A New Technique for Increasing Keratinized Tissue Around Dental Implants: The Partially Epithelialized Free Connective Tissue Graft. Retrospective Analysis of a Case Series

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INTRODUCTION

For decades, it has been known that the absence of keratinized gingiva around teeth and the resulting mobility of marginal tissues promote bacterial invasion of the gingival sulcus.[1] In particular, the presence of keratinized gingiva improves the long-term prognosis of restored teeth.[2] However, the relationship between a sufficiently wide zone of keratinized mucosa (KM) and the long-term success rate of oral implants remains controversial. A causal relationship has been postulated between the accumulation of bacterial plaque on implants and the progression of inflammatory processes in the peri-implant soft tissue.[3] Mucositis around implants is very similar to gingivitis around natural teeth, a fact that has been demonstrated in humans.[4] Some studies have shown that with adequate plaque control, peri-implant tissues can be maintained in a healthy state. In those studies, no correlation was found between implant survival or success and the presence of KM.[5,6] Other studies, however, have noted that in clinical practice, consistently good oral hygiene around restorations is difficult to maintain if no keratinized gingiva is present.[7,8] Several studies have demonstrated increased levels of plaque and inflammation around implants in the absence of KM.[9–11] More recent studies have shown that in spite of good oral hygiene and maintenance therapy, implants with less than 2 mm of KM in the peri-implant region were significantly more prone to bleeding and exhibited greater radiologic bone loss, as well as buccal soft tissue recession.[12–16] Moreover, elevated values of immunologicparameters (eg, PGE_2) were observed in these implants.[17] In order to minimize these risks, various proposals have been made regarding a potential surgical extension of the zone of KM around implants.

This article describes a novel technique developed by the authors to increase the width of KM around dental implants and presents results of a case series with up to 15 years of follow-up.

The partially epithelialized free connective tissue graft technique

The procedure is performed under local anesthesia using fourfold magnification loupes. A partial thickness incision is made along the implant's sulcus and extended approximately 5 mm both mesially and distally, following the mucogingival junction and separating the vestibular mucosa from the KM. The vestibular mucosal flap is then dissected from the periosteum to create an envelope that is approximately 15 mm deep (Figure 1a and b).

Using a scalpel with two parallel blades, grafts are harvested from the palate between the distal aspect of the lateral incisor and the mesial aspect of the first molar[18] in the following manner. With a minimal distance of 2 mm to the gingival margins, two parallel incisions are made to a depth of approximately 10 mm. With a single-blade scalpel, the graft is then dissected at the mesial, distal, and apical edges without removing the epithelium on top of the graft (Figure 2a through d).

The donor area is sutured and covered with a previously fabricated stent (Erkodent 1.5 mm, Erkodent GmbH, Pfalzgrafenweiler, Germany) to facilitate wound healing. The partially epithelialized free connective tissue graft (PECTG) is placed into the envelope that was created at the recipient site, positioning the keratinized portion near the incision line (Figure 3a). The KM graft portion is then sutured to the local keratinized tissues (Figure 3b). To optimize the blood supply to the graft, the mucosal flap is sutured to cover the connective tissue part of the graft, and the grafted site is protected with periodontal dressing.

Postoperatively, patients may be provided with analgesics (ibuprofen 400 mg), and they are advised to rinse with chlorhexidine 0.2% for up to 4 weeks. The stent is left in place for 48 hours at the donor site, and thereafter applied during

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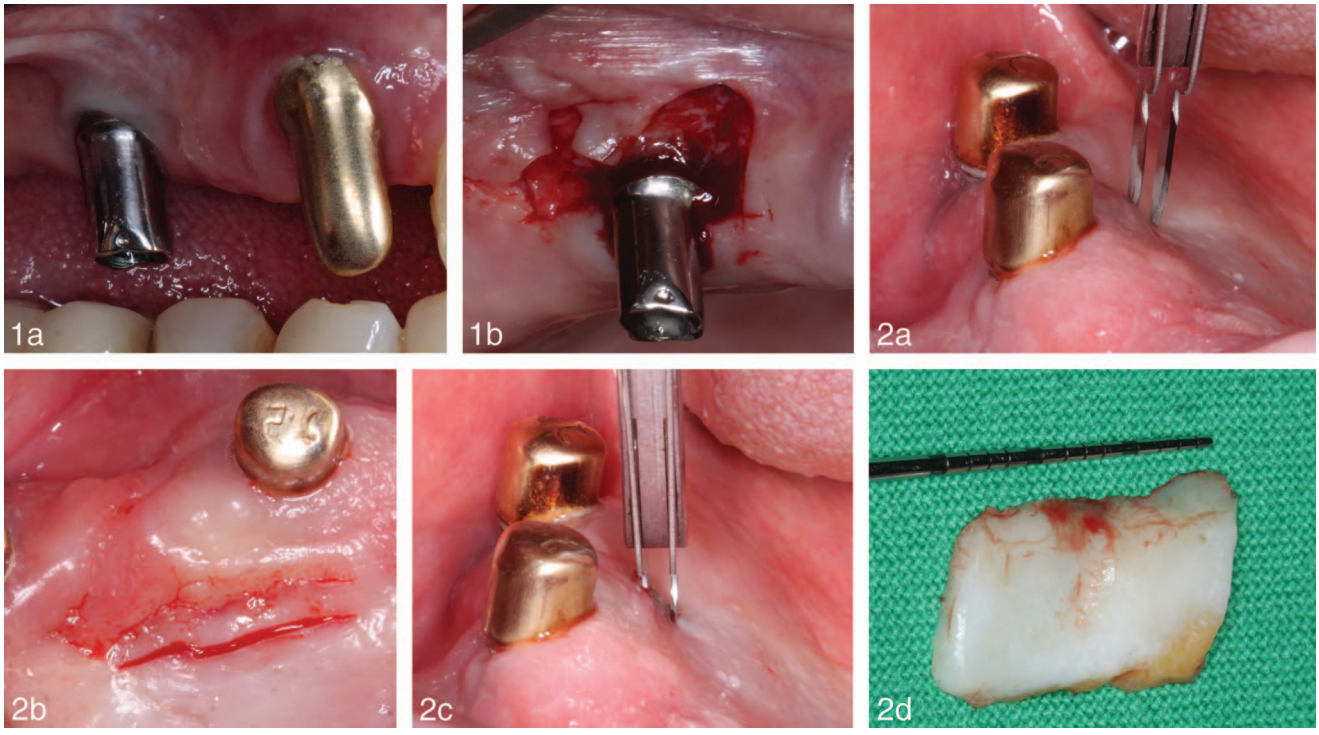


Figures 1 and 2. Figure 1. (a) Before surgery, the implant had thin tissues, recession, and a high inserting buccal frenulum. (b) Placement of a partially epithelialized free connective tissue graft (PECTG) began by creating a partial thickness incision along the implant's sulcus, following the mucogingival junction. The vestibular mucosa was then separated from the keratinized mucosa. **Figure 2.** (a) The PECTG is harvested from the palate, at least 2 mm from the gingival margins with a double blade scalpel. The grade of scalpel angulation defines the width of the keratinized part. (b) The parallel superficial incisions. (c) After a slight change of the scalpel's axis towards the teeth axes, the incision can be performed to the final depth to harvest a sufficient connective tissue part. (d) The PECTG after harvesting.

meals and at night for 5 additional days. Sutures can normally be removed after 7 days. Figure 4a through d illustrates healing of two PECTGs from day 7 through 1 year.

Case Series

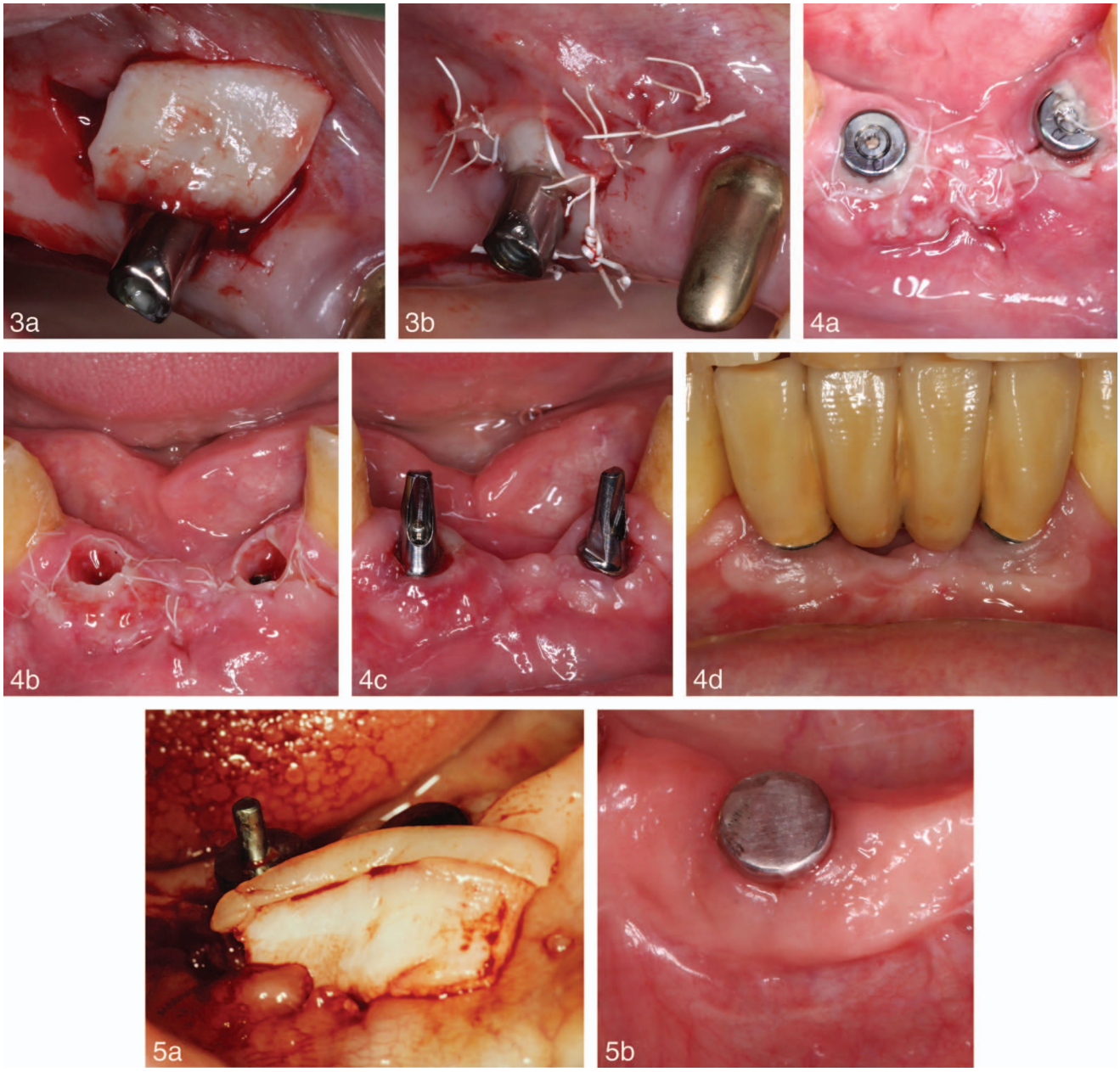
Between January 1997 and June 2012, a total of 42 implants in 22 patients were treated by an experienced periodontist (E.F.) with PECTGs to increase the amount of vestibular tissue around the implants. Peri-implant outcomes for patients who met the inclusion criteria were evaluated. In all cases, the indication for surgery was $\leq$1 mm of KM at the buccal aspect of an implant. The inclusion criteria were met by 12 nonsmoking patients (9 women, 3 men), with a mean age of 58.4 $\pm$ 10 years at the time of surgery (Table 1). Excluded were 3 patients who moved away, 2 patients who had a PECTG performed for treatment of peri-implantitis, and 5 patients who did not reach the minimum follow-up period (at least 1 year).

The mean follow-up period was 5 years (range: 1 to 15 years). In the 12 included patients, PECTGs were performed for 23 implants: 14 maxillary (60.9%) and 9 mandibular (39.1%) (Table 2). Different roughened-surface implant systems were included, and the included implants were restored with single crowns (2 = 8.7%), fixed bridges (8 = 34.8%), and removable dentures (13 = 56.5%) made of noble (n = 9/39.1%) or base (n = 14/60.9%) alloys, and retained with both screws (n = 11/47.8%) and cement (n = 12/52.2%).

All of the PECTGs survived, no implant was lost, and no peri-implantitis was recorded. The implant survival rate and implant success rate thus were both 100%. All implants showed a gain of keratinized tissue; the mean score changed from 0.24 mm KM preoperatively to 1.94 mm KM (mean KM gain of 1.7 mm) 5 years after PECTG surgery. Out of 23 implants, a majority of 74% (n = 17) exhibited a KM width of $\geq$2 mm after surgery, while none of the implants showed more than 0.75 mm before surgery (Table 3). The rate of peri-implant mucositis decreased from 73.9% before PECTG to 30.4% after PECTG was performed. Because a relatively small group of patients with a wide range of observation periods was included, only descriptive statistics were applied.

Discussion

The goal of this study was to evaluate a new technique for increasing keratinized tissue around dental implants. As all the grafts were successful after a mean follow-up period of 5 years, the study revealed the feasibility of PECTG surgery. After compliance with a supportive therapy program in a private practice, 100% implant survival and success rates (no diagnosis of peri-implantitis) were found, along with a considerable gain of KM in 23 implants. Weak points of the study were the relatively small number of treated patients and implants, inclusion of different implant systems, and different types of prosthodontic rehabilitations. Furthermore, no control group



Figures 3–5. Figure 3. (a) The keratinized portion of the partially epithelialized free connective tissue graft (PECTG) is positioned near the incision line in the envelope that was created at the recipient site. (b) The partially covered PECTG after suturing. **Figure 4.** (a) Two anterior mandibular PECTGs, 7 days after surgery. (b) At the 7 day appointment, the healing abutments were removed for impression making. (c) The sites, 2 weeks after PECTG surgery with implant abutments. (d) The graft sites, 1 year postoperatively, both implants are surrounded by a zone of keratinized mucosa (KM). **Figure 5.** (a) PECTG at the time of placement at 2 mandibular implant sites. (b) This magnified view of the same site 15 years later shows that the graft surface is indistinguishable from the local KM surfaces.

could be presented. Therefore, no strong conclusions can be drawn.

As there are no evidence-based guidelines for the treatment of peri-implantitis, prevention strategies have become increasingly important. On the one hand, installation of postimplant maintenance programs may contribute to long-term stability of peri-implant tissues. Several studies have demonstrated a positive influence of regular participation in a professional SIT program.[19–23] The findings of the present study confirm these results, as no case of implant loss or peri-implantitis developed. A recent review with observation periods $\geq$10 years including 2652 implants in 904 subjects found survival rates of 94.8%–99.6% and success rates of 83.1%–94.2%.[24] Patients who do not sufficiently comply with regular implant maintenance may be expected to show significantly higher values of plaque and peri-implant disease. This should be considered in the interpretation of our results.

On the other hand, the quality and thickness of peri-implant tissue also may influence the genesis of peri-implant diseases. Controversy has surrounded the question of whether

TABLE 1

Patient characteristics (n = 12)

	Total
Age, mean ± SD, y	62.7 ± 9.4
Gender, n (%)	
Female	9 (75%)
Male	3 (25%)
Smoking habits, n (%)	
Nonsmoker	12 (100%)
Smoker	0
General illnesses, n (%)	
Diabetes mellitus	0
Coronary heart disease	3 (25%)
Observation period, mean ± SD (median)	5.1 ± 5.6 (1.25)
Implants, n	23
Maxilla, n (%)	14 (61%)
Mandible, n (%)	9 (39%)

the presence or absence of KM affects peri-implant disease rates. Some studies have revealed significantly higher scores for peri-implant mucositis (bleeding on probing positive) at implants with $\leq$2 mm of KM width.[14–17,25,26] Other studies have not confirmed this.[9,13] In the present study, the mucositis rate was 38.9%. This is in accordance with a review of Roos-Jansaker et al,[27] who found mucositis rates between 39.6% and 52.3%. An actual systematic review with meta-analyses revealed significant differences in several periodontal parameters (ie, mucosal recession and attachment loss) depending on the KM width.[28]

An adequate peri-implant soft tissue level has been essential to achieving long-term esthetic success in implant therapy. Therefore, preventing peri-implant mucosal recession has increasingly been a focus of attention. Marginal tissue recession around natural teeth can occur even in populations with high oral hygiene standards.[29,30] Correspondingly, recession may be expected in implant sites too, but data on this topic have been scarce. Bianchi and Sanfilippo[31] investigated 22 implants in 22 individuals after submerged implant placement using connective tissue grafts (CTG). Another 20 implants were placed immediately in 20 patients without using CTG. They served as a control. After 6–9 years, mucosal recession of $>$1 mm was found in 5% of the CTG group and 20% of the control group. Evans and Chen[32] found $\geq$1 mm of midfacial recession to be a common phenomenon that may be expected in 40.5% of sites. Individuals with a thin biotype and buccal positioning of the implant shoulders were more prone to recession. Several recent studies have found the soft tissue biotype to be an important parameter in achieving esthetics and preventing mucosal recession.[33–37] Another study revealed that initial gingival tissue thickness at the crest has a significant influence on marginal bone stability around implants.[38] In implant restorations, the thick flat tissue biotype was found to be an important factor for a successful esthetic treatment outcome.[35]

It can be summarized that implants in individuals with buccal position of the implant shoulders, implants in individuals with a thin biotype, implants with only a thin coverage of soft tissue, and implants with little to no keratinized tissue may be prone to mucosal recession, esthetic problems, and peri-implant bone loss. Therefore, in order to increase mucosal thickness and KM width in those cases, peri-implant soft tissue augmentation should be considered. The PECTG was created with the aim of at least partially overcoming these problems. The hope was that patients could benefit by reducing the risk of esthetic problems, midfacial mucosal recession, and inflammatory peri-implant diseases that could lead to progressive bone loss and implant failure in the long term.

Many years ago, Harris,[18] recommended a double-blade scalpel for harvesting connective tissue graft material for root-coverage procedures. Such a scalpel also can be effectively used to harvest PECTGs with a defined thickness of approximately 1.5 mm and an approximately 2-mm wide band of KM. Because all grafted tissues are cut off from their original blood supply, a primary goal in developing the PECTG procedure was to create maximal vascular adjacency to help ensure the maximum number of cells would survive until new blood vessels were able to form. An advantage of the PECTG has been its position mostly in direct contact with vascularized tissue, the underlying periosteum, and the covering alveolar mucosa. This facilitates early nourishment of the graft cells from both sides, as does the recently proposed partly epithelialized free gingival graft.[39]

Free gingival grafts, while used for many years in cases requiring KM around natural teeth, are nourished only from the underlying periosteum. Esthetic outcomes of this mucogingival surgical technique have been less than optimal because the color and texture of the palate are transposed to the operation site. A recent study of esthetic outcomes of different root-coverage procedures found the soft tissue appearance was a significant factor in cosmetic assessments. Submerged and envelope techniques had esthetic outcomes that were superior to nonsubmerged grafts.[40] In line with that finding, PECTGs typically do not result in a different appearance between the graft and local tissue surfaces (Figure 5a and b). A recent review found weak evidence that peri-implant augmentation with soft tissue grafts may result in increased soft tissue thickness and improved esthetics. However, there is insufficient evidence regarding the best soft tissue augmentation technique and the benefits of an increased width of KM for implants.[41]

TABLE 2

Distribution of implants and teeth according to tooth and jaw position (American Dental Association notation)

Implants in the maxilla	0	0	1	3	1	2	1	0	0	1	1	2	0	1	1	0
Tooth position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
Implants in the mandible	0	0	0	0	1	1	2	0	0	2	1	1	1	0	0	0

TABLE 3

Clinical parameters and outcomes of patients/implants (n = 12 patients)*

Parameters	Preoperative (n = 18 Implants)	Postoperative (n = 23 Implants)
PPD, mean ± SD (range), mm	NA	3.4 ± 0.8 (2.5–5.5)
BOP-positive (peri-implant mucositis), n (%)	17 (94.4%)	7 (30.43%)
KM, mean ± SD (range), mm	0.24 ± 0.26 (0–0.75)	1.9 ± 0.7 (0.5–3.0)

*PPD indicates pocket depth; BOP, bleeding on probing; KM, width of keratinized mucosa; and NA, not applicable.

Conclusions

High survival and high success rates and a low prevalence of peri-implant diseases over long periods of time may be expected in patients attending professional SIT programs. Use of the PECTG proved to be feasible and resulted in an increased KM width around implants. However, due to the lack of a control group, no strong conclusions can be drawn. Future independent and prospective evaluations should compare horizontal and vertical tissue dimensional changes following use of the PECTG with other surgical approaches.

Abbreviations

BOP: bleeding on probing
CTG: connective tissue grafts
KM: keratinized mucosa
PECTG: partially epithelialized free connective tissue graft
PPD: pocket depth

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