiksel olarak anlamlı fark görüldü ($p <0.05$). İmplant çevresi keratinize doku kalınlığı başlangıca göre artmış bulundu. Bununla birlikte, otojen ve domuz kollajen greft materyalleri arasında büyük bir fark gözlenmedi.

Sonuç: Kolajen matrisler, tüm gruplarda dişeti sağlığının iyileştirilmesi açısından keratinize diş etini artırmada yararlı olmuştur.

Anahtar kelimeler: İmplant; Keratinize dişeti; Kolajen matriks; Periodontal cerrahi

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INTRODUCTION

The connective and support tissue around the implant keeps and protects the implant as it is in natural teeth.[1] Insufficiency of keratinized gingival tissue, around the implant is one of the major problems in terms of maintaining the health of the connective and supportive tissue around the implant.[2] Sufficient amount of keratinized gingiva around the implant protects the connective and supporting tissue by reducing the accumulation of plaque and creating an immobile gingival sulcus.[3] The amount of keratinized gingiva varies depending on the age of the patient and the location of the tooth. It is known that a minimum of 1 or 2 mm of keratinized gingival tissue is required to maintain the health of periodontal tissues.[4] Recently the importance of keratinized tissue has been emphasized for better organization of the supportive tissue with a better understanding of the differences between natural tooth and implant tissue.[5, 6] Unlike natural teeth, the parallel course of connective tissue fibrils around the implant abutment creates a weaker sulcular barrier area. If the mucosa around the abutment does not have sufficient characteristics, the microbial invasion of dental plaque is facilitated and results with inflammation.[7, 8] There is a consensus about the positive effects of keratinized tissue width on the survival rate of dental implants.[9]

Various methods are used to measure or increase keratinized gingiva around the implant.[10] Augmentation is a method to gain keratinized gingiva. Various graft alternatives can be used in an augmentation. Augmentations with autogenous grafts are preferred due to the low costs and less complications. However, autogenous grafts may be disadvantageous in terms of patient comfort. Alternative allograft materials have been developed to eliminate the disadvantages of autogenous grafts (free gingival graft). One of its alternatives, Mucoderm® (Botiss gmbh, Berlin, Germany) is an allograft obtained from porcine dermis containing elastin and type 1-3 collagen and transformed into acellular dermal matrix by various processes. Mucoderm® creates a homogeneous healing area in the tissue with its three-dimensional structure. Mucograft® (Geistlich Biomaterials GmbH, Baden, Germany) is another alternative allograft. The Mucograft® consists of non-cross-linked type 1-3 porcine collagen and has two layers. The first layer has an easily sutured elastic structure and the second layer has a spongy, thick, porous structure. Collagen matrix grafts create three dimensional structures with fibroblasts, epithelial cells, and blood vessels. It has been thought that the vascularity improves with the structure of the collagen matrix by the stabilization of the clot, creates new tissue by creating a gap and therefore it will provide better results in implants with some keratinized tissue around the surrounding gingiva.[11]

The aim of the study was to evaluate the safety and efficiency of Mucograft® and Mucoderm® as an alternative to the free gingival graft procedures designed to increase keratinized gingiva around the implant.

MATERIAL AND METHODS

The present study was planned as a randomized controlled clinical design with 6 months follow-up. A total of 18 patients and 36 implants with prosthetic superstructure, functional keratinized tissue width of 2 mm or less and peri-implant mucositis at the soft tissue around the implant, were selected from the patients included in maintenance programs of the Periodontology Department of Gazi University, Ankara, Turkey. Informed consent was obtained from all participants, based on the study approval of the Institutional Review Board at Ankara University, Faculty of Dentistry, Ankara, Turkey (Protocol ID: 07.02.2013-46) and performed in accordance with the Helsinki Declaration of 1975, as revised in 2000.

Patient Selection

Inclusion criteria were as follows; not to use corticosteroid-containing drugs, without any metabolic or systemic disease and pregnancy, the presence of keratinized gingiva ≤2 mm associated with plaque accumulation, no history of mobility, trauma and unsuccessful prosthetic restorations. Patients older than 18 years old, with good oral hygiene, not bleeding on probing (BoP)[12], dentate that were not needed prosthetics or orthodontic treatment were included in this study. Exclusion criteria were: 1)Smoking, 2) Uncontrolled diabetes, 3)Systemic conditions precluding periodontal surgery, 4)Systemic conditions affecting the periodontium 5)History of mucogingival surgery in the area and 6)Pathologic movement of the involved teeth.

In the present study, a blind assignment was performed to the randomization of the patients in each group. The patients were ordered according to the time of surgery. Secret assignment was performed using closed and encrypted envelopes which were opened just before the surgery. There were 3 groups examined in this study. The test group 1 (TG1) included 12 implants and use of Mucograft®, test group 2 (TG2) included 12 implants and use of Mucoderm® and the control group (CG) included 12 implants using only Free Gingival Graft (FGG). All the operations were performed with an experienced surgeon who was blind to the randomization procedures.

Clinical Parameters

Patients received oral hygiene instructions four weeks prior to surgery. If necessary, phase 1 and phase 2 periodontal treatments were performed. Patients with no expected improvement following phase 1 treatment were excluded from the study. Four weeks after the completion of the phase 1 treatment, a PhD student who was blind to the study protocol performed a 'whole mouth plaque index (PI) and gingival index (GI) prior to surgery. Patients with values below < 15% were included in this study. All the measurements were performed with a standard periodontal probe (Williams periodontal probe, Hu-Friedy®, Chicago, IL, USA) 1)PI[13], 2)GI[14], 3)Bleeding on probing (BoP)[12], 4) Probing depth (PD) was measured from the distance between the margin of the peri-implant mucosa through the base of the peri-implant sulcus, 5) The width of the keratinized mucosa (KMW) in the buccal regions of the implants was measured from the margin of the peri-implant mucosa to the muco-gingival junction; 6) Thickness of keratinized mucosa (KMT) was measured at mid-buccal aspect of the implant sites, 1 mm apical to the peri-implant mucosal margin within keratinized mucosa using a 15 endodontic reamer (Mani, Takanezawa, Japan) attached to a rubber stopper under local anesthesia. The distance between the tip of the reamer and the rubber stopper was measured using a digital caliper with 0.05 resolutions (Alpha Tools, Mannheim, Germany).

Surgical Procedure

All the operations were performed by the same surgeon under local anesthesia (Ultracain® DS forte; Sanofi, Paris, France). Before the surgery, mouth was rinsed with 10-15 ml of 0.2% chlorhexidine digluconate mouth rinse (Klorhex®, Drogsan, Turkey) for 1 min. A horizontal split-thickness incision was made at the mucogingival border with a #15c blade (Beybi®, İstanbul, Turkey) and a mucosal half thickness flap was raised. The mucosal flap was sutured to the apical of the periosteum to create vestibular depth with 5-0 resorbable sutures (Dogsan®, Trabzon, Turkey). A FGG was taken from the appropriate donor site, where the molar teeth were located for the control group. Autogenous graft recipient site was sutured with 4-0 silk sutures (Dogsan®, Trabzon, Turkey). FGG was secured in the recipient site with simple suture using non-resorbable silk suture 5-0 (Dogsan®, Trabzon, Turkey). In the test groups where collagen matrix was applied, the area was prepared and then covered with collagen matrix grafts. The collagen matrix was sutured through the four edges of the surrounding mucosa with resorbable 5-0 suture (Dogsan®, Trabzon, Turkey).

Postoperative care procedures

Patients were prescribed a 0.2% chlorhexidine digluconate mouth rinse (Klorhex®, Drogsan, Turkey) twice daily for 2 weeks. Sutures were removed at 2 weeks. After the stitches were removed, a soft-bristled toothbrush (Curaprox® CS Surgical, mega soft toothbrush, Switzerland) was recommended. The patients were recalled at 1st, 3rd, and 6th months to obtain periodontal parameters and also postsurgical controlling. In case of need, the professional tooth cleaning has been done for removing the existing deposits.

Statistical analysis

The Wilcoxon Sign Ranks test was used to compare the differences within the groups, and the Kruskal Wallis-H test was used to compare the differences between the groups. Data analysis was performed using statistical software (IBM SPSS®, Chicago, IL, USA). A significance level was defined as $p<0.05$.

RESULTS

Patients

The study population consisted of 18 patients. The 36 single-unit implants were included in this study. Distribution of the dental implants according to the localizations in all the groups were as follow: TG1; 7 molar, 5 premolar area, TG2; 5 molar, 4 premolar, 3 incisor area, CG; 5 premolar, 5 molar, 2 incisor area.

Clinical examinations

Clinical parameters for full mouth within and between groups were found to have statistically significant differences between baseline and at 1st, 3rd and 6th month values for the full mouth PI. The within group data for GI in all the groups showed p<0.05 with baseline values being significantly higher than the values at 1st, 3rd and 6th months (Table 1).

There was also a statistically significant difference between the baseline and at the 1st, 3rd and 6th month values of the full mouth PD in CG (p<0.05). It was found that the baseline values were significantly higher than the values at 1st, 3rd and 6th months. For the TG1, there was no statistically significant difference between the baseline and at the 1st, 3rd and 6th month values of the full mouth PD (p>0.05). However, a statistically significant difference was observed between the baseline and at 1st month values of full mouth PD in TG2 (p<0.05). Baseline values were found to be significantly higher than those at 1st month (Table 1).

The baseline values of full mouth PI significantly differed between groups (p<0.05). It was seen that the values of the CG were significantly higher than the values of the TG1. The mean full mouth PI at the 1st month was statistically different according to the groups (p<0.05). It was observed that the values of the CG were significantly higher than the values of the TG2. There was no significant difference between the groups in full mouth PI at the 3rd month (p>0.05). The 6th month values of full mouth PI differed statistically according to the groups (p<0.05). It was observed that the values of the CG were significantly higher than the values of the TG1 and TG2 (Table 1). There was no statistically significant difference between the groups for baseline and 1st, 3rd and 6th month full mouth GI values (p>0.05) (Table 1).

In comparison of the mean PD values between groups; no statistically significant difference was observed between the groups in terms of baseline values of full mouth PD (p>0.05). The mean of full mouth PD at 1st month significantly differed between the groups (p<0.05). It was observed that TG2 values were significantly lower than the values of CG and TG1. The mean of full mouth PD at 3rd month was statistically different between the groups (p<0.05). The CG values were found to be significantly lower than the TG1 values. Full mouth PD 6th month values

Table 1. Full mouth intra- and intergroup comparisons of clinical parameters

Parameters		Baseline	1 Month	3 Month	6 Month	p values		
		Mean± SD	Mean± SD	Mean± SD	Mean± SD	Baseline 1 Month	Baseline 3 Month	Baseline 6 Month
PI	TG1	0.45± 0.24	0.38± 0.19	0.34± 0.14	0.32± 0.12	0.003[a]	0.003[a]	0.003[a]
	TG2	0.68± 0.33	0.30± 0.35	0.29± 0.24	0.31± 0.19	0.002[a]	0.002[a]	0.002[a]
	CG	0.96± 0.37	0.71± 0.46	0.49± 0.30	0.59± 0.30	0.007[a]	0.002[a]	0.002[a]
	p value	0.013[b]	0.017[b]	0.236[b]	0.006[b]			
GI	TG1	0.99± 0.39	0.70± 0.20	0.59± 0.13	0.57± 0.10	0.003[a]	0.003[a]	0.003[a]
	TG2	0.88± 0.11	0.50± 0.15	0.48± 0.12	0.48± 0.12	0.002[a]	0.002[a]	0.002[a]
	CG	1.14±0.46	0.76± 0.36	0.55± 0.09	0.50± 0.19	0.002[a]	0.002[a]	0.002[a]
	p value	0.256[b]	0.105[b]	0.157[b]	0.253[b]			
PD(mm)	TG1	2.11± 0.34	2.06± 0.38	2.11± 0.30	2.18± 0.27	0.054[a]	0.238[a]	0.952[a]
	TG2	1.68± 0.34	1.51± 0.36	1.75± 0.29	1.80± 0.29	0.005[a]	0.959[a]	0.238[a]
	CG	2.33± 1.07	2.06± 0.80	1.67± 0.33	1.95± 0.59	0.003[a]	0.005[a]	0.003[a]
	p value	0.062[b]	0.004[b]	0.005[b]	0.034[b]			

a:Wilcoxon Signed Ranks Test
b: Kruskal Wallis-H Test
PI: Plaque Index, GI: Gingival Index, PD: Probing Depth
TG1: Test Group 1, TG2: Test Group 2, CG: Control Group

Table 2. Augmentation site intra- and intergroup comparisons of clinical parameters

Parameters		Baseline Mean± SD	1 Month Mean± SD	3 Month Mean± SD	6 Month Mean± SD	p value Baseline 1 Month	p value Baseline 3 Month	p value Baseline 6 Month
PI	**TG1**	1.09±0.40	0.70±0.48	0.61±0.44	0.31±0.28	0.028[a]	0.012[a]	0.003[a]
	TG2	1.47±0.44	0.85±0.54	0.38±0.39	0.19±0.33	0.007[a]	0.002[a]	0.002[a]
	CG	1.58±0.52	0.75±0.41	0.63±0.39	0.67±0.53	0.003[a]	0.005[a]	0.003[a]
	p value	0.035[b]	0.726[b]	0.265[b]	0.023[b]			
GI	**TG1**	1.97±0.12	1.13±0.24	0.82±0.44	0.53±0.39	0.002[a]	0.002[a]	0.002[a]
	TG2	1.82±0.33	0.91±0.33	0.73±0.33	0.52±0.41	0.003[a]	0.003[a]	0.003[a]
	CG	1.94±0.11	1.24±0.63	0.74±0.45	0.61±0.53	0.011[a]	0.002[a]	0.003[a]
	p value	0.333[b]	0.087[b]	0.725[b]	0.991[b]			
BoP	**TG1**	0.85±0.24	0.14±0.22	0.00±0.00	0.06±0.13	0.002[a]	0.002[a]	0.002[a]
	TG2	0.86±0.23	0.25±0.21	0.11±0.16	0.14±0.17	0.002[a]	0.003[a]	0.002[a]
	CG	0.85±0.28	0.33±0.45	0.06±0.19	0.08±0.21	0.007[a]	0.002[a]	0.002[a]
	p value	0.979[b]	0.411[b]	0.067[b]	0.326[b]			
PD(mm)	**TG1**	2.30±0.68	2.07±0.66	1.99±0.58	1.85±0.59	0.074[a]	0.056[a]	0.041[a]
	TG2	2.82±0.82	2.08±0.64	1.98±0.28	1.99±0.53	0.012[a]	0.008[a]	0.013[a]
	CG	3.07±1.60	2.54±0.83	2.22±0.83	2.34±0.86	0.144[a]	0.028[a]	0.021[a]
	p value	0.306[b]	0.254[b]	0.807[b]	0.222[b]			
KMW(mm)	**TG1**	0.76±0.81	2.12±1.02	2.00±1.22	1.97±1.19	0.002[a]	0.003[a]	0.003[a]
	TG2	0.96±0.86	2.04±1.33	2.25±1.57	2.08±1.28	0.002[a]	0.002[a]	0.002[a]
	CG	0.25±0.62	1.13±0.84	1.38±0.88	1.29±0.88	0.005[a]	0.003[a]	0.003[a]
	p value	0.058[b]	0.051[b]	0.325[b]	0.233[b]			
KMT(mm)	**TG1**	2.47±1.10	2.97±1.53	2.55±0.79	2.57±0.80	0.099[a]	0.814[a]	0.754[a]
	TG2	2.37±0.90	2.87±1.18	2.99±1.03	2.82±0.89	0.084[a]	0.023[a]	0.060[a]
	CG	3.14±1.16	3.14±0.87	3.02±0.85	2.97±0.89	0.906[a]	0.695[a]	0.695[a]
	p value	0.134[b]	0.442[b]	0.323[b]	0.479[b]			

a:Wilcoxon Signed Ranks Test
b: Kruskal Wallis-H Test
PI: Plaque Index, GI: Gingival Index, BoP: Bleeding on Probing, PD: Probing Depth, KMW: Keratinized Mucosa Width, KMT: Keratinized Mucosa Thickness,
TG1: Test Group 1, TG2: Test Group 2, CG: Control Group

significantly differed between the groups (p<0.05). It was seen that TG1 values were significantly higher than the values of CG and TG2 (Table 1).

Clinical parameters for augmentation area within and between groups showed statistically significant difference between the baseline and at 1st, 3rd and 6th months values for PI, GI, BoP, KMW of the augmentation site (p<0,05). Baseline PI, GI, BoP values were found to be significantly higher than the mean values at 1st, 3rd and 6th month for all groups. The mean of KMW at baseline was found to be significantly lower than the follow-up periods for TG1, TG2 and CG (Table 2).

PD and KMT values differ within groups. There was a statistically significant difference in PD between the baseline and at the 3rd and 6th month values of CG and TG2 group (p<0.05). Baseline values were found to be significantly higher than the values at 3rd and 6th month for these two groups. Unlike for TG1; there was a statistically significant difference between the baseline and at the 6th month values of PD (p<0.05). Baseline values were found to be significantly higher than the values at the 6th month (Table 2).

At the augmentation site, KMT values for CG and TG1, no statistically significant difference was observed between the baseline and at the 1st, 3rd and 6th month values of BMT (p>0.05). In group TG2, there was a statistically significant difference between baseline and at 3rd months for the values of BMT (p<0.05). Baseline values were found to be significantly lower than the values in the 3rd month (Table 2). Moreover, in comparison PI values at the augmented site between groups were statistically significant (p<0.05). In CG, PI values were found to be significantly higher than TG1. There was no statistically significant difference between the groups in

terms of the 1st and 3rd month PI values (p>0.05). However, PI at 6th month values were significantly higher in CG than TG2 values (p<0.05) (Table 2). There was no statistically significant difference between the groups for the baseline, and at 1st, 3rd and 6th month for GI, PD, BoP, KMW, and KMT values (p>0.05) (Table 2).

DISCUSSION

Performance of three different grafts used in augmentation in increasing keratinized gingiva was evaluated in the present study. The effect of keratinized gingiva on the health of the tissue around the implant was compared. The importance of the presence of keratinized gingiva in the health of natural teeth has been shown in many studies.[15-20] Peri-implant mucositis is a soft tissue disease that turns into peri-implantitis with the destruction of the marginal bone.[23] There is a similar relationship between implant survival and width of keratinized gingiva.

In this study, FGG was applied to the control group to increase keratinized gingiva around the implant.[21, 22] Two different collagen grafts were applied to the test groups; it has been observed in studies that it is an alternative method of gaining keratinized gingival tissue.[19] Besides the disadvantages of autogenous graft applications such as second surgical wound formation, bleeding and pain, the use of collagen grafts provides an advantage. There are studies with similar results in case of using autogenous grafts.[5, 19, 23, 24] Studies have indicated that the acellular dermal matrix causes an increase in the amount of keratinized tissue and has similar cellular component but it is less effective in increasing the keratinized tissue width and covering the open root surface when compared to the subepithelial connective tissue grafts.[19, 25-27]

Periodic measurements were performed in order to understand the effect of having sufficient keratinized gingiva on oral health. In our study, baseline PI values showed that oral hygiene of patients was sufficient. However, the fact that patients diagnosed with peri-implant mucositis did not show high index values, indicating that oral hygiene alone is not sufficient in maintaining periodontal health.[15, 28, 29] In individuals with low incidence of implant failure, the connective tissue barrier around the titanium structure is considered to be intact.[30] Studies about the implant surrounding tissues have exhibited a correlation between low keratinized tissue and inflammation.[6, 17, 31] This situation was also observed in the present study, GI values decreased in the follow-up periods in all groups due to the decrease in inflammation. This decrease in GI value was also seen in PI values. This can be attributed to the reduction of inflammation in the area that eliminates the plaque. All implants used in the study were positive in BoP. In order to evaluate bleeding parameter properly volunteers of this study were selected among patients who are medically healthy, not smoker and not on any use of medication. It was determined that, bleeding values decreased in the 1st, 3rd, and 6th months after surgical procedures. Although the average ideal PD value for dental implants was not available in the literature, it has been reported that increased PD may be associated with increased inflammation in the mucosa around the implant.[32, 33] Significantly higher baseline values in FGG and collagen matrix applied groups were found compared to the values obtained at the 3rd and 6th months. When changes between groups were analyzed, there was no statistically significant difference in PD values for all groups. Although KMW increased in all groups, the least increase was observed in CG. This can be considered a disadvantage for CG. Despite that, CG has not displayed unsuccessful results compared with other groups in terms of KMW values.

In this study, it was observed that the collagen matrix increased keratinized tissue around the implant, at the same time; it facilitated the formation of a clot with its spongy inner layer and induced angiogenesis. Even operatively, the biggest advantage is that it does not need primary closure, although it has little or no adherent gingival tissue, it has been observed that it provides the formation of keratinized gingiva. Similarly, in our study, keratinized tissue increase was observed in the groups that received collagen matrix; compared to the group with FGG where the donor site was not operated. Besides, the patient's morbidity and duration of surgery were less in collagen matrix graft groups.

In this study, similar post-operative results were observed when collagen matrix grafts were used for keratinized tissue augmentation comparatively with

FGG. There was a little difference in the structure by the use of Mucograft® or Mucoderm® materials. In terms of post-operative keratinized tissue increase and change of GI no statistically significant differences were determined. Therefore, it is concluded that collagen allografts are a good alternative to autogenous grafts to increase the width of keratinized gingiva in the peri-implant soft tissue augmentation in order to gain sufficient keratinized gingival tissue width that has a positive effect on oral health.

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