

Research Article



OPEN ACCESS

Received: Jun 14, 2016

Accepted: Aug 16, 2016

*Correspondence to

Hyun-Seung Shin

Department of Periodontology, Dankook University College of Dentistry, 119 Dandae-ro, Dongnam-gu, Cheonan 31116, Korea.

E-mail: perioshin@dankook.ac.kr

Tel: +82-41-550-0263

Fax: +82-303-3442-7364

Copyright © 2016 Korean Academy of Periodontology

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>).

ORCID

Chang-Soon Kim

<http://orcid.org/0000-0001-7348-6003>

Hieu Pham Duong

<http://orcid.org/0000-0001-5409-0361>

Jung-Chul Park

<http://orcid.org/0000-0002-2041-8047>

Hyun-Seung Shin

<http://orcid.org/0000-0002-1410-9731>

Funding

The present research was conducted with the use of a research fund from Dankook University in 2013 (R-0001-18842).

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Preservation of keratinized mucosa around implants using a prefabricated implant-retained stent: a case-control study

Chang-Soon Kim,¹ Hieu Pham Duong,² Jung-Chul Park,¹ Hyun-Seung Shin^{1*}

¹Department of Periodontology, Dankook University College of Dentistry, Cheonan, Korea

²Department of Maxillo-Stomatology, Vietnam National University School of Medicine and Pharmacy, Hanoi, Vietnam

ABSTRACT

Purpose: The aim of this study was to clinically assess the impact of a prefabricated implant-retained stent clipped over healing abutments on the preservation of keratinized mucosa around implants after implant surgery, and to compare it with horizontal external mattress sutures.

Methods: A total of 50 patients were enrolled in this study. In the test group, a prefabricated implant-retained stent was clipped on the healing abutment after implant surgery to replace the keratinized tissue bucco-apically. In the control group, horizontal external mattress sutures were applied instead of using a stent. After the surgical procedure, the width of the buccal keratinized mucosa was measured at the mesial, middle, and distal aspects of the healing abutment. The change in the width of the buccal keratinized mucosa was assessed at 1 and 3 months.

Results: Healing was uneventful in both groups. The difference of width between baseline and 1 month was -0.26 ± 0.85 mm in the test group, without any statistical significance ($P=0.137$). Meanwhile, the corresponding difference in the control group was -0.74 ± 0.73 mm and it showed statistical significance ($P<0.001$). The difference of width between baseline and 3 months was -0.57 ± 0.97 mm in the test group and -0.86 ± 0.71 mm in the control group. These reductions were statistically significant ($P<0.05$); however, there was no difference between the 2 groups.

Conclusions: Using a prefabricated implant-retained stent was shown to be effective in the preservation of the keratinized mucosa around implants and it was simple and straightforward in comparison to the horizontal external mattress suture technique.

Keywords: Dental implants; Gingiva; Stents; Suture techniques

INTRODUCTION

The presence of keratinized mucosa around dental implants is a critical component for the maintenance of their health. Interestingly, there is a lack of consensus in the literature regarding the relationship between the width of the keratinized mucosa and the health of peri-implant tissues. Wennström et al. [1] reported that there is no correlation between implant success rate and the presence of keratinized tissue in the peri-implant soft tissue.

On the other hand, Warrer et al. [2] reported that experimentally ligated implants without keratinized mucosa accumulated more dental plaque and showed significantly more recession with attachment loss than implants where keratinized mucosa was present. Recently, a number of studies have reported that a lack of adequate keratinized mucosa around implants seems to be significantly associated with more plaque accumulation, tissue inflammation, mucosal recession, and attachment loss [3,4].

In contemporary implant treatment, the necessity of guided bone regeneration (GBR) has increased due to the concept of contour augmentation, and frequent GBR procedures usually lead to the reduction of keratinized mucosa around implants, since the flaps have to be advanced for tensionless primary closure [5,6]. To correct these mucogingival issues, a free gingival graft (FGG), an apically positioned flap, or a connective tissue graft is required if there is a minimal width of keratinized tissue, in order to increase the width [7]. If there is a sufficient amount of keratinized tissue near the implants, apically or laterally positioned flaps can be applied using the pre-existing keratinized mucosa [8,9], or the combination of an apically positioned flap (APF) and FGG can be used [10,11]. However, these techniques have distinct limitations, such as a limited quantity of donor tissue, common infections, morbidity of patients, bleeding from the donor area, and unpredictable failure. Also, these techniques are highly technique sensitive and time consuming, and therefore general clinicians may not favor them [12,13].

To overcome these disadvantages, a prefabricated implant-retained stent (Figure 1) clipped on provisional abutments was developed and evaluated in our previous study [14]. Using this prefabricated stent, pre-existing keratinized mucosa can be displaced in the bucco-apical direction and the width of the keratinized mucosa can be substantially preserved. Also, vertical pressure can be additionally applied over the displaced buccal flap, reducing the dead space under the flap, helping the displaced gingiva firmly attach to the underlying periosteum, and preserving the width of the pre-existing keratinized mucosa.

The aim of this study was to perform a prospective case control study to clinically assess the preservation of keratinized mucosa around implants after implant surgery using a prefabricated implant-retained stent clipped over healing abutments and to compare it with the application of horizontal external mattress sutures.



Figure 1. Clinical photo of a prefabricated implant-retained stent.

MATERIALS AND METHODS

Patient selection

This study was conducted according to guidelines from the Institutional Review Board (IRB) of Dankook University Dental Hospital (No. H-1503/003/004). All patients >18 years of age requiring first-stage implant surgery or second-stage implant surgery were enrolled after obtaining informed consent. The criteria for exclusion were as follows: 1) the presence of severe or aggressive untreated periodontal disease; 2) a history of systemic disease that would contraindicate surgical treatment; 3) reported long-term steroidal or antibiotic therapy; 4) current pregnancy; 5) unwillingness to return for the follow-up examination; and 6) smoking of >10 cigarettes per day.

A total of 50 patients (25 controls and 25 tests) were enrolled in this study (Table 1). Each patient was randomly allocated to a test group or control group.

Surgical procedures and measurements

Following local anesthesia, a lingualized incision was made to mobilize the keratinized mucosa to the buccal aspect. Implants were placed and healing abutment was connected to the implant fixture. In the test group, a prefabricated implant-retained stent (Louis Button®, Dentis Co., Daegu, Korea) was clipped on the healing abutment and adjusted to apply adequate pressure to the displaced flap (Figure 2). Additional sutures were minimally performed if there was a risk of slippage of the flaps from the stent. In the control group, horizontal external mattress sutures were applied to adapt flaps around the healing abutment and to apply vertical pressure (Figure 3). After surgical procedures, clinical photographs were taken and the amount of buccal keratinized mucosa was measured in the mesial, middle, and distal sites of the healing abutment using a periodontal probe (Williams®, Hu-Friedy, Chicago, IL, USA). The average of these measurements was used to represent the width of buccal keratinized tissue. Medication prescribed to all subjects consisted of 500 mg of amoxicillin plus sulbactam (Sultamox®, Kunwha, Seoul, Korea) and 370 mg of talniflumate (Somalgen®, 370 mg, Kunwha, Seoul, Korea), twice a day for 5 days, and mouthwash (Gum Gargle®, Sunstar, Tokyo, Japan). Patients were directed to use mouthwash, twice a day, and not to brush the surgical sites for 10 days. Stents and sutures were removed 10 days after surgery. Patients were recalled after 1 and 3 months. The amount of buccal keratinized mucosa was measured at these time points.

Table 1. Demographic information of the enrolled patients

Characteristics	Prefabricated implant-retained stent group (test)	Horizontal external mattress suture group (control)	P value
Gender			0.239 ^{a)}
Male	14	18	
Female	11	7	
No.	25	25	
Age (yr)			0.301 ^{b)}
Mean	54.28	54.40	
Median	54	54	
SD	7.15	7.09	
Min	38	44	
Max	74	68	
Site			0.569 ^{a)}
Maxilla	13	15	
Mandible	12	10	
No.	25	25	

SD, standard deviation; Min, minimum; Max, maximum.

^{a)}P values (statistically significant at the level of $P < 0.05$) with a χ^2 test for differences in means between groups in categorical variables; ^{b)}P values (statistically significant at the level of $P < 0.05$) with an independent-samples t-test for differences in means between groups.



Figure 2. Clinical photograph of #37 implant first-stage surgery, which was adopted with the horizontal external mattress suture technique (control group). (A) The flap was secured using horizontal external mattress sutures and vertical pressure was applied over the flaps. (B) Ten days post-operation. (C) Three months post-operation. The healing was uneventful and the width of keratinized mucosa was well preserved.



Figure 3. Clinical photograph of #35 implant first-stage surgery using a prefabricated implant-retained stent (test group). (A) The flap was placed bucco-apically using the stent. Dead space could be eliminated by vertical pressure from the stent. (B) Ten days post-operation. (C) Three months post-operation. Soft tissue healing is uneventful and the width of keratinized mucosa was well preserved.

Statistical analysis

Chi-square tests and *t*-tests were performed for demographic analysis. Mean values and standard deviations (SD) were calculated for each width assessed in the 2 treatment groups. Initially, changes of the width over the observation periods were determined with the use of the Friedman test. The Wilcoxon signed rank test was used to evaluate the differences between baseline and 1 month, and baseline and 3 months, while the Wilcoxon rank-sum test was used to evaluate the differences between the 2 groups at each time point. All evaluations were performed using SPSS software version 18.0 (IBM Corp., Armonk, NY, USA). The statistical significance was set at $P < 0.05$.

RESULTS

The test and control groups were composed of 14 male, 11 female patients, and 18 male, 7 female, respectively (Table 1). The mean age of the study patients was 54.28 ± 7.15 years in the test group and 54.40 ± 7.09 years in the control group. The surgical sites were divided into maxilla (52% in the test group and 60% in the control) and mandible. A total of 6 patients were excluded during the study since they failed to show up for the recalls. In the end, 44 patients were successfully treated and healing was uneventful in all patients.

At the end of the study, the width of keratinized mucosa had decreased over time in both groups. At baseline, the mean width of the keratinized mucosa around the healing

Table 2. Mean values and SD of the width of keratinized mucosa around the healing abutment with group differences

Groups	No.	Width of keratinized mucosa (mm)			Difference between baseline and 1 mon (mm)	Difference between baseline and 3 mon (mm)
		Baseline	1 mon	3 mon		
Prefabricated implant-retained stent group (test)	23	5.05±0.31	4.79±0.31	4.48±0.26	-0.26±0.85	-0.57±0.97 ^{a)}
Horizontal external mattress suture group (control)	21	4.22±0.28	3.48±0.23	3.36±0.23	-0.74±0.73 ^{b),c)}	-0.86±0.71 ^{d)}

SD, standard deviation.

^{a)}Statistically significant difference compared to the baseline at 3 months in the test group ($P=0.011$); ^{b)}Statistically significant difference compared to the baseline at 1 month ($P<0.001$); ^{c)}Statistically significant difference between test and control groups at 1 month ($P=0.034$); ^{d)}Statistically significant difference compared to the baseline at 3 months in the control group ($P<0.001$).

abutment was 5.05±0.31 mm in the test group and 4.22±0.28 mm in the control, and there was no statistical difference between groups (Table 2). After 1 month, the mean width of keratinized mucosa was 4.79±0.31 mm and 3.48±0.23 mm, respectively. The difference of width between baseline and 1 month was -0.26±0.85 mm in the test group without any statistical significance ($P=0.137$). Meanwhile, the corresponding difference in the control group was -0.74±0.73 mm and it showed statistical significance ($P<0.001$). These changes between the 2 groups were compared and the amount of reduction of keratinized tissue was greater in the control group, with statistical significance ($P=0.034$), suggesting that the sutures failed to preserve the width of keratinized tissue in the early healing phase at 1 month. The mean width of keratinized mucosa after 3 months was 4.48±0.26 mm in the test group and 3.36±0.23 mm in the control group. The difference of width between baseline and 3 months was -0.57±0.97 mm in the test group ($P=0.011$) and -0.86±0.71 mm in the control group ($P<0.001$). These amounts of reduction were statistically significant compared to the baseline. The reduction was substantially greater in the control group; nonetheless, there was no statistical difference. After these observations, all of the patients were treated with prostheses successfully, and they were routinely recalled for checkup thereafter.

DISCUSSION

The original idea of using stents for the mobilization and stabilization of displaced keratinized tissue around dental implants came from a number of previous studies, which used acrylic stents following periodontal plastic surgery [15-23]. After the soft tissue has been grafted, the secure immobilization of the graft for successful vascularization and healing, and the protection of the surgical area to prevent discomfort for patients, are crucial factors to consider in a clinical setting. For these purposes, acrylic stents have been utilized in various cases with perimandibular sutures [15-21], fixation bone screws [22,23], and adhesive [21,24] or osseointegrated dental implants [25,26]. Although these attempts have shown predictable and satisfying results, the time for the production of these stents is extensive, since these surgical stents are fabricated in the laboratory in advance before the surgery using altered casts, which also introduces additional cost. To overcome these shortcomings, the Loma Linda stent has been proposed, which can be fabricated chairside using photopolymerized resin [27]. However, the Loma Linda stent still takes additional processing and this may hinder clinicians from applying the tool in daily practice. The prefabricated implant-retained stent utilized in this study can be very useful, since it is of minimal cost and it significantly reduces chair time. Also, the size of the stent is as small as the healing abutments and the patient rarely feels any discomfort. The removal of the stent is also as easy as its connection, which can be very beneficial to clinicians in daily clinics.

In the present study, the impact of prefabricated implant-retained stent connection on the preservation of keratinized mucosa was compared to the horizontal external mattress suture technique following implant surgery. It was shown that the stent could effectively provide vertical pressure and stabilize the displaced flap during the initial healing period. Meanwhile, horizontal external sutures required meticulous effort and a significant amount of time to achieve the same purpose. Width reduction of the keratinized mucosa was similarly observed in both groups; however, it should be noted that the change in keratinized mucosa at 1-month follow-up was significantly greater in the control group than in the test group.

Because of less vascular supply and fewer fibroblasts, tissue around the implant is more susceptible to the development of inflammation and bone loss when exposed to plaque accumulation. For these reasons, the preservation of keratinized mucosa is one of the most important factors in implant maintenance. Several studies have indicated that the adequate width of keratinized mucosa for healthy tissues around dental implants is at least ≥ 2 mm [28-30]. Although a lack of keratinized mucosa may not influence the long-term survival rate of implants [1], many studies have commonly shown that the presence of keratinized mucosa is more important around restorations and prostheses than natural tooth, irrespective of oral hygiene status [31,32]. Also, implants surrounded by keratinized mucosa are less prone to plaque accumulation and gingival recession, without regard to whether patients engage in sufficient oral hygiene or receive adequate supporting periodontal therapy [4]. Therefore, clinicians should consider that it is essential to provide and maintain adequate keratinized mucosa for the successful long-term maintenance of implants.

Using a prefabricated implant-retained stent was shown to be equally effective for preserving the keratinized mucosa around a healing abutment compared to the control group after 3-month follow-up of the initial healing period. In the case of the conventional suturing method, it is time-consuming, and it is also difficult to apply enough vertical pressure over the displaced flap, leading to the creation of a dead space under the flaps. This dead space could be related to the delayed healing process or necrosis of the keratinized tissue in the worst cases. In contrast, the utilization of stents has the following benefits [14]: 1) the flap can be displaced in the bucco-apical direction with the existing keratinized mucosa, securing its position (Figure 4); 2) the flap

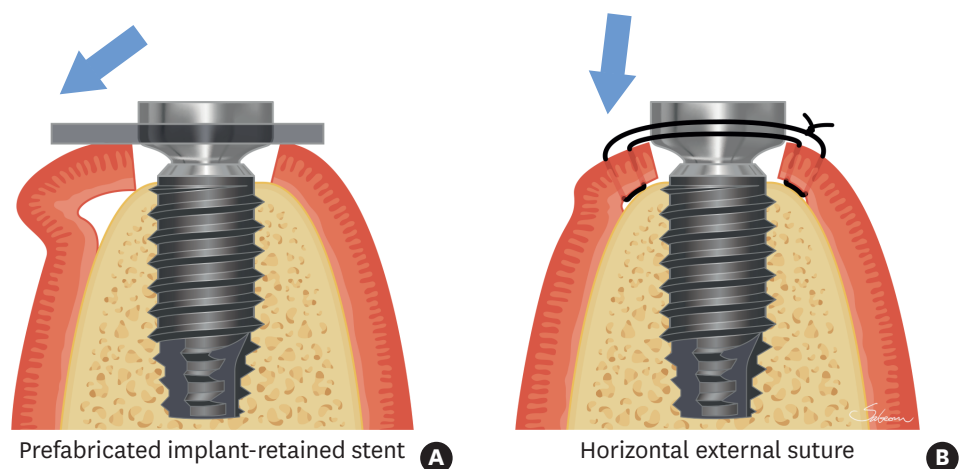


Figure 4. Schematic illustration showing the 2 different approaches. (A) Following the lingualized incision, the keratinized tissue was mobilized bucco-apically, and the prefabricated implant retained stent was applied to the healing abutment (test group). The flap is pressed down and displaced to preserve the keratinized tissue. (B) The external mattress suture is applied and the displaced flap is pushed down and apically (control group). However, there is limitation in the displacement in comparison to that of using the stent.

can be compressed and stabilized over the underlying periosteum and can prevent the reduction of the keratinized mucosa; 3) the application of sutures on vertical incision lines is not required; and 4) the stent can be used off-the-shelf conveniently, since it is standardized according to the size of the healing abutments the clinician used.

In sum, use of a prefabricated implant-retained stent was shown to be effective in the preservation of the keratinized mucosa around implants in comparison to the conventional external mattress suture technique, and it substantially reduced time and effort.

REFERENCES

1. Wennström JL, Bengazi F, Lekholm U. The influence of the masticatory mucosa on the peri-implant soft tissue condition. *Clin Oral Implants Res* 1994;5:1-8.
[PUBMED](#) | [CROSSREF](#)
2. Warrer K, Buser D, Lang NP, Karring T. Plaque-induced peri-implantitis in the presence or absence of keratinized mucosa. An experimental study in monkeys. *Clin Oral Implants Res* 1995;6:131-8.
[PUBMED](#) | [CROSSREF](#)
3. Lin GH, Chan HL, Wang HL. The significance of keratinized mucosa on implant health: a systematic review. *J Periodontol* 2013;84:1755-67.
[PUBMED](#) | [CROSSREF](#)
4. Rocuzzo M, Grasso G, Dalmasso P. Keratinized mucosa around implants in partially edentulous posterior mandible: 10-year results of a prospective comparative study. *Clin Oral Implants Res* 2016;27:491-6.
[PUBMED](#)
5. Fugazzotto PA. Maintenance of soft tissue closure following guided bone regeneration: technical considerations and report of 723 cases. *J Periodontol* 1999;70:1085-97.
[PUBMED](#) | [CROSSREF](#)
6. Trombelli L, Tatakis DN, Scabbia A, Zimmerman GJ. Comparison of mucogingival changes following treatment with coronally positioned flap and guided tissue regeneration procedures. *Int J Periodontics Restorative Dent* 1997;17:448-55.
[PUBMED](#)
7. Seibert JS. Reconstruction of deformed, partially edentulous ridges, using full thickness onlay grafts. Part I. Technique and wound healing. *Compend Contin Educ Dent* 1983;4:437-53.
[PUBMED](#)
8. Carnio J, Miller PD Jr. Increasing the amount of attached gingiva using a modified apically repositioned flap. *J Periodontol* 1999;70:1110-7.
[PUBMED](#) | [CROSSREF](#)
9. Carnio J, Camargo PM. The modified apically repositioned flap to increase the dimensions of attached gingiva: the single incision technique for multiple adjacent teeth. *Int J Periodontics Restorative Dent* 2006;26:265-9.
[PUBMED](#)
10. Karring T, Ostergaard E, Løe H. Conservation of tissue specificity after heterotopic transplantation of gingiva and alveolar mucosa. *J Periodontal Res* 1971;6:282-93.
[PUBMED](#) | [CROSSREF](#)
11. Karring T, Lang NP, Løe H. The role of gingival connective tissue in determining epithelial differentiation. *J Periodontal Res* 1975;10:141.
[PUBMED](#) | [CROSSREF](#)
12. Del Pizzo M, Modica F, Bethaz N, Priotto P, Romagnoli R. The connective tissue graft: a comparative clinical evaluation of wound healing at the palatal donor site. A preliminary study. *J Clin Periodontol* 2002;29:848-54.
[PUBMED](#) | [CROSSREF](#)
13. Soileau KM, Brannon RB. A histologic evaluation of various stages of palatal healing following subepithelial connective tissue grafting procedures: a comparison of eight cases. *J Periodontol* 2006;77:1267-73.
[PUBMED](#) | [CROSSREF](#)
14. Park JC, Yang KB, Choi Y, Kim YT, Jung UW, Kim CS, et al. A simple approach to preserve keratinized mucosa around implants using a pre-fabricated implant-retained stent: a report of two cases. *J Periodontal Implant Sci* 2010;40:194-200.
[PUBMED](#) | [CROSSREF](#)

15. Moore JR. A modification of stent design for preprosthetic surgery. *J Oral Surg* 1970;28:263-6.
[PUBMED](#)
16. Sanders B, Starshak TJ. Modified technique for palatal mucosal grafts in mandibular labial vestibuloplasty. *J Oral Surg* 1975;33:950-2.
[PUBMED](#)
17. Firtell DN, Oatis GW, Curtis TA, Sugg WE Jr. A stent for a split-thickness skin graft vestibuloplasty. *J Prosthet Dent* 1976;36:204-10.
[PUBMED](#) | [CROSSREF](#)
18. Hughes WG, Howard CW 3rd. Simultaneous split-thickness skin grafting and placement of endosteal implants in the edentulous mandible: a preliminary report. *J Oral Maxillofac Surg* 1992;50:448-51.
[PUBMED](#) | [CROSSREF](#)
19. Kahnberg KE, Nystrom E, Bartholdsson L. Combined use of bone grafts and Brånemark fixtures in the treatment of severely resorbed maxillae. *Int J Oral Maxillofac Implants* 1989;4:297-304.
[PUBMED](#)
20. Nyström E, Kahnberg KE, Albrektsson T. Treatment of the severely resorbed maxillae with bone graft and titanium implants: histologic review of autopsy specimens. *Int J Oral Maxillofac Implants* 1993;8:167-72.
[PUBMED](#)
21. Small SA. Surgical stents and major oral maxillofacial surgery. *Dent Clin North Am* 1989;33:497-509.
[PUBMED](#)
22. ten Bruggenkate CM, Krekeler G, van der Kwast WA, Oosterbeek HS. Palatal mucosa grafts for oral implant devices. *Oral Surg Oral Med Oral Pathol* 1991;72:154-8.
[PUBMED](#) | [CROSSREF](#)
23. Grgurević J, Knezević G, Kobler P, Krmpotić I. An alternative method of fixation of alveolar ridge mucosa during the vestibuloplasty procedure. *Br J Oral Maxillofac Surg* 1988;26:370-4.
[PUBMED](#) | [CROSSREF](#)
24. Hall HD. Vestibuloplasty, mucosal grafts (palatal and buccal). *J Oral Surg* 1971;29:786-91.
25. Brygider RM, Bain CA. Custom stent fabrication for free gingival grafts around osseointegrated abutment fixtures. *J Prosthet Dent* 1989;62:320-2.
[PUBMED](#) | [CROSSREF](#)
26. Ziccardi VB, Misch C, Patterson GT, Nawrocki JS. Use of endosseous implants to fixate a surgical stent in conjunction with mandibular vestibuloplasty. *Compendium* 1993;14:774, 776, 778-9.
27. Proussaefs P, Lozada J, Kleinman A. The "Loma Linda stent": a screw-retained resin stent. *J Oral Implantol* 2003;29:19-23.
[PUBMED](#) | [CROSSREF](#)
28. Langer B, Langer L. Overlapped flap: a surgical modification for implant fixture installation. *Int J Periodontics Restorative Dent* 1990;10:208-15.
[PUBMED](#)
29. Landi L, Sabatucci D. Plastic surgery at the time of membrane removal around mandibular endosseous implants: a modified technique for implant uncovering. *Int J Periodontics Restorative Dent* 2001;21:280-7.
[PUBMED](#)
30. Lee KH, Kim BO, Jang HS. Clinical evaluation of a collagen matrix to enhance the width of keratinized gingiva around dental implants. *J Periodontal Implant Sci* 2010;40:96-101.
[PUBMED](#) | [CROSSREF](#)
31. Valderhaug J, Birkeland JM. Periodontal conditions in patients 5 years following insertion of fixed prostheses. Pocket depth and loss of attachment. *J Oral Rehabil* 1976;3:237-43.
[PUBMED](#) | [CROSSREF](#)
32. Stetler KJ, Bissada NF. Significance of the width of keratinized gingiva on the periodontal status of teeth with submarginal restorations. *J Periodontol* 1987;58:696-700.
[PUBMED](#) | [CROSSREF](#)