Clinical Study of Flap Design to Increase the Keratinized Gingiva Around Implants: 4-Year Follow-Up

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Since the presence of keratinized gingiva is so important for peri-implant outcome, the aim of this study is to describe a partial thickness flap design to increase the amount of keratinized peri-implant tissue as well as its thickness. A total of 131 implants were placed in 85 patients: 103 implants (78.63%) in the mandible and 28 implants (21.37%) in the maxilla. Before implant placement in edentulous ridge the residual keratinized mucosa usually was measured with a periodontal probe in a buccal–palatal direction. A palatal or lingual incision was made to raise a partial thickness flap with the residual keratinized tissue. After implant placement the flap was apically repositioned and secured with loose periosteal sutures. Keratinized tissue levels were calculated at baseline, at 6 months, and every year follow-up. Measurements were reported for each implant diameter. At 4-year follow-up, implant survival rate of 87.79% was reported. Peri-implant keratinized mucosa confirmed clinical gain in all cases; mean levels at 1- and 4-year follow-ups were 7.26 $\pm$ 2.01 mm and 7.37 $\pm$ 2.12 mm, respectively. The levels remained stable over time. This flap design allows immediate correction of adaptation of the keratinized tissue around the implant, increasing the thickness and amount of the keratinized tissue.

Key Words: peri-implant tissue, partial thickness flap, secondary intention healing

INTRODUCTION

Aesthetics is one of the major topics of modern implant dentistry. This goal, however, can be difficult to achieve, especially if the regenerative potential of soft and hard tissues is overlooked. An aesthetically pleasant result is based not only on the quality of prosthetic treatment but also on the implant emergence profile as well as the morphology of the supporting tissues.[1] The concept of gray, pink, and white aesthetic (the colors of aesthetic) defines those factors to be met toward achieving a long-term aesthetic result. *Gray esthetics*, defined by periapical radiographs, refers to the morphology of the supporting bone, the position and the diameter of the implant, as well as the connection between implant and abutment, and prosthesis and abutment. Pink esthetics refers to the morphology of healthy peri-implant mucosa and *white esthetics* represents the natural-looking appearance of the final prosthesis.

Soft tissue management represents an important issue in implant dentistry, and gingival esthetic represents a critical factor in implant-prosthetic restoration. It is generally established that a more ideal and functional soft tissue-implant interface can be established if an adequate zone of keratinized mucosa is present[2] and for this aim, surgical procedures that enlarge the size of keratinized mucosa and recreate the appearance of gingival margin are discussed.[3,4] A gentle surgical approach must be considered as a leading factor for success in implant dentistry[5] since ridge preservation procedure, avoiding osseous exposure by periosteal flap reflection, and keratinized mucosa are necessary not only for long-term success of dental implants but

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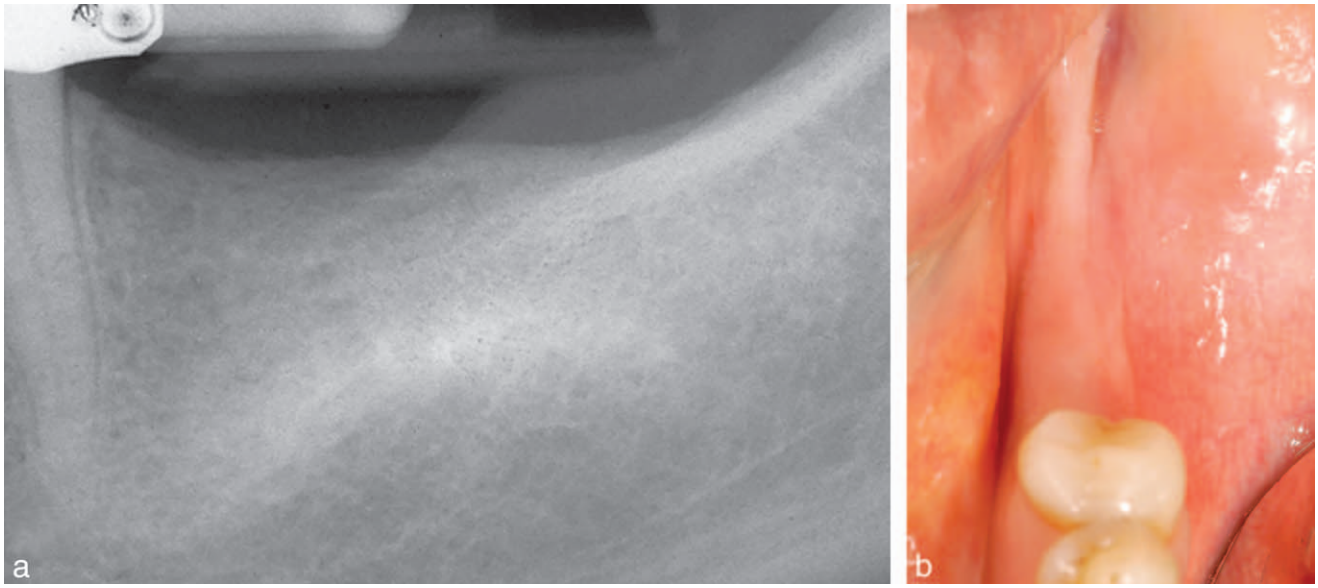

Figure 1. (a) Preoperative radiograph. (b) Clinical photograph showing the edentulous ridge of the mandible with keratinized mucosa situated at the bone crest level.

also for a predictable manipulation of the peri-implant soft tissue;[6,7] these suggested procedures can prevent tissue resorption. For implant placement, a flap design should be considered which requires minimal flap reflection without disturbing the periosteum.[8] The basic concept is to preserve the blood supply to the adjacent papillae and soft tissues to minimize recession, since despite careful execution of implant placement, gingival recession may occur, especially with a thin, scalloped periodontium.[9] Several clinical evidences suggest that thick tissue bears up trauma and subsequent recession, facilitate tissue manipulation, promotes creeping attachment, improves implant esthetics and exhibits less clinical inflammation.[10,11] In an animal study, Strub et al[12] described the important function of the amount of keratinized tissue necessary in the health of peri-implant structure. Since the presence of keratinized gingiva is so important for peri-implant outcome, the aim of this study is to describe a partial thickness flap design to increase the amount of keratinized peri-implant tissue as well as its thickness.

Materials And Methods

Patient selection

Between May 2004 and October 2005, 85 patients (52 females and 33 males) with a mean age 61.54 ± 22.75 years (range from 33–81 years) were included in this prospective study. The patients were treated by one oral surgeon in a private office.

The following inclusion criteria were adopted: good general health, no chronic systemic diseases. Exclusion criteria were the presence of chronic systemic disease, smoking of more than 10 cigarettes per day, bruxism habits, uncontrolled diabetes, coagulation disorders, alcohol or drug abuse, and poor oral hygiene.

All patients gave their informed consent for implant treatment. Before surgical procedure, all patients received oral hygiene instructions and scaling and root planning by a dental hygienist.

Surgical procedure

In edentulous ridge, the residual keratinized mucosa usually is situated at the bone crest level. In this study, it was measured with a periodontal probe (Hu-Friedy PGF-GFS, Hu-Friedy, Chicago, Ill) in a buccal-palatal direction (Figure 1). A palatal or lingual incision was made to raise a partial thickness flap[13] with the residual keratinized tissue. A parasulcular buccal releasing incision was performed to make the flap flexible (Figure 2). A distal vertical incision was used only when no other teeth were within the surgical field. When a distal tooth was present, a distal parasulcular incision was made to mobilize the buccal flap. A second incision was also made on the palatal aspect of the ridge to display

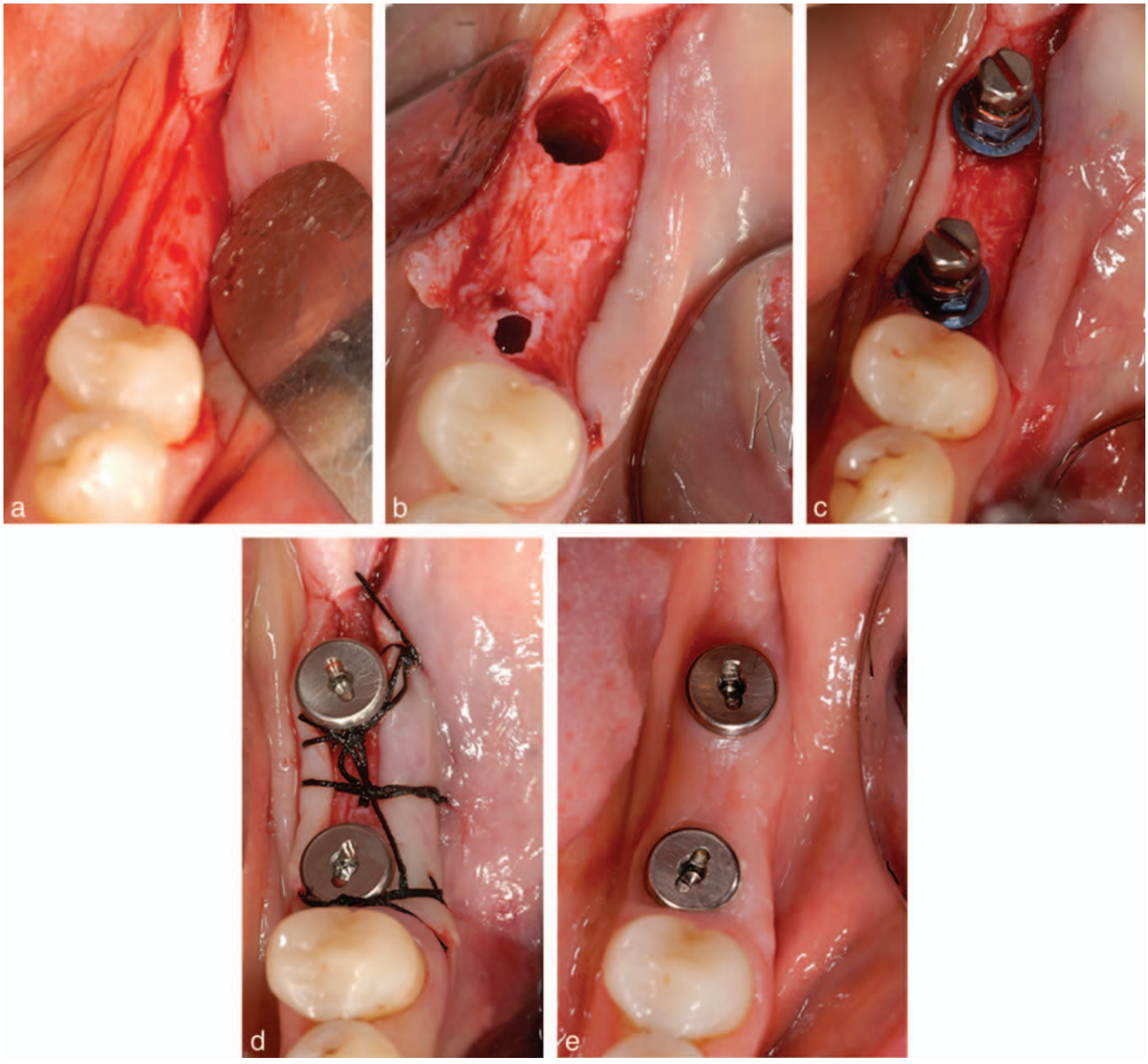

Figure 2. (a) Exposure of the crest with the partial-thickness flap. (b) Clinical photograph showing final preparation of implant sites. (c) Clinical photograph of implant placement. (d) The buccal flap was then adapted around the lateral borders of the healing abutment and apically repositioned and secured with loose periosteal sutures. (e) Healing of keratinized mucosa around abutments 3 months later.

its anatomical characteristics. The incision revealed the anatomy of the alveolar process, leaving a thin connective tissue and the underlying periosteum still covering the bone. This flap design allowed a clear view of the surgical field and guaranteed a large blood supply by maintaining the integrity of the periosteum. When a minimal buccal concavity was present, the flap was raised starting from the palatal or lingual aspect of the ridge and extended buccally and then apically, slightly beyond the mucogingival junction. When a more pronounced concavity existed, the incision continued toward the deeper aspect of the vestibule until the concavity could be seen. The incision was always made close to the focal point of the concavity, which was used as a reference for implant direction so that the implants could be placed deep enough within the bone housing and distant from the cortical surface.

A total of 131 implants (PILOT, Sweden-Martina, Padova, Italy) were placed: 103 implants (78.63%) in

Table 1

Implant dimensions (n = 131 = implants)

Length (mm) / Diameter (mm)	8.5	10.5	13	15	Total
3.8	0	2	17	2	21
4.7	2	12	40	3	57
5.7	0	6	21	2	29
6.7	0	6	14	4	24
Total	2	26	92	11	131

the mandible and 28 implants (21.37%) in the maxilla.

The distribution of implants by location is reported in Table 1. Implants dimensions were 3.8, 4.7, 5.7, and 6.7 mm in diameter, and 8.5, 10.5, 13, and 15 mm in length, respectively (Table 2).

The buccal flap was then adapted around the lateral borders of the healing abutment and pushed down for few seconds to reduce the chance of a postoperative hematoma. Finally, the flap was apically repositioned and secured with loose periosteal sutures. This suture technique avoids tension of the repositioned flap and may control the blood flow. The healing abutment was very important to stabilize the keratinized tissue on buccal side. The existing gap between the margins of the palatal and buccal flaps was allowed to heal by secondary intention, thus favoring the natural thickening of the peri-implant tissue. The collagen was placed under the detached palatal tissue and then secured with silk sutures.

Radiographic examination

Intraoral periapical radiographs (Schick CDR, Schick Technologies Long Island City, NY) of the surgical areas were taken using the long cone parallel technique during the diagnostic and surgical phase as well as the prosthetic session and the annual check-up appointments. The radiographs were used to examine the height of the edentulous ridge and the mesiodistal area at the implant sites; the adjacent teeth and the root anatomy; and the radiographic characteristics of peri-implant hard tissue. The radiographs were also taken during each surgical procedure.

Table 2

Implant positions (n = 131 = implants)

Teeth	Mandible	Maxilla	Total
Incisors	6	3	9
Canines	3	0	3
Premolars	28	15	43
Molars	66	10	76
Total	103	28	131

Table 3

Mean keratinized mucosa levels at baseline, 1-year and 4-year follow-up (n = 131 = implants)

Time Diameter (mm)	Baseline (mm)	1 year (mm)	4 years (mm)
3.8	2.12 ± 0.13	5.62 ± 0.46	5.89 ± 0.32
4.7	2.32 ± 0.29	6.90 ± 0.31	6.89 ± 0.43
5.7	2.39 ± 0.41	8.01 ± 0.15	8.03 ± 0.28
6.7	2.09 ± 0.16	8.51 ± 0.29	8.67 ± 0.36

Statistics

Dedicated software was used for all statistical analyses (SPSS 11.5.0, SPSS Inc, Chicago, Ill). All data were reported as mean ± standard deviation. Keratinized tissue levels were calculated at baseline, at 6 months, and every year follow-up.

Measurements were reported for each implant diameter.

Results

Baseline mean keratinized mucosa levels were 2.23 ± 0.25 mm (n = 131 = implant site).

After about 20 days, the central areas, which healed by secondary intention, were completely filled. No delay in the healing process was reported—neither redness, abscesses, nor inflammation. The flap design allowed the apical shift of the mucogingival junction, which was then repositioned to its natural level.

At the 4-year follow-up, a survival rate of 87.79% was reported. Sixteen implants were lost within 1 year from their placement. Between failures, 10 implants were placed in the maxilla, and 7 in the upper left molar site.

Peri-implant keratinized mucosa demonstrated clinical gain in all cases; Table 3 reports mean keratinized mucosa levels at baseline, 1 year, and 4 years for each implant diameter.

Mean levels at 1- and 4-year follow-ups were 7.26 ± 2.01 mm and 7.37 ± 2.12 mm, respectively.

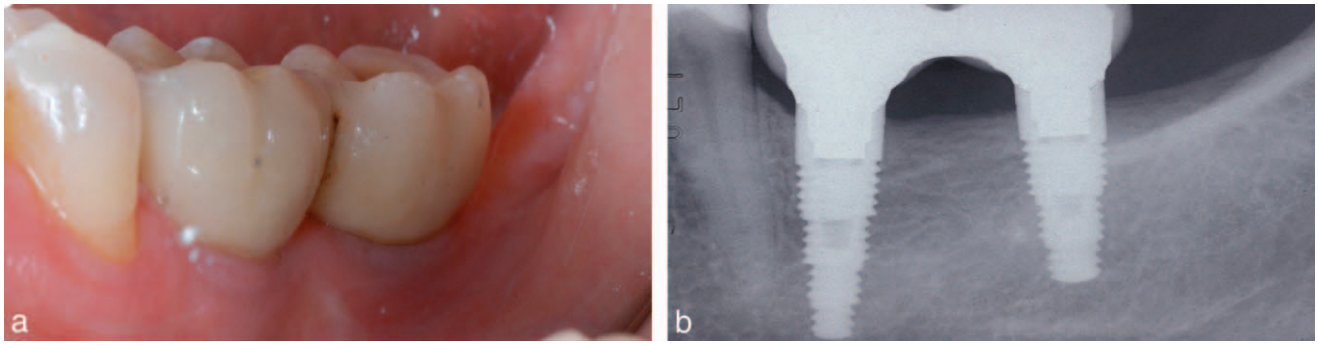

Figure 3. (a) Clinical photograph showing final restoration and the maintenance of keratinized gingival tissue after 4-year follow-up. (b) Periapical radiograph performed 4 years later.

The levels remained stable over time.

The periapical radiographs revealed the presence of the lamina dura and the absence of crestal bone resorption, demonstrating the early pattern of the biologic width.

Discussion

Although osseointegration of dental implants can be achieved both with 1-stage and 2-stage surgical procedures,[14–20] a correct management of peri-implant tissues is advocated for the long-term biological equilibrium of the peri-implant tissue stability over time. In an animal study, Berglundh and Lindhe[21] reported bone resorption at sites where the ridge mucosa prior to abutment connection was thin (<2 mm). They concluded that a certain minimum width of the peri-implant mucosa may be required and that bone resorption may take place to allow a stable soft tissue attachment. Apical displacement of the soft tissue margins occurs during the first months after prosthetic restoration.[22] Bengazi[7] evaluated longitudinally alterations in the position of the peri-implant soft tissue margin, occurring during a 2-year period after insertion of fixed prostheses. A baseline examination was performed at time of insertion of the prosthetic construction, which involved assessments of marginal soft tissue level, width of masticatory mucosa, and marginal soft tissue mobility. The descriptive analysis showed a slight decrease in mean probing depth (0.2 mm) and width of masticatory mucosa (0.3 mm) during 2-year follow-up periods. Apical displacement of the soft tissue margin mainly took place during the first 6 months of observation. Lingual sites in the mandible showed the most pronounced soft tissue recession, decrease of probing depth, and decrease of width of masticatory mucosa. Recession of the soft tissue margin was recorded in 38% of implant-supported restorations, and statistical analysis revealed that lack of masticatory mucosa and mobility of the peri-implant soft tissue at time of bridge installation were poor predictors of soft tissue recession occurring during the 2 years of follow-up. It was suggested that the recession of the peri-implant soft tissue margin mainly may be the result of a remodeling of the soft tissue in order to establish "appropriate biological dimensions" of the peri-implant soft tissue barrier, that is, the required dimension of epithelial-connective tissue attachment in relation to the faciolingual thickness of the supracrestal soft tissue.

Jemt et al[23] observed implant sites bordered by non-keratinized or movable tissue showed higher incidence of recession than sites with masticatory, non-movable marginal tissue. After mucogingival surgery a thick keratinized gingiva seems to be advantageous for wound healing promoting clotting, revascularization, and maintenance of the blood supply.[24] For this aim, use of rotated and rotated split palatal flaps have been advocated at time of implant placement.[25] Thus, it is necessary to preserve and increase the pre-existing keratinized tissue, essential for two reasons: during osseointegration phase,[14] it keeps the surgical area protected from the action of perioral muscles; and during the prosthetic phase,[2] it recreates the natural-looking morphology of the peri-implant soft tissues, which solves the inconvenient of an implant emerging profile from a flat crest as well as the lack of gingival festooning.

Linkevicius et al[26] demonstrated the initial gingival tissue thickness at the crest may be considered as a significant influence on marginal bone stability around implants. If the tissue thickness is 2.0 mm or less, crestal bone loss up to 1.45 mm may occur, despite a supracrestal position of the implant-abutment interface.

Finally, this natural tissue profile allows a reconstruction that is not only aesthetic but also easily amenable to home care. Using this flap design, all the drawbacks of using wide-body diameter implants virtually disappear. A possible explanation for the high rate of wide-body implant failures, reported in the literature, could be the increased diameter of the cover screws that, being much larger than usual, might have resulted in an inadequate blood supply as well as tension between the inner part of flap and the buccal metallic angle of the implant, which can create an injury zone. The flap design suggested in the present study eliminates the tension of the soft tissues and obtains the same success rate of narrower implants. This technique aims to the attainment of pink aesthetics, meaning the maintenance or, more often, the creation of a healthy and natural-looking peri-implant mucosa. This flap design allows to immediately correct the adaptation of the keratinized tissue around the implant—increasing the thickness and height of the keratinized tissue, thereby preserving the soft tissue anatomy of the adjacent teeth and maintaining papillae profile. Although these encouraging results, further clinical studies are mandatory to understand and explain the importance of keratinized mucosa around dental implants.

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