Chapter 20

Soft tissue enhancement after implant placement

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Introduction

Replacement of missing teeth with endosseous implants is a predictable and reliable procedure, with high implant and prosthetic survival rates and stable long-term results (Esposito et al., 2009a,b).

In recent years, the goal of implant treatment in the anterior zone has progressed from mere fixture survival to obtaining a long-lasting esthetic result with stable peri-implant tissue conditions as well as harmony of implant-restorations with neighboring teeth (Meijer et al., 2005). Therefore, additional factors such as soft tissue appearance, restorative outcomes, and patient satisfaction have to be taken into consideration in evaluating the success of implant patient rehabilitation, especially in the anterior esthetic zone.

The aim of this chapter is to give an overview of soft tissue healing and biology and to focus on different techniques to improve esthetic outcomes during second-stage surgery of dental implants.

Keratinized tissue around dental implants

For years one of the most controversial subjects regarded the amount of keratinized gingiva (KG) necessary to maintain the periodontal health around teeth. Lang and Löe (1972) stated that a minimum of 2 mm of KG with at least 1 mm of attached gingiva should be present in order to prevent soft tissue recession, but clinical and experimental studies reported that healthy conditions could be maintained almost with no attached gingiva (Dorfman et al., 1980, 1982; Hangorsky and Bissada, 1980; Kennedy et al., 1985; Miyasato et al., 1977; Wennstrom, 1983; Wennstrom and Lindhe, 1983; Wennstrom et al., 1981). However, due to the inductive potential of the periodontal ligament to determine the characteristics of periodontal mucosa, a width of 0.5 mm of KG is always present around healthy teeth (Karring et al., 1975). Wennstrom (1987) was not able to demonstrate differences in the progression of inflammation in areas with limited keratinized tissue in an animal model, and human studies did not report significant changes in the attachment level if plaque control is adequate (Dorfman et al., 1982; Freedman et al., 1999; Hangorsky and Bissada, 1980; Kennedy et al., 1985; Kisch et al., 1986; Lindhe and Nyman, 1980; Salkin et al., 1987; Schoo and van der Velden, 1985). In a study based on 32 patients with bilateral areas of minimal or no keratinized tissue, Kennedy performed a free gingival graft (FGG) on one side while the contralateral area was maintained as control. After 6 years, there was no statistical difference related to recession and clinical attachment loss between the two groups, if a proper oral hygienic protocol was maintained (Kennedy et al., 1985).

Clinical experience, more than scientific evidence, suggests that thick gingiva may be more resistant and may reduce possible soft tissue recession in the presence of gingival inflammation or brushing trauma. Many clinical studies (Arowojolu, 2000; Checchi et al., 1999; Khocht et al., 1993; Kozlowska et al., 2005; Sangnes and Gjermo, 1976; Tsami-Pandi and Komboli-Kontovazeniti, 1999; Vehkalahti, 1989) showed a direct relationship between brushing and noninflammatory recessions, even though
a recent systematic review (Rajapakse et al., 2007) drew inconclusive results and pointed out that duration and frequency of brushing, technique, force, frequency of changing brushes, and type of bristles should be taken into account.

Before analyzing the role of KG around dental implants, it is important to summarize some existing differences of dental implants compared to natural teeth: absence of cementum and periodontal ligament, reduced blood supply, and fewer fibroblasts with a parallel orientation of the supracrestal fibers along the abutment’s surface (Lindhe, 2008). The lack of periodontal ligament prevents an inductive establishment of a minimum amount of KG around implants. There is no attachment apparatus around implants like the one present in natural dentition, composed of collagen fibers inserting into the dentin or the cementum of the root. These characteristics make dental implants more prone to the development of inflammation and bone loss in case of plaque accumulation or bacterial invasion. An intact and stable biological seal around dental implants becomes fundamental for the long-term success of implant treatment.

Experimental investigations on animals showed that absence of keratinized mucosa increases plaque accumulation and causes bone loss (Warrer et al., 1995). Thirty implants were placed in the mandible of five monkeys, in areas with and without keratinized mucosa. After a period of 3 months, all implant fixtures were exposed to plaque accumulation, and around some of them cotton ligatures were applied. Ligated implants with no keratinized tissue showed significant recession and bone loss compared with the other fixtures (Warrer et al., 1995). In a human study, Kim et al. (2009) evaluated 276 implants in 100 patients with an average follow-up of 13 months and reported increased bone loss and mucosal recession around fixtures with inadequate keratinized tissue. Similar results were found by Bouri et al. (2008) around 200 implants. Adibrad et al. (2009) analyzed 66 dental implants supporting overdentures and reported higher plaque accumulation, gingival inflammation, and recession of the soft tissue with less than 2 mm of keratinized mucosa. Chung et al. (2006) analyzed the success rates of implants with different surfaces in relation to the amount of keratinization. Only in the posterior area did they find a relationship between higher plaque accumulation, inflammation, and reduced attached mucosa, but there was no evidence of increased bone loss based on the amount of keratinized tissue. Moreover, the type of implant surface failed to demonstrate an influence on the periodontal index. They concluded that the hygiene of posterior implant-supported prostheses in close contact with the tissue might be difficult to maintain.

If a proper oral hygiene level is present, however, keratinized mucosa does not appear to be a requirement for the maintenance of healthy peri-implant tissue, but if we consider that the quality of plaque control can change during the course of years, the presence of adequate amount of attached mucosa is advocated (Schou et al., 1992).

### Introduction to surgical techniques

Soft tissue management in areas of implant placement can be performed (i) before implant placement, (ii) during the second-stage surgery and before the prosthetic phase, and (iii) after delivery of the final crowns. We will focus on the different procedures the clinician can use with particular regard to the esthetic area.

The ideal solution of some cases requires a multidisciplinary approach or multiple procedures with a precise timetable between each surgery. Some situations cannot be completely corrected because of biological limitations or a compromised starting point, and it is important to disclose this fully to the patient in order to avoid medico-legal involvements or unrealistic expectations. The general opinion regarding the best moment to correct soft tissue defects is that the earlier the intervention, the better the result. Although each situation is different and should be treated accordingly, the predictability of soft tissue augmentation is higher if the deficiency is treated as soon as it appears. The clinician must also understand the difference between actual hard and soft tissue deficiencies and discrepancies seen during the natural course of healing. For instance, the maturation of interdental papilla after restoring a proper contact point takes a certain period of time as does socket remodeling postextraction; ignorance regarding healing times may lead a clinician to overtreatment. Then again, some defects cannot be completely treated with one surgery only, and sometimes additional tissue augmentations are indicated after implant integration as refinement of previous grafting. Moreover, additional surgeries may be necessary to correct situations with minimal residual KG or to augment or restore interimplant papillae for esthetic reasons.

Two indications exist that warrant soft tissue augmentation: (i) expanding the width of keratinized mucosa, as reviewed earlier, and (ii) expanding mucosal volume to attain a natural, cosmetic drape around the implant. In particular, implant recession and papillary regeneration will be addressed.

The methods to increase the amount of keratinized tissue are (i) apically positioned flap (APF), (ii) APF in combination with autogenous tissue, and (iii) APF in combination with allogeneous tissue (Thoma et al., 2009). If the purpose is to gain more volume, FGG, subepithelial connective tissue graft (CTG), pedicle flap, or allografts could be viable alternatives (Cairo et al., 2008; Thoma et al., 2009).
Surgical techniques: preliminary considerations

Proper patient selection, correct diagnosis, and apt treatment planned together with an adequate surgical and prosthodontic protocol are fundamental to the long-term success of implant restorations. Nowadays, with the increased expectations of patients, soft tissue management in the anterior area can represent the most critical and difficult part of the entire rehabilitation. Anatomical familiarity and biological knowledge of the area of interest are prerequisites for safe surgery and for choosing the right technique. During the last few years, a microsurgical approach has radically changed the way of treating soft tissue defects. The use of magnification devices, microsurgical instruments, blades, and needles can make the difference in the final result.

In presence of adequate keratinized tissue during second stage surgery, a tissue punch is used to remove just the tissue immediately over the cover screw, without raising a flap. This technique has the advantage of decreasing the morbidity for the patient and of speeding up the healing time before the impression phase. As no bone is exposed, there is a reduction in possible resorption and scar formation. Yet useful keratinized tissue gets disposed. Alternatively, the simplest technique to build a soft tissue contour consists of dividing the mucosa in two halves through a midcrestal incision and in repositioning equal amounts of tissue around buccal and lingual sides of the healing abutment. To combine a minimally invasive approach with an increase of keratinized mucosa at the buccal aspect of the implant, a semilunar incision over the cover screw has been recommended by Stappert (2007). The semilunar incision should barely exceed the dimensions of the cover screw, sparing the proximal papillae (Fig. 20.1). The convex aspect of the incision points to the oral side of the alveolar ridge. By elevating the miniflap over the cover screw, additional keratinized tissue is moved to the buccal side when the abutment is placed (Figs. 20.2 and 20.3). (Case courtesy of Dr. Christian F.J. Stappert, 2011.)

Frequently after ridge augmentation or bone grafting performed simultaneously with implant placement, flap release and coronal advancement is necessary to get primary closure of the wound. Consequently after healing, the mucogingival line may exist at a more coronal position, decreasing the amount of functional keratinized mucosa. Although the absence of keratinized mucosa may not compromise the long-term success of implant restorations, its presence improves esthetics, reduces plaque accumulation by improved cleansibility, and guarantees a stable mucosal seal. For those reasons, keratinized tissue augmentation may be indicated.

In 1954, Nabers proposed the concept of repositioning the attached gingiva by raising a full-thickness flap and displacing it apically in order to augment the amount of KG and to eliminate possible periodontal pockets. The alveolar bone was left exposed to the oral cavity, and this...
The periosteum (split- or partial-thickness flap) has been utilized since 1960 (Wilderman, 1963). This new APF with the retention of the attachment apparatus, whereas the partial-thickness flap shows limited amount of reabsorption in case of a partial-thickness flap, with no apical migration of the attachment apparatus, whereas the full-thickness flap results in a modification of the inner structure, changes in the attachment apparatus, and some osteogenesis activity still running.

In summary, the use of an apically positioned partial-thickness flap to increase the amount of KG is indicated in cases of adequate thickness of the gingival mucosa (at least ≥3 mm), good depth of the vestibule, and thick alveolar bone. In case of complete absence of keratinized mucosa, an FGG associated with a partial-thickness flap is desirable for more predictability and for the possibility of protecting the underlying connective tissue and bone (Fagan and Freeman, 1974; Sato, 2008).

An effective method to build up keratinized tissue around implants during second-stage surgery is by a modified apically repositioned flap or even a laterally repositioned flap, originally reported for teeth (Cairo et al., 2008). An incision may be made where the existing keratinized mucosa is more abundant, usually closer to the palatal or lingual side. A partial-thickness flap may then be raised and secured with sutures to the buccal side of the healing abutments. Healing occurs by secondary intention.

**Case report #1: apically repositioned partial-thickness flap**

This patient was diagnosed with generalized aggressive periodontitis, gingival inflammation, plaque, and calculus (Fig. 20.4). Radiographs illustrated severe bone loss, with prominent vertical defects around teeth #2, #4, #9, #11, #18, and #30, and horizontal bone resorption around the remaining dentition (Fig. 20.5), resulting in mobility grades II and III. Clinically, severe canine recession was seen on both arches, though a wide band of KG remained in the maxilla (Fig. 20.6). After extractions, sinus lifts, and delayed implant placement (Fig. 20.7), a narrow band of keratinized tissue resulted mainly on the right side, with lining mucosa extended almost to the level of the crest and covering part of the implant heads (Fig. 20.8). The purpose of the second-stage surgery was to increase the amount and the thickness of the KG at the buccal aspect mainly. A linear incision was performed in approximately 4–5-mm distance of the mucogingival line toward the palatal side, and a partial-thickness flap was...
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Raised to expose the cover screws. At all times, the periostium and a minimum connective tissue layer of 0.5–1 mm thickness remained on the alveolar bone. The flap was moved to the buccal side, secured by horizontal sutures and compressed against the alveolar bone with mattress sutures (4-0 Prolene® black, monofil, Ethicon GmbH & Co. AG, Norderstedt, Germany). Part of the palate was left exposed to the oral cavity and left to heal via second intention (Fig. 20.9). After maturation of the tissue—which occurred in at least 3 weeks—adequate keratinized mucosa (a band of 2 mm or more) was detected circumferentially around each implant (Fig. 20.10). The construction of a custom-made titanium bar on the implants to retain an overdenture, with adequate space to ensure hygienic maintenance, was generated (Fig. 20.11). The prosthetic superstructure fulfilled the need of hard and soft tissue replacement and provided adequate lip support. Good retention of the overdenture, based on the

Fig. 20.5 Periapical X-rays evidenced severe bone loss as a combination of vertical defects and horizontal resorption for most teeth.

Fig. 20.6 The occlusal view of the maxillary arch showed a dentition with multiple crown restorations and inflammatory gingival tissue.

Fig. 20.7 Severe bone loss and active inflammatory status led to extraction of the residual dentition in preparation for implant placement and upper implant-supported restoration. Healing resulted in reduction of keratinized gingiva and positioning of the mucogingival junction at the alveolar ridge at midcrestal level.

Fig. 20.8 Panoramic radiograph after bilateral sinus augmentations and implant placements in both arches.

Fig. 20.9 A split-thickness flap was raised containing a band of keratinized gingiva from the palate and secured on the buccal side of the healing abutments with monophilic sutures (4-0). The palate was left for healing by second intention.
Implant site development

custom-made titanium bar and Swiss-lock components, made a coverage of the palate abdicable (Fig. 20.12). (Case courtesy of Dr. Christian F.J. Stappert, 2002.)

Different techniques have been developed over the years to minimize surgical trauma, avoid scarring in the esthetic area, and create natural soft tissue architecture around implants. Establishing the interimplant papilla certainly remains one of the most difficult challenges. A most recent trend is to maintain the existing tissue architecture by placing an immediate implant in the fresh extraction socket and providing direct fixed temporization to prevent the tissue from collapsing. This represents a minimally invasive procedure limited to one surgery, but the cascade of events taking place after tooth extraction and the biological differences between teeth and implants makes this approach somewhat unpredictable.

As an alternative to immediate implantation, second-stage surgical intervention may be performed to create natural soft tissue architecture using subtractive or additive techniques (Misch et al., 2004). The first method, subtraction, removes tissue to get access to the cover screw and to define the soft tissue contour, but generally, a reduction of papilla height is the consequence (Moy et al., 1989). The second method, addition, augments the peri-implant soft tissue using available adjacent tissue or connective tissue transplants as well as allografts (Adriaenssens et al., 1999; Azzi et al., 2002; Davidoff, 1996; Misch et al., 2004). Therefore, tissue volume of the recipient site, mainly buccal or interproximal of teeth or implants, increases.

FGGs

In case #1, a simple repositioning flap allowed for enough tissue gain to increase the thickness and the amount of KG on the buccal side. But when more keratinized tissue is required, at least 4 mm, and the amount available at the alveolar ridge is minimal or a thin phenotype is present, an FGG is indicated.

The classic technique proposed by Bjorn in 1963 entails removing a piece of KG from the palate (donor site) and suture stabilization to the recipient site. The palatal donor site usually spans the area starting from first premolar until the end of the first molar, depending on the extent of the deformity; this zone is free of palatal rugae and relatively far away from important vascular and nervous structures.

Clinical investigations measured the thickness of the palatal mucosa with different techniques: bone sounding with a periodontal probe (Studer et al., 1997; Warasawat et al., 2001); ultrasonic device (Kydd et al., 1971; Müller et al., 2000); conventional computed tomography (CT) scan (Song et al., 2008); and cone beam CT (Barri via et al., 2009). All studies evidenced increasing thickness moving from the gingival margin to the midpalate and from canine area to the second molar, with the exception of the donor site area.
on the first molar because of the prominence of the palatal root. The canine-premolar area seems to be the most suitable donor site. The tuberosity also allows harvesting a thick graft due to its abundant soft tissue, but the area of the graft is limited here.

Wara-Aswapati et al. (2001) analyzed the thickness of the mucosa in 62 fully dentate subjects with a bone sounding method, using a periodontal probe and an acrylic stent. Mean mucosal thickness ranged from 2.0 to 3.7 mm, with values of 4.3 and 6.1 mm close to the mid-palatal line of the first and second molar sites, respectively. Variations were reported according to the age of the patient, showing an increase of mean tissue thickness (2.8 ± 0.3 mm vs. 3.1 ± 0.3 mm) for older subjects. Some authors documented a direct relationship between mucosal thickness and periodontal phenotype (Müller and Eger, 2002), body mass index (Schacher et al., 2010; Stipetic et al., 2005), and age (Barriviera et al., 2009; Song et al., 2008; Wara-Aswapati et al., 2001), while disagreement exists regarding association with gender (Barriviera et al., 2009; Müller et al., 2000; Schacher et al., 2010; Song et al., 2008; Wara-Aswapati et al., 2001).

Conditions necessary for the healing process include the presence of a thin graft in close and stable contact with the host tissue. A thick blood clot would delay the fluid circulation during the first part of healing and the creation of the vascular network, increasing the risk of necrosis. Thus, in order to avoid the creation of a hematoma between the graft and the recipient site, it is advisable to maintain pressure over the grafted site for approximately 5 minutes with wet gauze to prevent a dead space under the graft following suturing.

The graft should include the epithelial layer as well as the underlying connective tissue because its survival during the first few hours is strictly dependent on its connective tissue bed; a graft composed of only epithelium will undergo necrosis because it lacks blood vessels. The mean thickness of orthokeratinized palatal epithelium has been reported as 0.31 mm (Schroeder, 1986), though there is variability up to 0.6 mm (Soehren et al., 1973).

**Case report #2: extended FGGs at the mandible**

The patient presented with two implants placed in the lower jaw meant to support an overdenture (Fig. 20.13). One implant head became exposed to the oral cavity, while the other was still covered by alveolar mucosa; however, in both sites, less than 4 mm of KG was present. Two FGGs were prepared to allow for simultaneous augmentation of the keratinized tissue and vestibule deepening. First, a partial-thickness recipient bed was prepared by sharp dissection 0.5 mm above the mucogingival junction with a 15c blade and muscle attachments were carefully detached to ensure immobilization of the graft to the underlying peristeum, graft stability being one of the crucial keys to success. Healing abutments of adequate heights were connected to the implants, and the attached gingiva present in the area was moved to the lingual side of the abutments without detaching it from the bone (Fig. 20.14). Two FGGs 20 × 8 mm with an approximate thickness of 1.8 mm were taken from both sides of the palate; this guaranteed enough connective tissue for the survival of the graft during the first days of healing (Figs. 20.15 and 20.16). A 4-0 chromic gut suture (Ethicon, Johnson & Johnson, Boston, MA) with a P3 needle was used to secure the graft; this material was chosen for its tensile strength, minimal inflammatory inducement, and fast enzymatic dissolution. The 3/8 circle needle 13 mm long guaranteed good manageability and a precise cutting power with reduced trauma for the tissue. A few single interrupted sutures at the
superior corner of each graft maintained them close to the healing abutments and at the same time favored the establishment of blood supply to the flap. At the inferior border of the grafts, suturing to the periosteum occurred; additional mattress sutures compressed the graft against the periosteal bed to promote plasmatic circulation (Fig. 20.17). Pressure with wet gauze was maintained for 5 minutes onto the sutured grafts to reduce any dead space between the graft and the periosteum. The healing of the FGGs was reported after 1 month (Figs. 20.18 and 20.19). Complete maturation of the grafts occurred after 1 month, with full keratinization of the epithelial layer.

Fig. 20.15 Free gingival grafts were taken from the palate with a 15c scalpel.

Fig. 20.16 Two FGGs with 20-mm lengths and a good amount of connective tissue were harvested and adapted to fit into the recipient site.

Fig. 20.17 The two FGGs were secured to the underlying periosteum with resorbable sutures. Additional vertical mattress sutures secured stabilization and blood supply.

Fig. 20.18 One month later a wide band of keratinized tissue surrounded the implants, with a good color match with the residual tissue.

Fig. 20.19 The depth of the vestibule has increased and the prosthetic rehabilitation could be seated with greater stability 1 month after surgery. (Courtesy of Dr. Christian F.J. Stappert and Dr. Jose Pérez.)
natural blending with the preexisting keratinized tissue was detected, with distinct graft borders (Fig. 20.18). As a result, a wide band of keratinized tissue was present on the buccal side of the implants and the increased depth of the vestibule allowed for more stable prosthetic support (Fig. 20.19). Soft tissue contouring was required between the two fixtures to facilitate hygienic procedures. (Case courtesy of Dr. Christian F.J. Stappert and Dr. Jose Peréz, 2007.)

Before considering a case of free gingival grafting in the maxillary arch, a description of the surgical technique, step-by-step, will be provided.

FGG technique modified by Stappert: Step-by-step

In some situations, more frequently after ridge augmentation techniques, the mucogingival junction can be located close to the top of the alveolar crest. In order to increase the width of keratinized tissue, FGG placement is suggested. Before starting with the surgical procedure, specific attention should be given to the local anesthesia protocol. Procedures of soft tissue grafts and split-thickness flaps are associated with greater bleeding. The use of articaine chlorhydrate 4% and adrenaline 1:100.000 (Alfacaina N, Weimer Pharma, Rastatt, Germany) are recommended for several reasons. This anesthetic has a plasmatic metabolism, with a short life and no accumulation in the human body, giving clinicians the opportunity of using higher concentrations with limited risk of toxicity. Besides, its intrinsic constrictions property provides a strong anesthetic activity, 1.8 times greater than lidocaine. The injection should be done with adequate time (1 mL every minute), giving tissue the opportunity to absorb the product for a long-lasting effect. All these factors contribute to reduce the bleeding without creating ischemic condition, increasing the comfort for the patient and the clinician. A 15c scalpel represents a good compromise between dimension of the blade and cutting power, but microsurgical instruments are admitted according to clinician habits. It is important to use sharp instruments during flap elevation and to avoid multiple incisions at different levels that result in tissue damage and compromised blood supply.

The preparation of the recipient site should start with a linear incision in the KG approximately 3–5 mm palatal of the mucogingival junction. The primary incision initiates at the KG of the palate, not at the buccal mucosal epithelium or the mucogingival junction, to reposition a band of KG further apical of the vestibule. Therefore, the FGG will be surrounded by KG coronally and apically. This technique avoids the creation of a nonkeratinized interface between the graft and the palate, which frequently results in scar tissue. The initial incision should be performed in a 90° angle and approximately 2 mm depth without cutting the periosteum (Fig. 20.20). The split-thickness flap preparation is executed by more shallow crestal incisions (≤45° angle) following the alveolar ridge contour and maintaining a uniform layer of periosteum and at least 0.5 mm of crestal connective tissue. Special attention should be given during flap elevation at the curvature of the crestal and buccal bone. The use of atraumatic tissue pliers can reduce the risk of perforation during the change in direction of the blade. A sufficient thickness of the buccal split-thickness flap is important on its borders to avoid necrosis due to compromised blood supply. It is essential to thin out the crestal mucosal connective tissue at the base of the vestibule and disconnect muscle or ligament initiations to provide maximum tissue stabilization at the alveolar ridge (Fig. 20.21). The mobilized band of keratinized tissue at the coronal part of the buccal mucoepithelial flap helps to position the flap apically and to secure it to the underlying periosteum with deep single horizontal sutures. Proper stabilization of the buccal tissue will avoid mobility and displacement of the FGG during mastication and phonetics and will secure the reestablishment of the vascular network (Fig. 20.22). An FGG of at least 1.5–2 mm thickness should be taken from the palate with a 15c scalpel. The dimensions of the FGG should be rather smaller than the recipient side to allow for keratinization of exposed connective tissue by secondary intention, which reduces scar tissue. The FGG will be transferred to the recipient site to create a new area of keratinized tissue (Fig. 20.23). The first line of horizontal sutures stabilizes the graft at the coronal
The flap should be secured with deep periosteal sutures to prevent mobility of the connective tissue above the mucoepithelial flap. (Graphics courtesy of Dr. Christian F.J. Stappert.)

Fig. 20.23 Free gingival graft will be harvested from the palate, leaving the area exposed for a second-intention healing. The graft extension should be smaller than the recipient site to minimize scar tissue. The tissue transplant should be placed directly onto the recipient site with only minor adjustments. (Graphics on the modified FGG technique courtesy of Dr. Christian F.J. Stappert.)

Fig. 20.24 First, the flap should be fixed by interrupted horizontal sutures at the coronal and vestibule flap margins. The secondary vertical and horizontal mattress sutures span over the FGG and lock the graft onto the underlying periosteum to establish plasmatic circulation. (Graphics on the modified FGG technique courtesy of Dr. Christian F.J. Stappert.)

Clinical findings evidenced a shallow vestibule, with unattached mucosa approximating the abutment levels of the anterior implants (Fig. 20.26). The implant positions were approximately 8 mm further linguall than the restored anterior tooth positions. Therefore, the upper lip was constantly rubbing over the fixed dental prosthesis and food impaction was evident (Fig. 20.27). It was proposed to take FGGs from both sides of the palate to
Fig. 20.25 The panoramic radiograph demonstrates a full-arch rehabilitation with bilateral sinus augmentations and multiple-implant placements. The patient has a compromised upper implant-supported fixed dental prosthesis.

Fig. 20.26 A narrow band of keratinized tissue surrounded some of the fixtures on the buccal side of the anterior maxilla.

Fig. 20.27 The shallow vestibule caused food impaction. Rubbing of the labial mucosa over the resin base of the fixed dental prosthesis created labial sore spots for the patient repeatedly.

Fig. 20.28 An increase of keratinized gingiva was planned. A split-thickness flap was raised buccally from the second bicuspids of both sides to the anterior dentition without vertical incisions. Muscle insertions were carefully detached.

Fig. 20.29 The mucoepithelial flap was positioned apically and secured with periosteal sutures to create a recipient site for free gingival grafts.

move the mucogingival junction more apically to increase patient comfort. A linear incision in the KG close to the implant heads was performed and a split-thickness flap was raised with complete muscle dissection (Fig. 20.28). The flap was firmly secured to the periosteum with single interrupted sutures to avoid any apical movement (5-0 GORE-TEX® sutures, nonabsorbable monofilament, WL. Gore & Associates, Flagstaff, AZ) (Fig. 20.29). Two FGGs were taken as previously described (Fig. 20.30) and reshaped to fit the recipient sites (Fig. 20.31). The FGGs were sutured to the buccal mucosal connective tissue and to the underlying periosteum (5-0 and 6-0 GORE-TEX® sutures, nonabsorbable monofilament) (Fig. 20.32). After 2 weeks, a creation of a band of keratinized mucosa between the interfaces of the grafts was evident (Fig. 20.33). Two months after, a new depth of the vestibule was established (Fig. 20.34). The mucogingival junction was repositioned approximately 10–12 mm apical to its presurgical level (Fig. 20.35). The 1-year follow-up
Fig. 20.30 Two free gingival grafts were taken from the palate.

Fig. 20.31 The grafts were adapted to the recipient areas to increase the height of keratinized gingiva on the buccal side.

Fig. 20.32 The grafts were secured to the periosteum and to the palatal keratinized gingiva to guarantee immobilization during the healing phase.

Fig. 20.33 Two weeks after surgery, the buccal view of the surgical area showed fibrin clot resolution and signs of revascularization.

Fig. 20.34 After 2 months, the depth of the vestibule was improved and an increased band of keratinized gingiva was evident.

Fig. 20.35 The mucogingival junction was positioned approximately 10–12 mm further apical than its location before the surgery, providing a stable band of keratinized gingiva around the implants.
Preliminary consideration of the harvest area should be completed to evaluate the amount of tissue from donor sites before the surgical procedure. An injection needle with an endodontic stop can be used to probe the palatal mucosa after anesthetic injection. As mentioned before, tissue thickness can be related to the periodontal phenotype, body mass index, and age. Attention should be given to the anatomy and shape of the palate to identify the potential palatal artery path. Usually, high palatal vaults are associated with a deep position of vessels and nerves, allowing clinicians a relatively risk-free procedure compared with that performed in a wide and shallow maxillary arch.

Before taking the graft, the preparation of the recipient site is mandatory. A split-thickness flap should be raised and, whenever possible, vertical incisions avoided or at least minimized to secure good blood supply. The key is to maintain and guarantee an efficient blood vessel network for the survival of the graft to establish new vascularization. The creation of an envelope for the subepithelial CTG can provide a double source of nutrition: the one from the connective tissue of the underlying periosteum and the one from the overlying flap. Besides, presence of the periosteal layer provides protection of the bone, reducing bone resorption, and offers mechanical retention for mattress sutures. Stabilization of the graft is fundamental for the promotion of plasmatic circulation.

When the creation of the recipient site is completed, the clinician gains a general idea of the necessary dimensions of the CTG. Different methods can be used to harvest the subepithelial connective tissue, but we suggest strongly a modified “single incision” approach for reduced morbidity and discomfort of the patient (Del Pizzo et al., 2002; Lin and Weisgold, 2002). Horizontal incision perpendicular to the bone should be performed at least 4 mm apical to the gingival margin of premolars and first molar to avoid any interference with the periodontal attachment of the teeth. The length of the incision is related to the size of the graft. The first incision does not perforate the periosteum, but is the initiation of a split-thickness flap toward the midline of the palate. After the overlying mucoepithelial flap is created, a second incision should be conducted 1 mm below and parallel to the first incision, cutting the connective tissue including the periosteum (modification). The extension of the CTG will be defined then by cutting the connective tissue circumferential down to the bone level. The CTG is mobilized by periosteal elevation from the palatal bone and removed from the palatal donor site. The time elapsing between the harvesting and the positioning in the recipient site should be reduced to the minimum to avoid graft contamination and maintain its moisturizing. The palatal donor site should be kept under pressure with wet gauze for a few minutes to reduce bleeding. Palatal suspension sutures for primary closure should be performed after the surgical procedure at the recipient site is completed (Figs. 20.44 and 20.61).
Case report #4: CTGs—the envelope technique

The 42-year-old patient was eager to improve his dental function and his smile. He presented with gingival inflammation and multiple porcelain-fused-to-metal crowns and fixed dental prostheses in both arches, the majority of them with improper margins and secondary decay (Fig. 20.37). The patient underwent extensive dental treatment including periodontal and endodontic treatment as well as implant placement in the edentulous sites. Considering only the maxillary anterior region, the right central incisor was missing and one implant was placed including guided bone regeneration with a two-stage approach (Fig. 20.38). Six months later, a slight concavity was noted on the buccal side of the implant and a CTG was proposed to improve the soft tissue contour before final restoration (Fig. 20.39). The recipient site was prepared by intrasulcular incisions and a palatal positioned crestal incision connecting the palatal line angles of adjacent teeth. A split-thickness flap was raised by maintaining an intact periosteum and crestal connective tissue layer, resulting in the creation of a buccal envelope. The incision was extended beyond the mucogingival junction to allow for flap mobility and guarantee tension-free closure (Fig. 20.40). A CTG of 14 mm length was harvested from the palate by modified single-incision technique as previously described (Fig. 20.41). It was inserted into the soft tissue envelope (Fig. 20.42) and stabilized by resolvable sutures (5-0 Vicryl®, Ethicon) to the underlying periosteum and the overlying mucogingival flap. Single monofilic sutures provided primary closure of the overlying flap (Fig. 20.43). The palatal wound was secured by running sutures, embracing the adjacent teeth, spanning over the donor site and anchored horizontally in the apical intact tissue of the palate (Fig. 20.44). One month later, a custom-made zirconium oxide abutment was delivered and a fixed provisional inserted (Fig. 20.45). Aluminum oxide all-ceramic crowns were fabricated for the anterior dentition (Fig. 20.46) and
Fig. 20.41 Connective tissue graft (CTG) was taken from the palate.

Fig. 20.42 The CTG was placed in the envelope between buccal and periosteal connective tissue to correct the tissue deficiency and to improve the emergence profile of the restoration.

Fig. 20.43 The graft was stabilized to the underlying periosteum with resorbable mattress sutures. The CTG was completely covered by the mucogingival flap.

Fig. 20.44 The palatal wound at the donor site was closed by primary intention to reduce pain and morbidity for the patient.

Fig. 20.45 One month later a custom-made zirconium oxide abutment was placed on the implant and a fixed provisional inserted. At this stage the soft tissue had reached a good stability.

Fig. 20.46 Aluminum oxide all-ceramic crowns were fabricated for the anterior teeth and the implant.
Implant site development

adhesively bonded to the natural teeth and implant (Fig. 20.47). The panoramic radiograph demonstrated the final result of the full-mouth rehabilitation including site #8 (Fig. 20.48). One year after insertion of the permanent anterior all-ceramic restorations, the patient showed healthy and esthetically pleasing soft tissue conditions (Fig. 20.49). (Case courtesy of Dr. Christian F.J. Stappert, 2003.)

Case report #5: CTGs—modified tunnel technique

A 45-year-old female patient had tooth #9 extracted due to a vertical fracture, and a bone-level implant was placed immediately (4.1 × 12 mm). After 3 months of healing, a second-stage surgery was performed, and a provisional crown was placed at the day of surgery using a temporary cylinder. Ten weeks later, soft tissue healing was satisfactory with respect to the papilla heights of site #9 (Fig. 20.50). The occlusal view revealed a slight crestal undercontour of the cervical soft tissue dimensions (Fig. 20.51). It was thought to correct this deficit by better tissue support with the permanent implant abutment. Therefore, two polyether impressions were taken, one on implant level and one utilizing the screw-retained temporary to transfer the soft tissue contour to a soft tissue model (Elian et al., 2007) (Figs. 20.52 and 20.53). A zirconium oxide custom-made abutment and all-ceramic crown were fabricated as the final restoration and delivered to the patient. Two weeks later, a recession of the cervical area was noted vertically (Fig. 20.54) as well as horizontally (Fig. 20.55). A modified microsurgical tunnel technique was utilized to correct the recession at implant site #9 as well as the tissue contour of the neighboring teeth (Zuhr et al., 2007). The surgical procedure was accomplished by intrasulcular incisions and supraperiosteal split-thickness preparation of the buccal gingiva through the primary incision lines (Fig. 20.56). Initial
Soft tissue enhancement after implant placement

Intrasulcular incisions were performed with microsurgical blades. Microsurgical blades have cutting edges on both sides and on the tip of the blade, which minimizes the risk of tissue rupture. To gain mobility, the undermining preparation had to be extended into the mucosal tissue beyond the mucogingival junction. Tunneling knives (tunneling knives 1 and 2, Mamadent, American Dental Systems GmbH, Vaterstetten, Germany) were used to achieve the tunneling preparation. The split-thickness dissection was extended to the distal line angles of the two adjacent teeth. The split-thickness flap resulted in a good blood supply for the subepithelial

Fig. 20.51 The palatal view of implant site #9 revealed a cervical undercontour of the marginal soft tissue dimensions.

Fig. 20.52 A polyether impression was taken utilizing the screw-retained temporary to transfer the soft tissue contour and implant position for a soft tissue model.

Fig. 20.53 The soft tissue model showed the implant position #9 (implant analogue) and the unchanged tissue conditions at the presence of the temporary implant abutment. The model was used to generate a custom-made zirconium oxide abutment.

Fig. 20.54 Final zirconium oxide abutment and all-ceramic crown 2 weeks after delivery. A vertical recession of the cervical area of site #9 was noted.

Fig. 20.55 The buccal view of the implant site #9 revealed horizontal soft tissue volume loss. The gingival zenith of the implant restoration was approximately 1.5mm further apical than the zenith of the natural central incisor #8.
Implant site development

The papilla areas were raised as full-thickness tissue including the periosteum, which allowed them to detach completely. This was done with a small tissue elevator to avoid the risk of rapture. A CTG was harvested from the palate by single-incision technique as described previously (Hürzeler and Weng, 1999) (Fig. 20.57). The CTG was inserted into the “tunnel” from the intrasulcular incision of tooth #8 (Fig. 20.58) and positioned under the mucoepithelial tissue of sites #8 to #10 (Fig. 20.59). To do so, a support suture was used to guide the CTG into the recipient site. The suture was moved through each tunneled interdental area and was then secured in the CTG. By pulling the suture, the graft was gently pushed into the tunneled tissue with a packing instrument. A vertical mattress suture (7-0 polypropylene, Blue Perma Sharp Sutures, HuFriedy Mfg. Co., Chicago, IL) was applied to elevate the entire gingivopapillary tissue coronally (Fig. 20.60). The suture had to capture the buccal flap and the subepithelial connective tissue to stabilize the CTG. The donor site was closed by running sutures spanning over the palatal wound (4-0 Vicryl®) (Fig. 20.61). Healing was uneventful and the marginal tissue level of site #9 was reestablished 2 months after surgery (Figs. 20.62 and 20.63). The periapical X-ray demonstrated stable crestal bone conditions (Fig. 20.64).

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(Case courtesy of Dr. Notis Emmanouilidis and Dr. Christian F.J. Stappert, 2010.)
Soft tissue enhancement after implant placement

Fig. 20.60 A vertical mattress suture elevated the entire gingivopapillary tissue coronally. Temporary interproximal composite stops were used to secure the suture at the incisal edges.

Fig. 20.61 Closure of the donor site was achieved with running sutures spanning over the palatal wound. The sutures provide coverage and protection of the donor site over the different stages of swelling and healing of the palatal tissue.

Fig. 20.62 The marginal peri-implant tissue level of site #9 was satisfactory after 2 months of tissue healing. Creeping epithelium was observed on teeth #8 and #10.

Fig. 20.63 The buccal connective tissue volume was improved for the four anterior incisor sites. Symmetry of gingival levels was reestablished.

Fig. 20.64 Stable crestal bone conditions were observed around the bone-level implant with zirconium oxide abutment and restoration by periapical X-ray evaluation. (Case courtesy of Dr. Notis Emmanouilidis and Dr. Christian F.J. Stappert.)

Conclusion

Soft tissue management is one of the key factors for successful implant restoration. Esthetics can be strongly influenced by the conditions of the peri-implant tissue. Substantial knowledge of tissue anatomy and biology is a fundamental prerequisite for surgical success.

The present chapter introduced different techniques to improve the appearance of the soft tissue after implant placement. Cases of repositioned flaps, FGGs, and CTGs were presented along with biological considerations. It
was our intention to present various indications and options to the clinician to achieve an increased amount of peri-implant KG or connective tissue thickness. Stabilization of a tissue transplant as well as preservation of blood supply at the recipient site and donor site are key factors for uneventful healing. Minimally invasive techniques involve smaller flap designs, maintenance of the periosteum–bone interface, and fewer vertical incisions. Microsurgical instruments and thinner suture materials allow for gentle handling of the delicate soft tissue conditions in the esthetic zone.

The final goal is always a combination of long-term stability of the peri-implant tissue, implant restoration, and patient satisfaction.

References


