Chapter

Peri-Implant Soft Tissue Augmentation

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Abstract

The peri-implant soft tissue (PIS) augmentation procedure has become an integral part of implant-prosthetic rehabilitation. Minimal width of keratinized mucosa (KM) of 2 mm is deemed necessary to facilitate oral hygiene maintenance around the implant and provide hard and soft peri-implant tissue stability. PIS thickness of at least 2 mm is recommended to achieve the esthetic appearance and prevent recessions around implant prosthetic rehabilitation. The autogenous soft tissue grafts can be divided into two groups based on their histological composition—free gingival graft (FGG) and connective tissue graft (CTG). FGG graft is used mainly to increase the width of keratinized mucosa while CTG augment the thickness of PIS. Both grafts are harvested from the same anatomical region—the palate. Alternatively, they can be harvested from the maxillary tuberosity. Soft tissue grafts can be also harvested as pedicle grafts, in case when the soft tissue graft remains attached to the donor site by one side preserving the blood supply from the donor region. Clinically this will result in less shrinkage of the graft postoperatively, improving the outcome of the augmentation procedure. To bypass the drawback connected with FGG or CTG harvesting, substitutional soft tissue grafts have been developed.

Keywords: connective tissue graft, CTG, free gingival graft, FGG, apically positioned flap, APF, peri-implant soft tissue augmentation, subepithelial connective tissue graft, de-epithelized free gingival graft, keratinized mucosa

1. Introduction

Peri-implant soft tissue (PST) thickness and width of keratinized mucosa (KM) have a major impact on the esthetic appearance, stability, and health of implant/prosthetic reconstruction. Dental implants were introduced 50 years ago as a treatment modality for edentulous patients and, later on, for partially edentulous patients with shortened arches and single-tooth gaps [1]. Until lately, the success of implant treatment was based on implant survival rates, prosthetic stability, radiographic bone loss, and absence of infection [2, 3]. Today, patients' implant treatment expectations have changed. They have shifted from healthy and functional to healthy, functional, esthetic, and natural-looking tooth replacement [4]. Consequently, the PST augmentation procedure became a fundamental part of implant treatment algorithms.

There are two main objectives of soft tissue augmentation around implants—(1) to restore an adequate width of KM and (2) to increase the volume of peri-implant soft tissue [5].

1.1 KM width around implants

The displacement and loss of the KM can be a consequence of—(1) flap mobilization in order to achieve primary flap closure during horizontal or vertical bone augmentation procedures and (2) vertical bone resorption and reduction of distance between the bone crest and mucogingival line [6].

Today, the vast majority of published evidence supports the necessity of at least 2 mm of keratinized mucosa width around the implant.

The presence of an adequate amount of KM around implants (>2 mm) will facilitate maintenance of oral hygiene, which can lead to less plaque accumulation and lower incidence of peri-implant mucositis. Furthermore, KM can be associated with soft and hard tissue stability, resulting in decreased incidence in the recession of peri-implant mucosa, marginal bone resorption, and attachment loss (**Figure 1**) [5, 7–13].

KM is fundamental in maintaining health around implants in erratic maintenance compliers patients. Less than 2 mm of KM around implants is erratic compliers seems to be associated with a higher incidence of peri-implantitis [12, 14].

1.2 PIS volume

In literature, the suggested PIS thickness is at least 2 mm. PIS thickness has a major influence on two factors—(1) esthetic appearance of the implant/prosthetic rehabilitation and (2) marginal bone stability [13, 15].

1.2.1 Esthetic appearance

The color, texture, volume, level of mucosal margin of the PIS, and presence of papilla has a major influence on the overall esthetical outcome. The aforementioned elements must be in line with those of soft tissue around adjacent teeth in order to obtain a harmonious and natural-looking restoration. These parameters are influenced

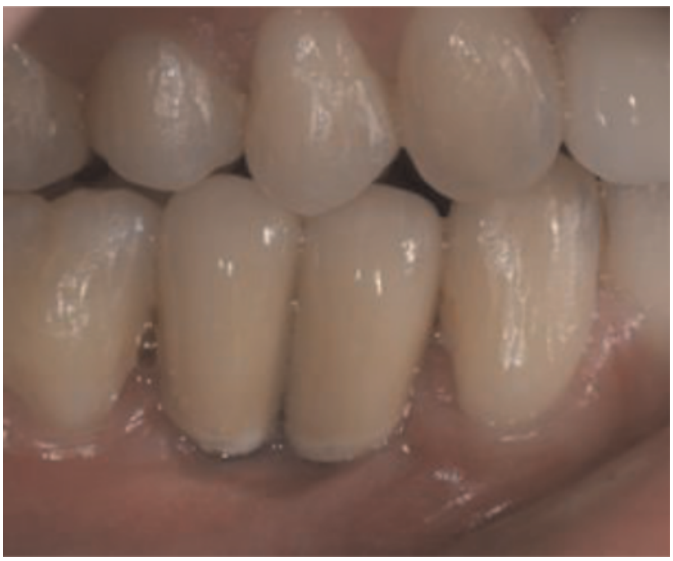

Figure 1.
Recession of the marginal mucosa caused by inadequate width of KM.

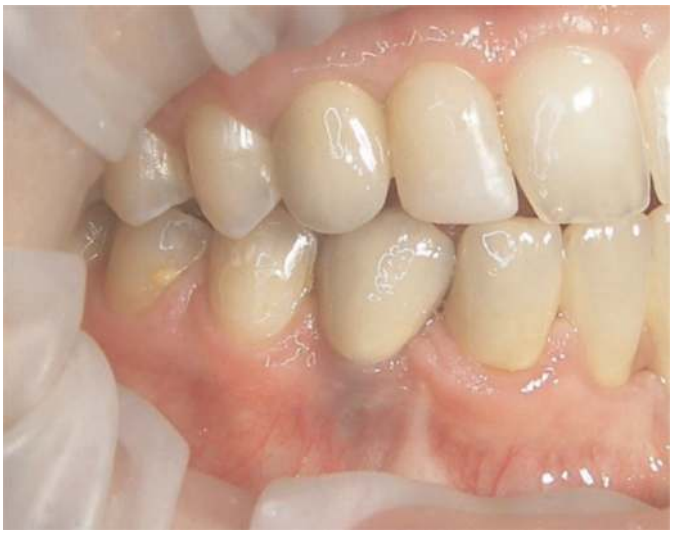

Figure 2.
Visible discoloration of the thin marginal mucosa caused by titanium abutment in the region of the lower right canine.

mainly by soft tissue thickness. Several indexes were developed to objectively evaluate the esthetical appearance of the implant/prosthetic restoration [16].

In literature, the suggested PIS thickness is at least 2 mm [15].

Inadequate PIS volume can be improved with soft tissue augmentation techniques. Furthermore, thick soft tissue can even mask and hide alveolar bone loss on the buccal side of implants [12, 13, 15]. Therefore, soft tissue augmentation is recommended in esthetical regions where a certain amount of buccal bone remodeling is expected, like immediate implant placement in situations with thin biotype or thin buccal bone plate [17, 18].

PIS thickness is essential for concealing the color of the prosthetic restoration and preventing PIS discoloration caused by prosthetic material. In cases with thin PIS (< 2 mm) titanium abutments will cause a visible color change of the buccal PIS (**Figure 2**) [12, 19–21].

1.2.2 Peri-implant marginal bone stability

PIS has a predetermined thickness of 2.5–4 mm, termed biologic width [22]. PIS is formed after healing abutment installation. In case when soft tissue is thinner than 2 mm, peri-implant marginal bone resorption will be initiated in order to establish sufficient space for the biological width [22, 23]. Augmentation of PIS volume with soft tissue grafts can prevent marginal bone resorption in the case of thin PIS [5, 14, 24].

2. General principles of PIS grafting

After transplantation to the recipient region, the soft tissue graft depends on plasmatic imbibition in order to receive sufficient nourishment. In the later stages, after 3–4 days, the soft tissue graft will be transvascularized with newly formed blood vessels. Blood vessel anastomoses will be formed between vessels of the recipient site and vessels already present in the graft [21, 25–29]. In order to achieve plasmatic imbibition and transvascularization certain factors must be met:

1. Rigid immobilization of the graft-excessive movement can hamper plasmatic imbibition and transvascularization of the flap

2. Intimate contact of the graft with the recipient site—decreased distance for the plasmatic diffusion or for new blood vessels to reach the graft will result in faster and complete nourishment of the graft. Furthermore, the formation of a blood clot or active hemorrhage between the vascular surface of the recipient site and graft can compromise the nourishment of the graft

3. Vascularity of the recipient site—the root surface of the tooth and the surface of the implant are avascular surfaces. In those situations, the survival of the graft will be accomplished either by using a larger graft than the avascular surface in order to obtain nourishment from the adjacent vascularized surfaces, preparing a split-thickness flap in order to assure nourishment from both sides of the flap, or by using a pedicle graft.

4. The PIS grafting procedure should begin with the preparation of the recipient site in order to decrease the time between graft harvest and graft transfer into recipient bed [21, 25, 26].

Most of the aforementioned conditions are met when the periosteum is used as a recipient site. The periosteum is well irrigated and it is immobile (**Figure 3**) [25, 30].

Likewise, to achieve those factors care must be taken while harvesting the soft tissue graft. The graft should be of uniform thickness to ensure even intimate contact of the inner surface of the graft and the recipient site [25, 26].

The composition of the graft can influence the nourishment of the graft—adipose and glandular tissue may hinder the nourishment of the rest of the graft so they should be dissected from the graft [26, 31].

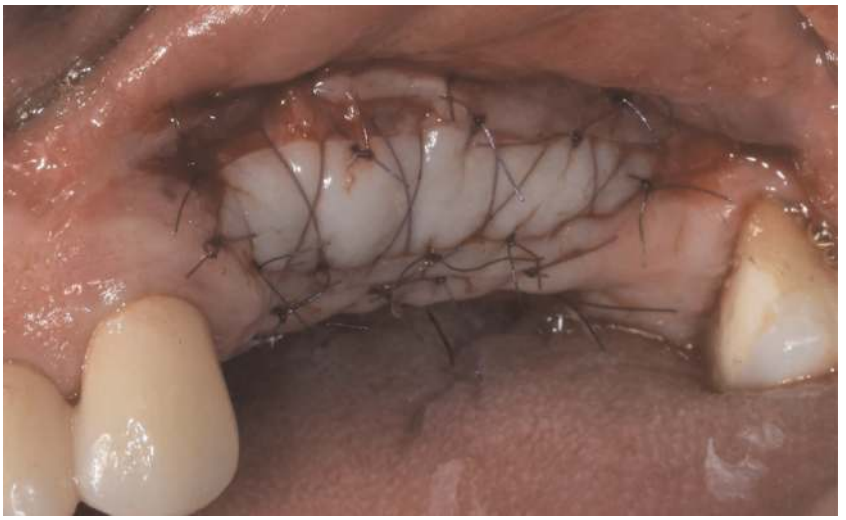

Figure 3.
Stabilization and intimate contact of the autologous soft tissue graft (free gingival graft) in the recipient site achieved with simple interrupted and cross mattress sutures. After the dissection and apical displacement of the mucosal flap, only the exposed periosteal surface is present in the recipient site. The periosteum is well irrigated and immobile surface, suitable for graft nutrition and stabilization.

3. Connective tissue graft (CTG)

The first description in literature of the use of connective tissue graft was by Alan Edel in 1974 for increasing the width of gingiva [32]. Since than the indications and the use of CTG graft increased significantly. Today, CTG is still regarded as the gold standard for most soft tissue augmentation treatments. It is indicated for:

1. Increasing the width of the keratinized gingiva [33]

2. Treatment of single and multiple gingival recession around teeth [34]

3. Treatment of mucosal recession around implants [35]

4. Furcation treatment [36]

5. Regeneration of infrabony defects [37]

6. Augmentation of edentulous alveolar ridge defects [38]

7. Augmentation of PIS [39]

Some of the aforementioned indications are overlapping with those of the FGG. The main advantage of the CTG over FGG is the superior esthetic outcome in terms of color and texture of the augmented area (**Figure 4**) [25, 26, 40–42].

3.1 Connective tissue graft harvesting (CTG)

The harvesting technique of the CTG has a direct influence on the graft dimension, histological composition, harvesting complications, morbidity, healing dynamics of

Figure 4.
Connective tissue graft.

the donor site, healing dynamics of the recipient site, and outcome of the grafting procedure. The ideal technique should enable the maximum volume and quality of the graft to be harvested, while concurrently limiting trauma, postoperative morbidity, and possible complications connected with CTG harvesting [43]. A variety number of techniques have been described in the literature for connective tissue graft harvesting. All the techniques can be divided into two groups—(1) connective tissue harvesting with the preparation of the primary flap (offend referred to as subepithelial connective tissue graft, sCTG) and (2) free gingival graft harvesting with extraoral de-epithelization. The first group can be further subdivided into free CTG or pedicle CTG depending if the CTG is completely dissected or remains attached by one side of the palatal soft tissue [26, 40, 42–45].

The palate is the most frequent site donor site for CTG or FGG harvesting [40]. Histologically, it is composed of different layers—the most superficial epithelial layer, covering a dense connective tissue layer (lamina propria). The submucosal layer is located below the lamina propria and above the periosteum, containing fatty and glandular tissue. Preferably, the CTG should consist only or mostly of the lamina propria layer, with little or no submucosa [26, 46]. Fatty and glandular tissue can hinder or slow the revascularization of the graft after its transplantation [31]. Furthermore, they can be responsible for the increased shrinkage rate of the CTG during healing, influencing the outcome of the grafting procedure [40, 47, 48].

Palatal soft tissue thickness differs greatly among the various areas of the palate and among individuals [49–51].

Limited data in the literature suggest that patients with thick palatal soft tissue have increased thickness mainly of the submucosal layer while the dimensions of lamina propria remain unchanged [49]. It could be hypothesized that CTG harvesting with the primary flap techniques in thick palatal soft tissue would always result in a graft composed of a lower percentage of lamina propria. The only layer that would have increased share in graft thickness would be the submucosal layer [49].

In the case of thin palatal soft tissue, there is not enough connective tissue thickness to prepare the primary flap and the CTG. The result of CTG harvesting with the primary flap in those situations can lead either to (1) primary flap necrosis if the primary flap is prepared to thin in order to increase the composition of the lamina propria inside CTG, or (2) CTG with a decreased thickness and composition of lamina propria which can result in the improper outcome of the harvesting procedure [48].

To overcome the aforementioned drawbacks, a new harvesting procedure was described—harvesting of an FGG and afterward, intra- or extra-oral de-epithelization of the FGG. As a consequence of the de-epithelization, the epitel layer is removed and the FGG graft is converted into CTG. With this harvesting procedure, the most valuable tissue (lamina propria) is almost completely inside the graft regardless of the initial thickness of the palatal soft tissue. In contrast, when the primary flap is used, a varying percentage of the lamina propria remains unutilized, attached to the inner side of the primary flap [40, 49, 52]. Furthermore, CTG obtained with the new harvesting procedure (de-epithelized FGG) is firmer and easier to manage during the grafting procedure with less variations in compositions among different CTG [48, 49].

The main disadvantage of the de-epithelized FGG procedure is the secondary intention healing of the donor site resulting in a slower healing process related to a higher percentage of complications linked to the donor site (pain and bleeding). Patients who underwent CTG graft harvesting experienced a lower incidence of donor site pain in the early postoperative period compared to FGG graft harvesting patients (**Table 1**) [49, 52–55].

Harvesting techniques of free CTG		
	CTG with primary flap (subepithelial connective tissue graft)	de-epithelized FGG
Advantages	Primary healing of the donor site	Larger graft dimensions
	Faster healing with less complications (pain, bleeding)	Higher quality of graft composition
	Better patient acceptance	Easier management of the graft
		Lower percentage of graft contraction during healing
Disadvantages	Reduced graft dimensions	Secondary healing of the donor site
	Lower quality of graft composition	Slower healing with more complication
	Higher percentage of contraction during healing	Lower patient acceptance
	Poor handling properties	

Table 1.
Advantages and disadvantages of CTG harvesting techniques: CTG with the primary flap and de-epithelized CTG.

3.1.1 Connective tissue harvesting with the preparation of primary flap- subepithelial connective tissue graft (sCTG)

3.1.1.1 The role of the primary flap

The main purpose of the primary flap is the protection of the donor wound region. At the end of the surgical procedure, the primary flap is repositioned and sutured in its original position, completely covering the wound area beneath it. Thus, thanks to the primary flap, the wound area is healing with primary intention. This will result in a reduced time of haling and postoperative morbidity. In case when the primary flap has reduced vascularity as a consequence of a surgical error during flap preparation (flap thinner than 1 mm, perforation of the flap) it will necrotize, leaving the donor area unprotected and left to heal with secondary intention 26, 25, 40, 42, 43, 47, 52 (**Figure 5**).

3.1.1.2 Donor area

The donor area for CTG graft harvesting is located in the palatal masticatory mucosa extending:

1. Mesiodistally: the donor iste is extending from the distal line angle of the canine to the mesial line angle of the platal root of the first molar. In this region, the soft tissue thickness is suitable for the CTG harvesting procedure.

2. Apically the donor area is limited with a zone containing blood vessels. The average distance between blood vessels and CEJ of adjacent teeth is 12 mm. The recommended apical limit of the donor area is set at 10 mm from CEJ, leaving 2 additional millimeters of the safety zone between the apical border of the CTG and the blood vessels.

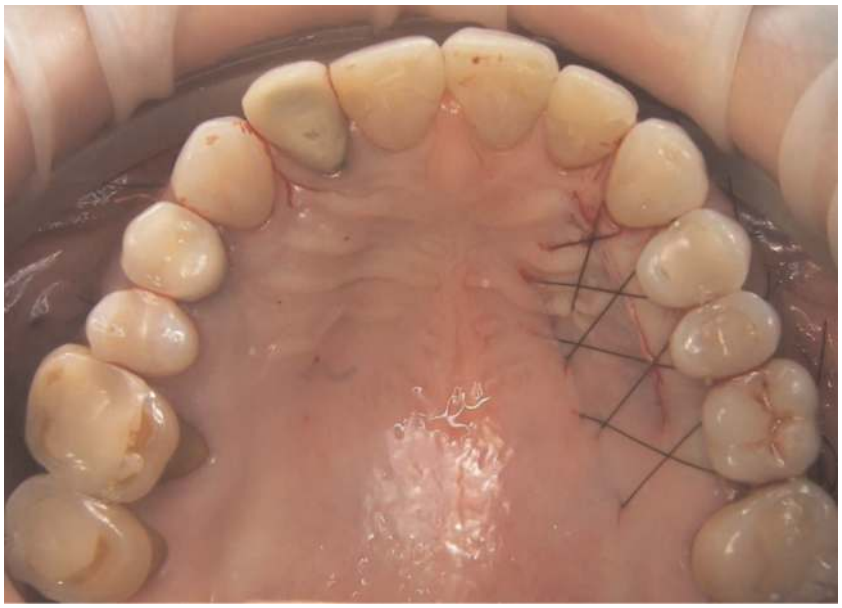

Figure 5.
sCTG harvesting. After the harvesting procedure of the sCTG the primary flap is repositioned in its original position. The primary flap protects the wound beneath it, enabling primary healing of the donor area.

3. The coronal incision is displaced 2 mm from the CEJ to prevent soft tissue recession on the palatal side of the adjacent teeth.

In patients with a flat palate, the palatine artery is closer to the CEJ, located 7 mm apically of the CEJ of adjacent teeth resulting in a limited height of the CTG [25, 26, 56–59].

Another limiting factor for CTG harvesting with the preparation of the primary flap is the palatal soft tissue thickness. The palatal soft tissue should be at least 3 mm thick, to allow the preparation of primary flap thick 1.0–1.5 mm and harvesting of 1.5–2.0 mm thick CTG. Therefore, before starting the grafting procedure, it is advisable to examine the thickness of the donor area [42, 60–63].

In case when inadequate palatal soft tissue thickness is present, three different solutions are available—(1) two-step procedures: Augmentation of the palatal soft tissue with the collagen sponge and after 8 weeks harvesting of the sCTG from the thickened donor site [60–62], (2) different grafting techniques of the CTG (de-epithelized CTG) [42, 48, 64], and (3) use of a substitutional soft tissue graft (allogenic or xenogenic soft tissue substitute graft) [65–68].

3.1.1.3 Surgical technique

The first part of the harvesting procedure consists of the preparation of the primary flap. The dissection of the primary flap starts with a horizontal incision 1.0–1.5 mm deep, 2 mm apical from the cementoenamel junction, and perpendicular to the mucosal surface. The blade angulation is changed to approximately 135° and a split-thickness flap is prepared in the apical direction. With the progression of the flap preparation, the angle of the blade is flattened until it becomes parallel with the gingival surface. The dissection is controlled from the external aspect of the flap in order to prevent flap perforation. The partial-thickness flap preparations end after reaching 8 mm from the first horizontal incision, this is 10 mm apically from the

cementoenamel junction, leaving a safe zone with 2 mm of distance from the possible location of blood vessels. This will result in the maximal apico-coronal graft dimension of 8 mm.

The primary flap is prepared with the sharp dissection, in a split-thickness manner. During the partial-thickness preparation, the blade is oriented parallel with the mucosal surface to prevent perforations or overthinning of the primary flap. Care must be taken to leave the minimum residual thickness of the primary flap at least 1.5 mm, otherwise it could be necrotized.

After finishing its dissection, the primary flap is partially reflected and the connective tissue graft is dissected just beneath it. It is suggested to place the coronal dissection line 1.0–1.5 mm apical from the coronal incision line of the primary flap. This will result in a 1.0–1.5 mm connective tissue band along the coronal incision line, improving the healing of the primary flap, but at the same reducing the apico-coronal dimension of the connective tissue graft from the maximal 8 to 7 or 6.5 mm [26, 44, 69–71].

The connective tissue graft can be harvested with or without the periosteum layer depending on if it is inner surface is prepared with sharp or blunt dissection. The CTG with the periosteum has better mechanical stability and better clinical handling. On the other hand, leaving a periosteal surface on the bone in the donor area will improve the healing of the primary flap. In clinical situations where the primary flap was prepared with reduced thickness (equal or less than the lower value of the recommended thickness) or perforated during dissection, it could be advisable to leave the periosteum covering the bone surface [26, 44, 69–71].

After the completion of the harvesting procedure, the primary flap is repositioned and sutured in its original position. Although, cross matters or a combination of parallel and cross sutures were recommended [26, 69, 70], it seems that the suturing technique does not have an influence on early wound healing in the donor area [72].

Once the CTG is harvested it must be kept in a moist environment, usually draped in wet gauze, until is transferred to the recipient site [26, 69–71].

3.2 Connective tissue pedicle flaps

Connective tissue can be harvested from the palatal donor site as a free graft or pedicle graft. Free grafts are completely dissected from the donor site while pedicle flaps remain attached by one part to the donor site. In that way, they retain the vascularization of the donor site which will influence positively the graft volume stability reducing the shrinkage of the graft postoperatively and improving the outcome of the augmentation procedure [44, 45, 73].

Pedicle palatal connective tissue was first described in 1980 [74].

The preparation of the primary flap is equal to the primary flap for the free connective tissue graft. The only difference is the length of the primary flap which can be elongated if the defect is located in the frontal region [45]. The main variation to conventional free connective tissue graft is the harvesting of the CTG. During the preparation of the pedicle, the connective tissue graft below the primary flap is freed from the rest of the palatal tissue on three sides, while one side remains attached to it [45, 73, 75–77].

Different modifications of this technique have been described, which can be divided into two groups—roll techniques and vascularized interpositional periosteal connective tissue flap. In the first group, the pedicle is attached by its coronal part to the buccal flap and rolled under the buccal flap. This flap is used mostly for minor augmentation of the buccal PIS during the single implant uncovering procedure

[78–80]. Other indications include soft tissue augmentation for pontic site development [81, 82] and multiple implants PIS augmentation and pontic site development at implant uncover procedure (**Figures 6–11**) [83].

The vascularized interpositional periosteal connective tissue flap (VIP-CTG) consists of a connective tissue pedicle that remains attached to the palatal tissue on the

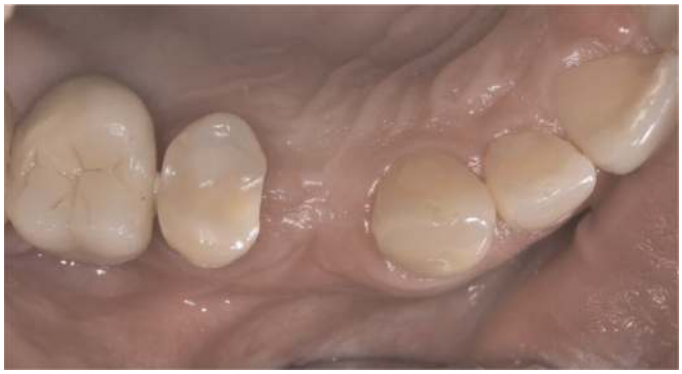

Figure 6.
Palatal roll technique for PIS augmentation around the single implant at uncovering procedure. Initial situation.

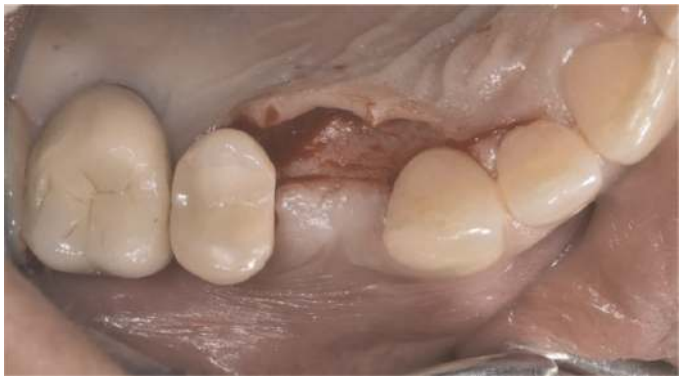

Figure 7.
The primary flap has been prepared.

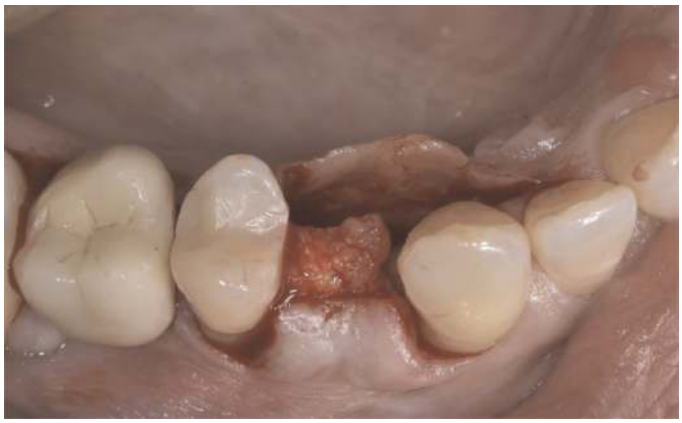

Figure 8.
The CTG remains attached to the buccal flap, while it is dissected from the adjacent palatal soft tissue on the apical, mesial, and distal side.

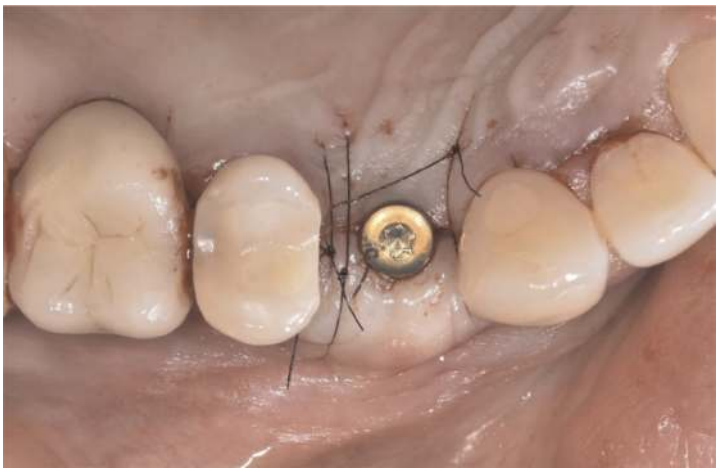

Figure 9.
The CTG pedicle graft has been rotated beneath the buccal flap and sutured in this position. The thickness of the buccal PIS has been visibly augmented.

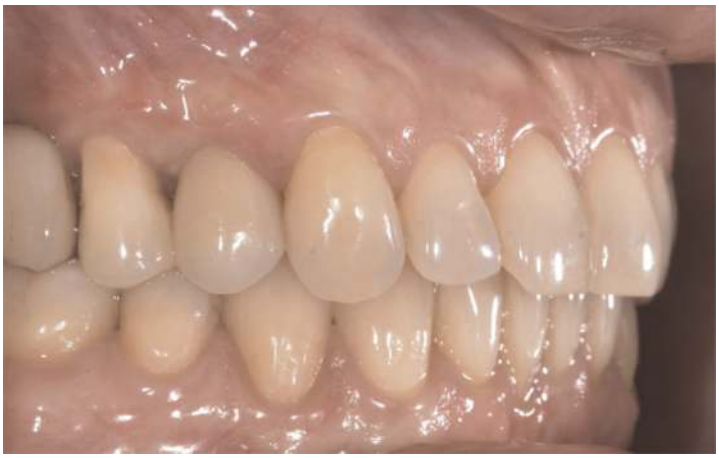

Figure 10.
Definitive zircon-ceramic screw-retained crown 14.

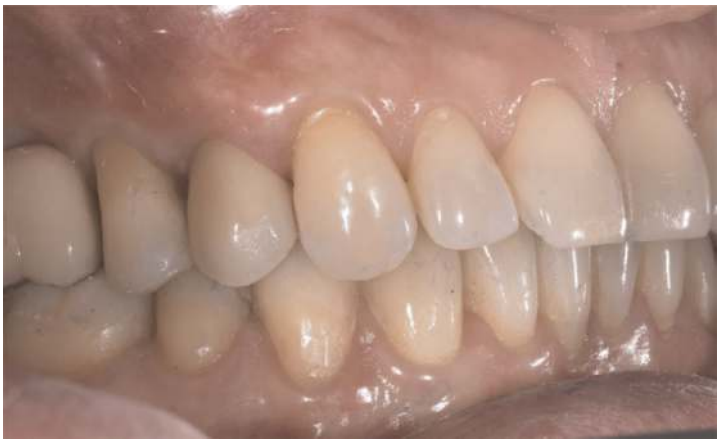

Figure 11.
Two years follow up.

distal or mesial side, depending on the defect location. It can be used for more pronounced soft-tissue defect augmentation (horizontal and vertical), allowing grafting of large soft tissue defects with only one procedure. Furthermore, VIP-CTG can be used for simultaneous soft and hard tissue augmentation procedures, reducing patient treatment time and morbidity. This procedure is indicated before implant placement, concomitant with implant placement, or during the implant osseointegration period [45, 75, 76] or pontic site development (**Figures 12–18**) [44, 73, 74, 84].

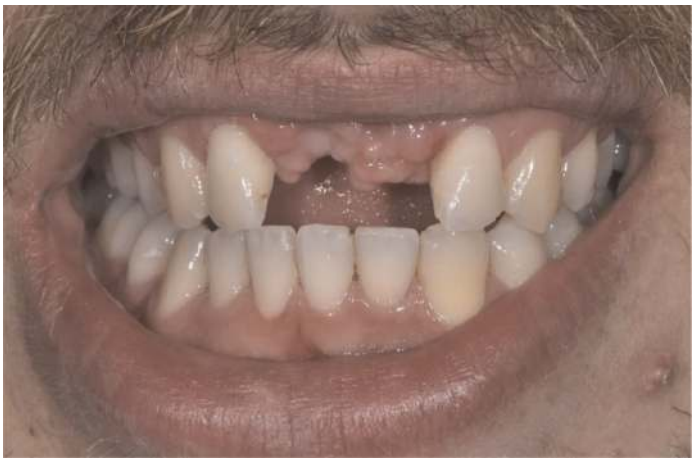

Figure 12.
VIP-CTG for the treatment of the vertical soft-tissue defect in an esthetical demanding situation. Initial situation.

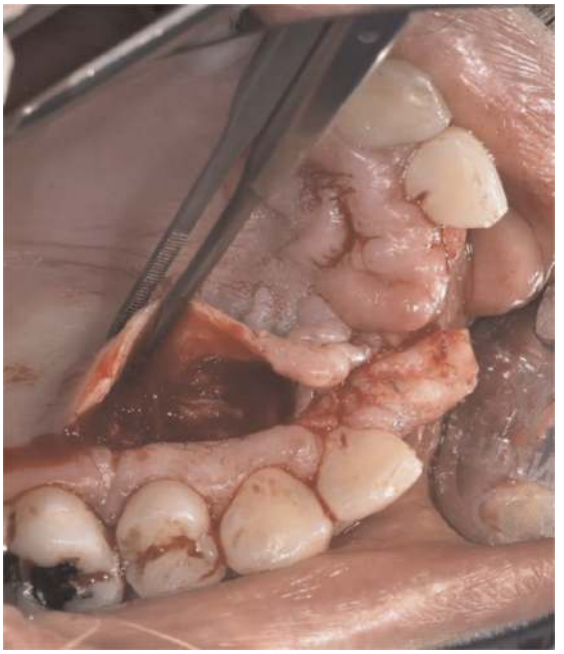

Figure 13.
The incision line of the primary flap is extending mesially until the defect site is located in the region of the central incisor. The VIP-CTG is dissected from the rest of the palatal soft tissue on three sides (distal, coronal, apical) and rolled over the buccal soft tissue in order to determine the size of the buccal pouch that will be prepared. The mesial side of the VIP-CTG will remain attached to the adjacent palatal soft tissue.

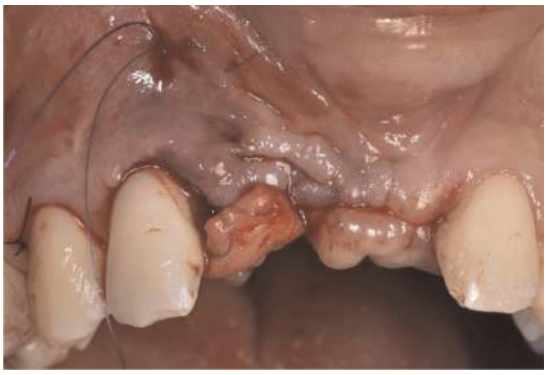

Figure 14.
With the help of two horizontal mattress sutures the VIP-CTG will be positioned and stabilized inside the pouch.

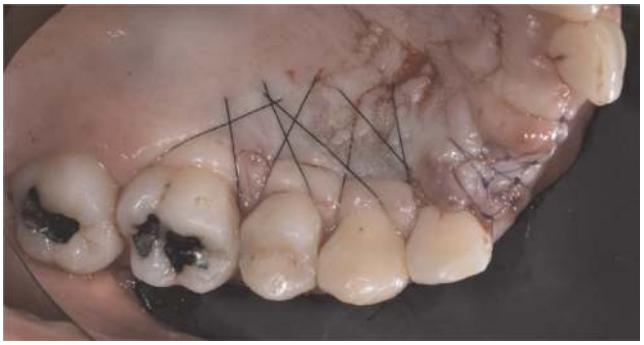

Figure 15.
Suturing of the donor and defect area. The donor and the defect sites will heal by primary intention.

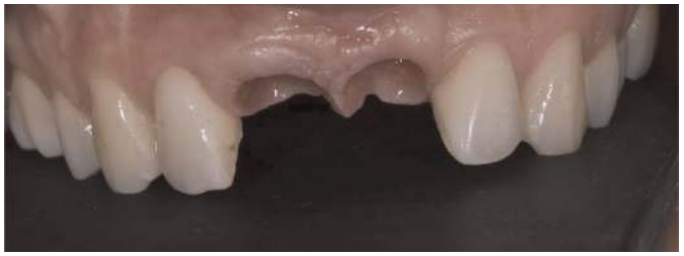

Figure 16.
Final appearance of the PIS after soft tissue conditioning with provisional crowns-frontal view.

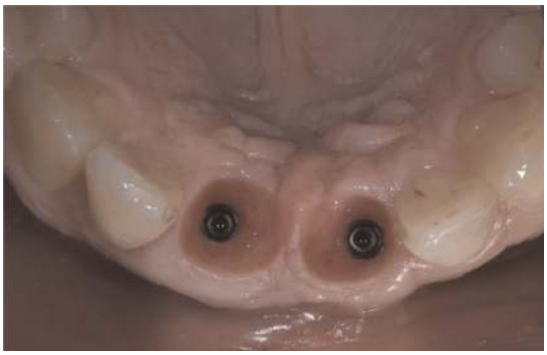

Figure 17.
Final appearance of the PIS after soft tissue conditioning with provisional crowns-occlusal view

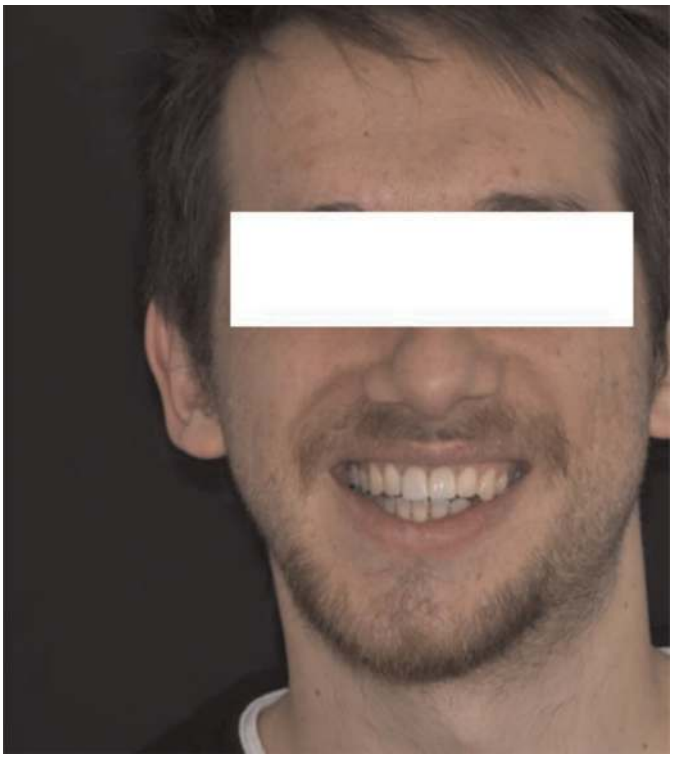

Figure 18.
Final screw-retained zirconia-ceramic crowns 21, 11.

3.3 Preparation of recipient site for CTG

The recipient site can be prepared with different surgical techniques. The techniques can be categorized in three groups:

1. Tunnel technique: The recipient site is prepared without vertical incisions and papilla incisions [21].

2. Coronally advanced flap without vertical incisions [85]

3. Single or double vertical incisions [86]

The vertical incision can compromise the vascular supply of the flap and cause an esthetical appearance. Incision through the papilla can cause papilla height reduction after healing, a likewise vertical incision can cause scare formation. On the other hand, the vertical incisions will facilitate the coronal advancement of the flap or the correct positioning and the stabilization of the graft [25].

4. Free gingival graft (FGG)

Soft tissue graft consisting of epithelial and connective tissue layer which is completely detached from the rest of the palatal soft tissue is defined as a free gingival graft (FGG) [40].

The FGG was introduced in 1966 [87]. Historically, FGG was used to expand the band of keratinized gingiva around teeth [32], cover exposed root surfaces [88], soft tissue augmentation of edentulous ridges [89, 90], and expand the band of keratinized tissue around implants [91]. Since the esthetic appearance of the augmented tissue is poor due to inadequate color blending with the adjacent soft tissue and a "patch" like appearance, today FGG grafts are used mostly to increase the band of keratinized mucosa around implants in nonesthetic areas. Other indications for FGG are seldom performed only in nonesthetic areas 38, 40. The combination of apically positioned flap and autogenous graft is considered the gold standard technique for increasing the width of keratinized mucosa around implants [15].

4.1 Recipient site preparation

The recipient site is prepared with the apically positioned flap technique.

A split-thickness flap is prepared along the mucogingival border. Usually, the flap design consists of a horizontal incision and two vertical incisions that are elongated to or apically to the mucogingival border depending on the amount of the apical displacement of the partial-thickness flap. The split-thickness flap is prepared with sharp dissection in the apical direction taking care to leave intact periosteal surface covering the bone; a 15C or 12D blade is used. In order to prevent perforations of the flap, the blade is oriented parallel with the mucosal surface during the dissection. Additionally, the progression of the flap dissection is monitored from the external flap surface. Muscle attachment, loose connective tissue fibers are removed from the periosteal surface. Care is taken to prepare an even surface that will allow an intimate contact of the graft with the vascularized surface. After the partial-thickness flap has been prepared, the flap is sutured in a new apical position. Sutures must engage the flap and the rigid periosteal surface in order to stabilize the flap [59]. The FGG is stabilized on the exposed periosteal surface with sutures or cyanoacrylate [40, 92]. After stabilization, the graft must be completely immobile, intimately adapted to the periosteal surface with no dead space remaining between the inner surface of the graft and the periosteal surface otherwise plasmatic imbibition and neovascularization bill be hindered. Furthermore, care must be taken to harvest an FGG with an even thickness to allow even precise adaptation to the recipient site throughout the inner surface of the graft. If present, fat tissue should be cut out from the FGG as it can slow down or prevent revascularization of the flap [25, 31, 40, 64].

4.2 Donor site preparation

The palatal masticatory mucosa is the most used donor site for FGG harvesting. Usually, the donor site is located inside the premolar and molar areas. The anterior palatal region where rugae are present is usually avoided since the rugae will remain present inside the FGG and will be transplanted to the recipient site, further deteriorating the appearance of the grafted site. The presence of the rugae can render the harvesting of the FGG challenging, especially in situations where the thin (1.0–1.5 mm) FGG grafts are harvested.

The harvesting procedure can be done freehand or with the help of a template.

The design of the flap consists of four incisions outlining the graft—coronal horizontal incision, mesial and distal vertical incision, and apical horizontal incision. Usually, the goal is to harvest an FGG which thickness is not exceeding 1.5 mm. For depth orientation during the performance of the outlining incision of the future graft, only the beveled part of the blade can be used which dimensions are approximately 1 mm [25, 44].

During healing, FGG undergoes contraction of around 30% of initially gain keratinized tissue band [7, 40, 93]. This fact should be taken into consideration while determining the dimension of the graft, which should be 30% larger than the site needing augmentation (**Figures 19–22**) [40].

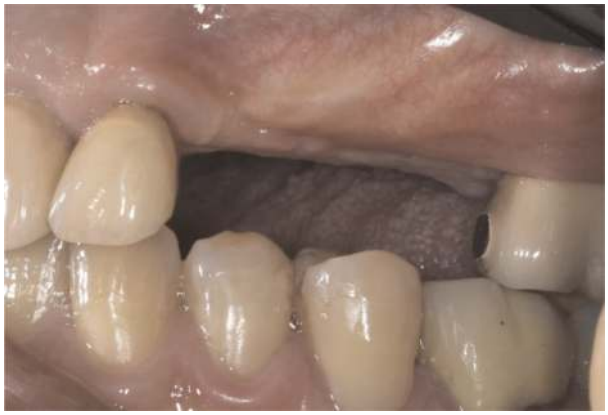

Figure 19.
Figure loss of vestibular depth and coronal and palatal displacement of keratinized mucosa after guided bone regeneration.

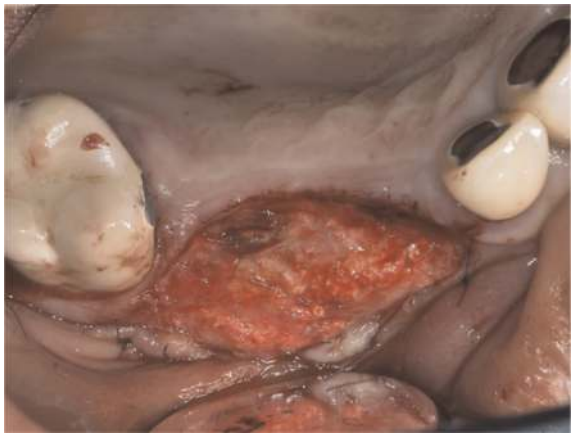

Figure 20.
Apically positioned flap-the recipient site has been prepared with the apical displacement of a split-thickness buccal flap. The exposed periosteal surface is present in the recipient site.

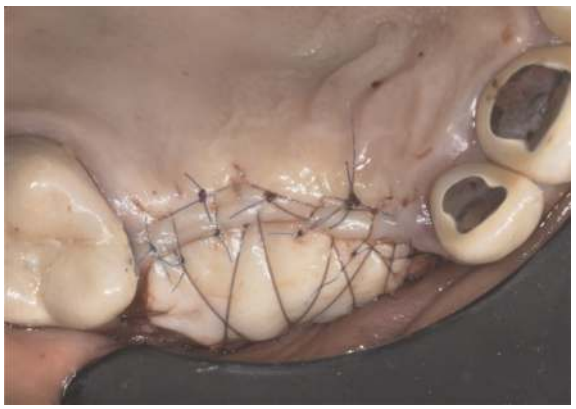

Figure 21.
Free gingival graft stabilized in the recipient site, on the exposed periosteal surface, with the help of sutures.

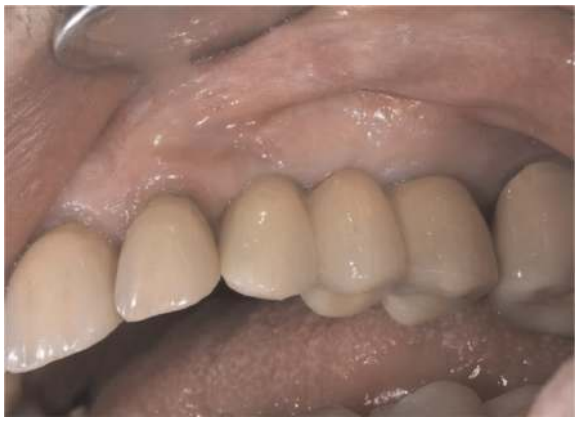

Figure 22.
Final three-unit screw-retained bridge. On the buccal side a wide zone of KM and deepen vestibule is present.

After completion of graft dissection, the wound in the donor site is protected. Different techniques have been proposed—sutures, absorbable gelatin sponge, cyanoacrylate bioadhesive, periodontal dressing, palatal stents, platelet-rich fibrin, or a combination of some of the aforementioned techniques (**Figures 23–34**) [25, 26, 48, 53, 94, 95].

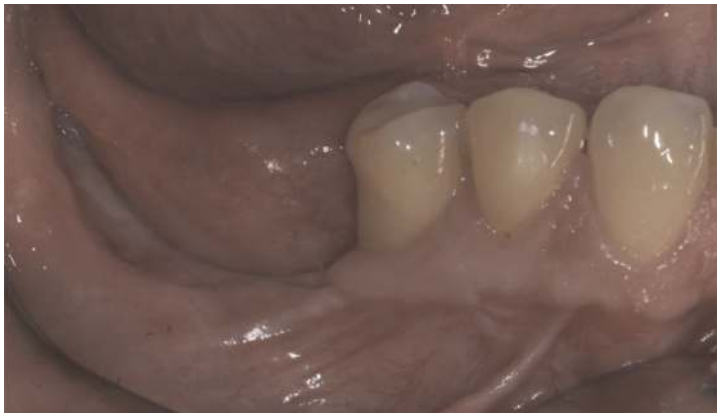

Figure 23.
Two months after implant insertion in the region 36. Visible loss of keratinized mucosa-lateral view.

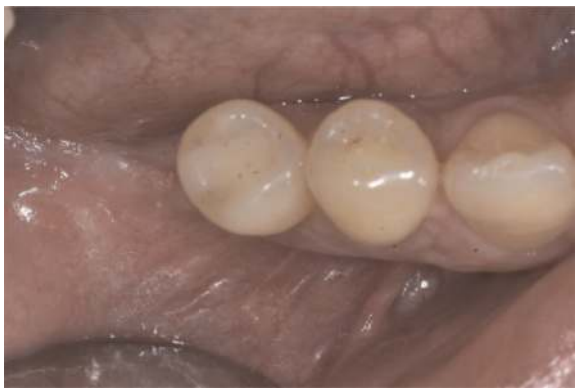

Figure 24.
Two months after implant insertion in the region 36. Visible loss of keratinized mucosa-occlusal view.

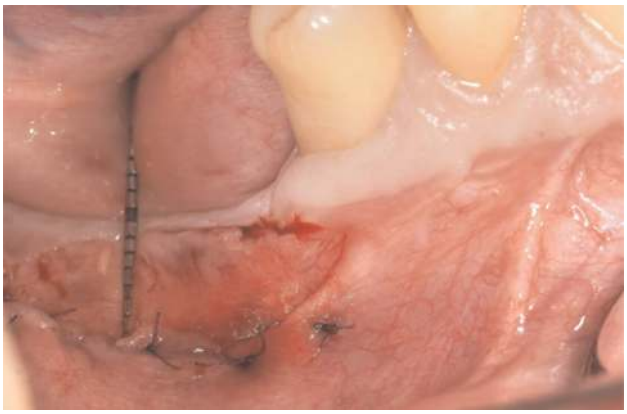

Figure 25.
Recipient site preparation—Apically positioned flap was prepared in the recipient region. The partial-thickness flap was stabilized in the new apical position using resorbable sutures. The height of the recipient site was measured.

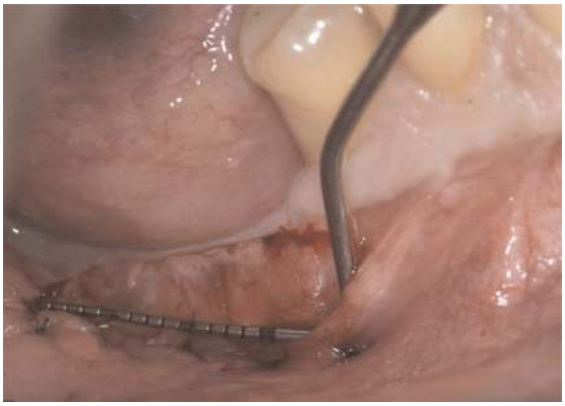

Figure 26.
Recipient site preparation—Apically positioned flap was prepared in the recipient region. The partial-thickness flap was stabilized in the new apical position using resorbable sutures. The width of the recipient site was measured.

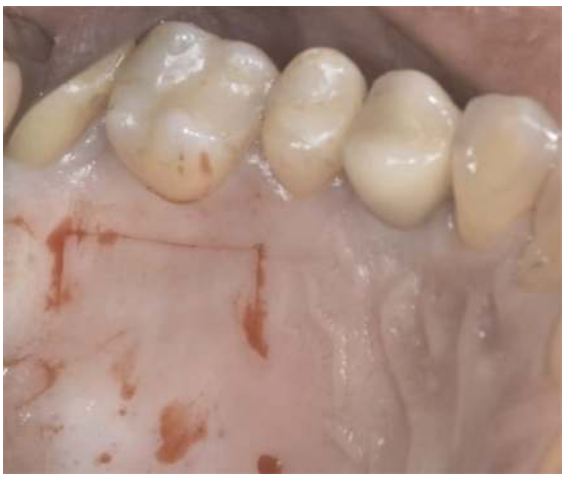

Figure 27.
Initial incisions outlining the future FGG—The dimensions of the graft were determined based on the measurements of the recipient site. The donor site was located in the region of the first molar, posterior to the rugae area. To avoid exercise bleeding during FGG preparation, the last outlining incision (horizontal apical incision) was done at the end of the procedure.

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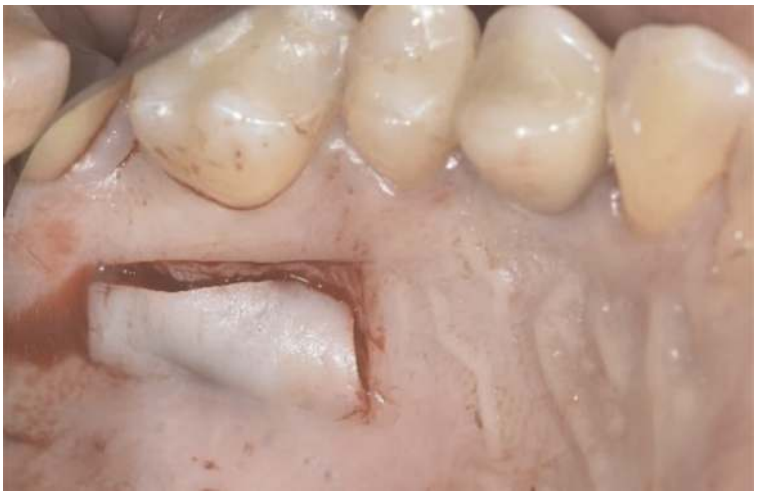

Figure 28.
1–1.5 mm thick flap was prepared, starting from the coronal horizontal incision extending apically until reaching the imaginary line connecting the apical end of the two vertical incisions. The preparation of the FGG was terminated with the horizontal apical incision which completely dissected the FGG from the rest of the palatal soft tissue.

Figure 29.
FGG after harvesting.

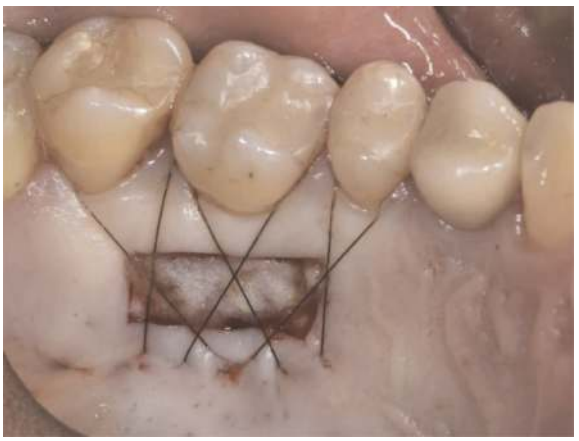

Figure 30.
Donor site protection—Absorbable gelatin sponge and compressive crossed mattress sutures.

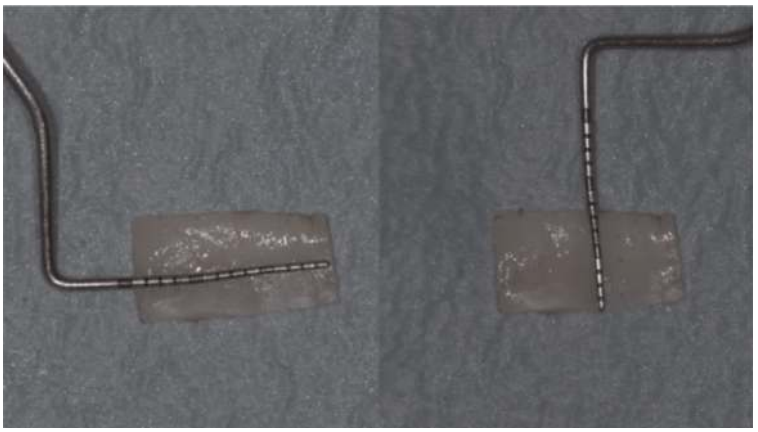

Figure 31.
Dimensions of the harvested FGG.

Figure 32.
Thickness of the harvested FGG—The thickness of the graft should not exceed 1.5 mm in order to reduce the postoperative morbidity associated with the donor site.

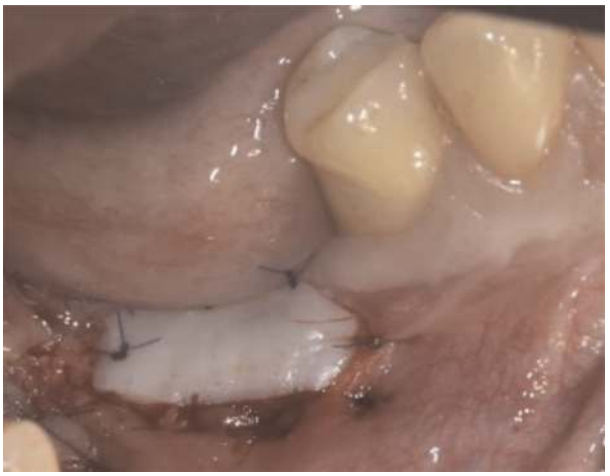

Figure 33.
Initial stabilization of the FGG in the recipient site—The stabilization of the graft is initiated by applying simple interrupted sutures on the coronal part of the graft. Afterward, one to two additional simple interrupted sutures are applied on the mesial and distal vertical border of the flap- stretching the flap over the exposed periosteal surface in the donor area. In order to stabilize the graft, the needle must engage the graft and the periosteal surface.

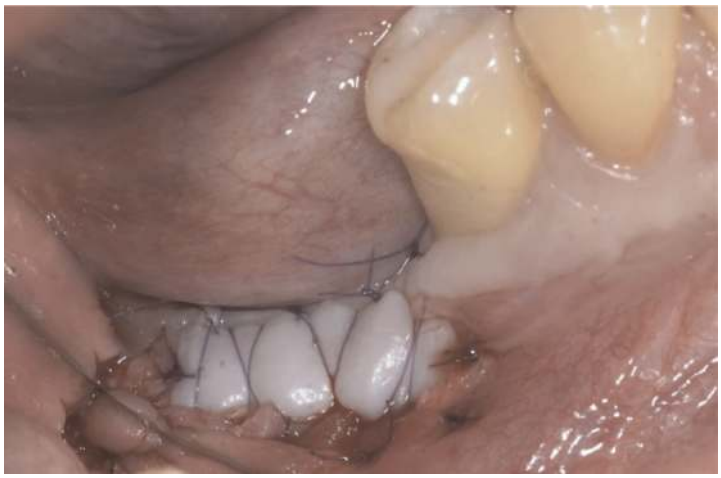

Figure 34.
Final graft stabilization—Mattress crossed sutures extending from the coronal to the apical part of the recipient site are used to secure even contact throughout the inner surface of the graft and the periosteal surface.

5. Alternative sites for free autogenous graft harvesting-maxillary tuberosity

Harvesting autogenous free grafts from the tuberosity are linked to different advantages compared to the classical palatal donor sites—the presence of a lower percentage of fatty/glandular tissue within the graft, higher percentage of collagen fibers within the graft, increased thickness of soft tissue in the donor area, and reduced patient morbidity and a lower percentage of other postoperative complications [26, 47, 96].

Soft tissue grafts from the tuberosity undergo minimal shrinkage during healing as a result of a higher quality of harvested soft tissue [47, 97]. A lower level of pain after tuber soft tissue graft harvesting may be explained by the faster rate of donor site healing compared to palatal donor sites. Additionally, the tuberosity donor site is less prone to masticatory friction [47, 96–98].

The presence of the fully erupted or semi-impacted third molar can prevent soft tissue grafting from the tuber region. In seldom clinical cases, hyperplastic response during haling of tuberosity CTG was observed, leading to an esthetic results (**Figures 35–38**) [47, 96].

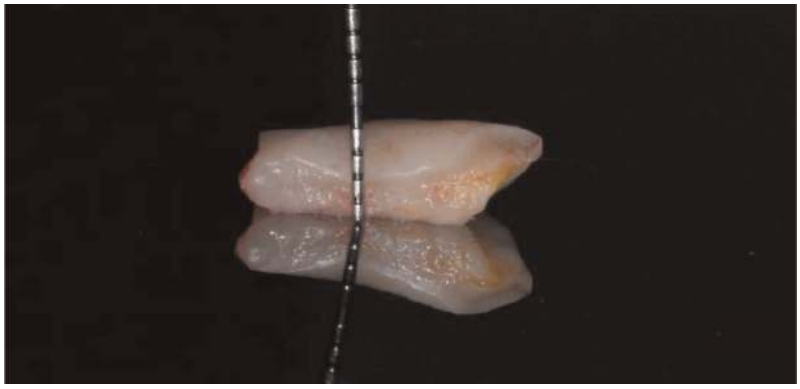

Figure 35.
CTG harvesting from the tuberosity. Autologous graft has been harvested as a free gingival graft. Note the increased thickness and the absence of the fatty tissue inside the CTG.

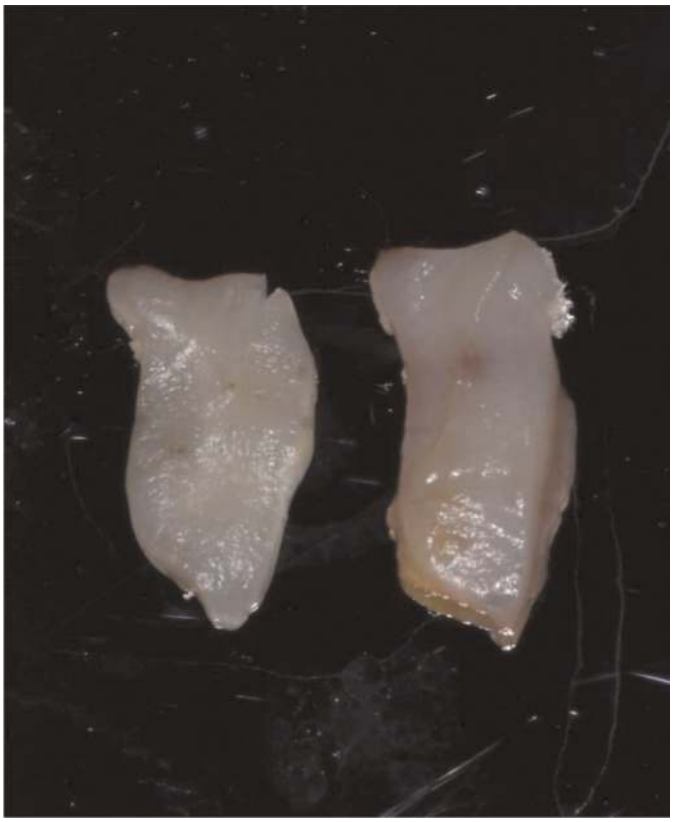

Figure 36.
After extraoral de-epithelization: Epithelial layer (left part of the picture) removed from the rest of CTG (right part of the picture).

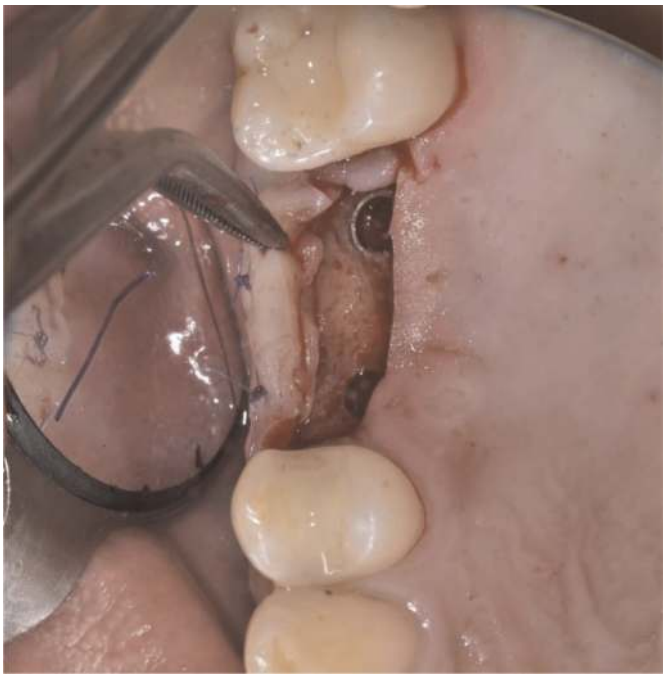

Figure 37.
The CTG from the tuberosity is stabilized beneath the buccal flap with horizontal matrasses suture.

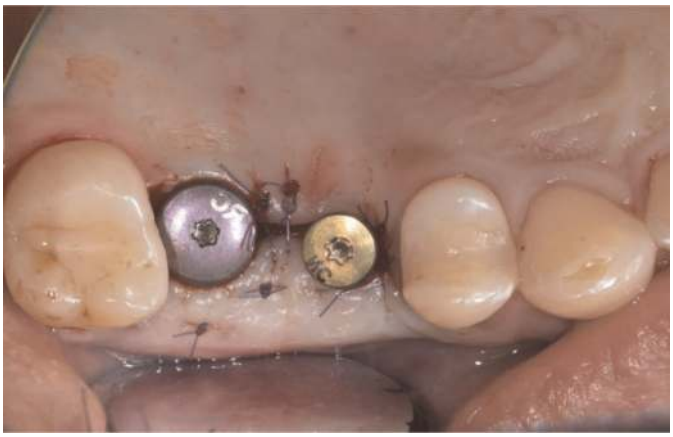

Figure 38.
Flap adaptation around healing abutments.

6. Substitutional soft tissue grafts

Although the results of PIS grafting with substitutional grafts, at the present are inferior to the results obtained after autogenous soft tissue grafting [5, 8, 65, 66, 93, 99], the absence of the donor site makes this treatment modality appealing to the patient and practitioners, as well [26, 42, 100].

The elimination of the harvesting procedure [25, 65] will lead to the reduction of surgical time [65], simplify the surgical procedure [42, 100], decrease the patient morbidity [26, 42, 65, 93], allow the unlimited supply of the soft tissue graft [26, 101, 102], and increase patient acceptance for the procedure [42, 65, 100, 103].

The augmentation procedure with substitutional soft tissue grafts will result in PIS with perfect color and texture blending to the adjacent soft tissue [65, 101].

Two types of substitutional grafts are available—xenogenic and allogeneic soft tissue grafts. Both of the grafts can be used for augmenting the volume and the width of keratinized mucosal band [25, 26, 65, 93, 99, 104].

The substitutional grafts are deprived of vital cells. During the manufacturing procedure, cells and antigenic components are removed, preserving only the extracellular matrix consisting mainly of collagen and elastin fibers. The three-dimensional structures of the aforementioned scaffold will promote fibroblast and keratinocyte migration and vascular ingrowth from the surrounding tissue [105–107]. This will result in an excellent color match since the keratinocytes are derived from the surrounding tissue. Nevertheless, compared to autogenous soft tissue grafts, they do not possess the ability to promote keratinization, limiting their application for increasing the width of KM [105, 106]. To overcome this drawback, a combination of an FGG graft with reduced apico-coronal dimensions to 2 mm and an XCM was proposed [6].

When used to augment PIS thickness, substitutional grafts are less resistant to compression of the overlaying flap compared to CTG. Loss of the initial volume of the substitutional graft can lead to the compromised outcome of the grafting procedure. To overcome this drawback, a volume stable collagen matrix was developed [105]. As a result of the cross-linking process of the collagen fibers, the collagen matrix becomes more volume stable and prone to withstand soft-tissue pressure [108, 109]. At the moment there is a lack of literature on the long-term stability of augmented PIS with the substitutional grafts (**Figures 39–66**) [105].

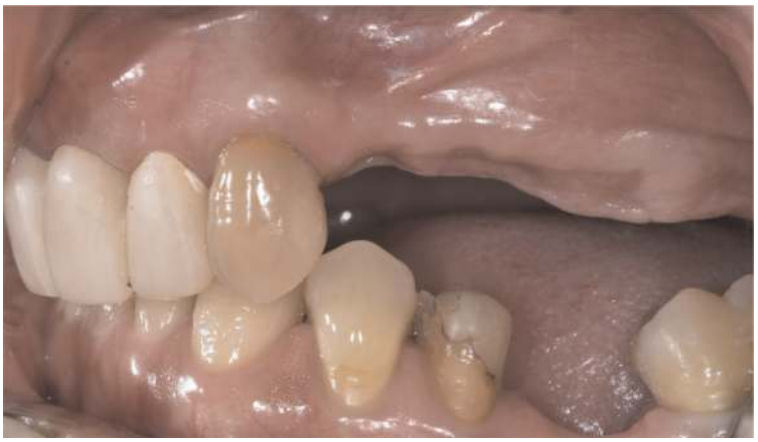

Figure 39.
Initial situation—Lateral view.

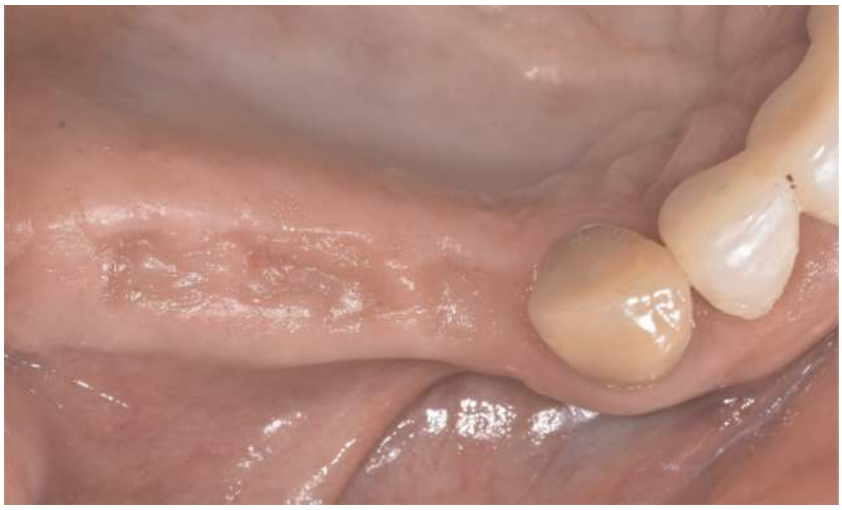

Figure 40.
Initial situation.

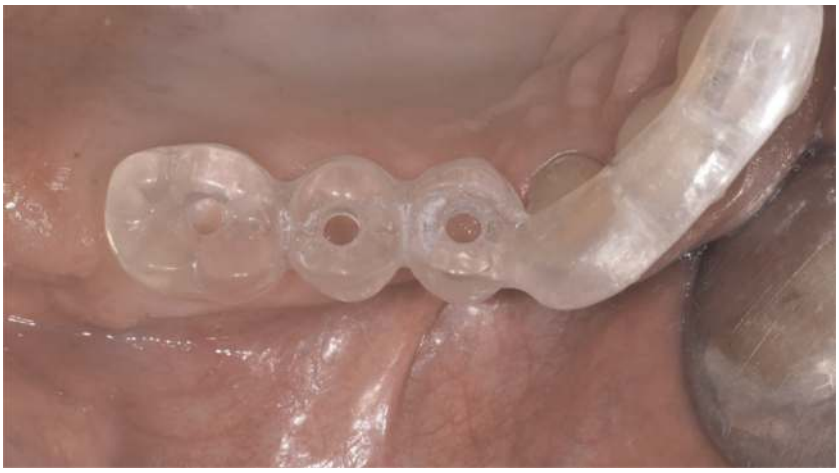

Figure 41.
Surgical stent.

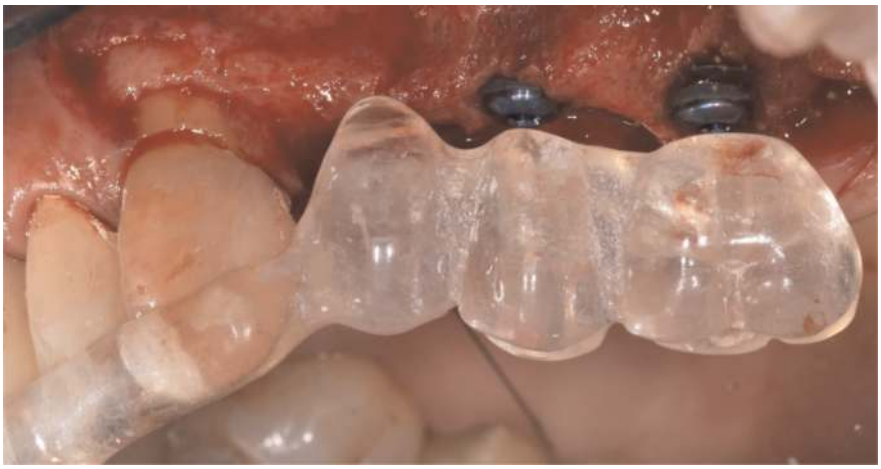

Figure 42.
Dehiscence bone defects around implant 16 and 15.

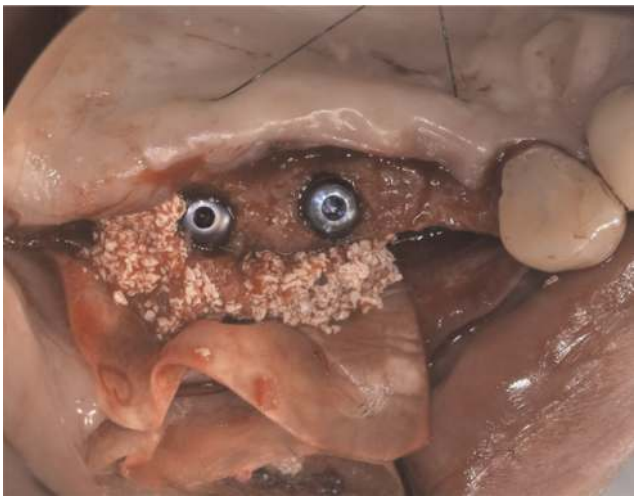

Figure 43.
GBR: A composite bone graft was used consisting of 50% autogenous and 50% xenogenic graft. The bone graft was applied in two layers—The internal layer which is covering the exposed implant surface, is made out of autogenous bone and the external layer is consisting of a xenogenic bone graft.

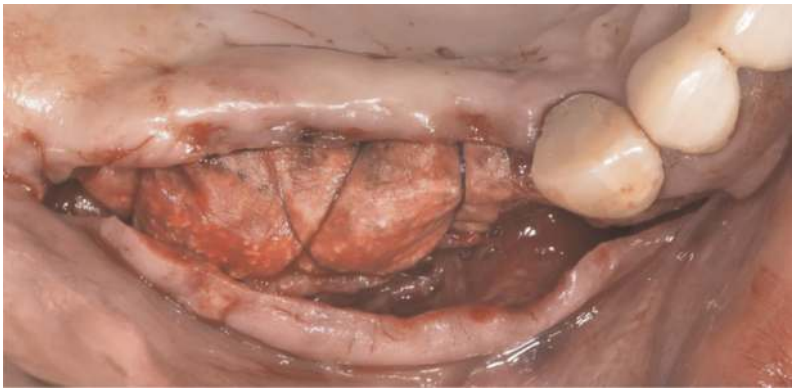

Figure 44.
GBR: Native collagen membrane stabilized with resorbable sutures.

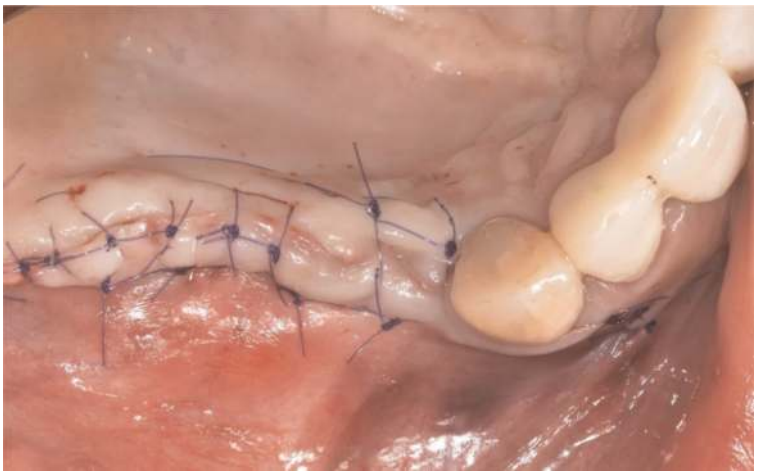

Figure 45.
Suturing in three layers;(1) palatal-apical position—Mattress sutures for membrane stabilization, (2) buccal-apical—Mattress sutures for initial closing of the flap, and (3) bucco-coronal—Simple interrupted suture for the final closure of the flap.

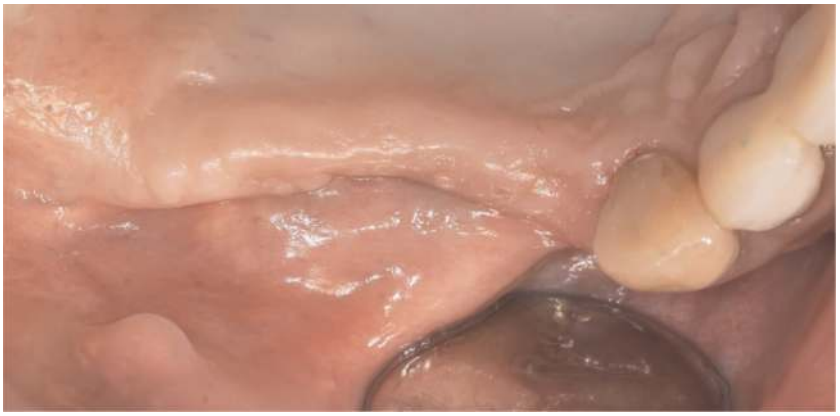

Figure 46.
Four months after the GBR, the palatal displacement of the mucogingival line is evident. Occlusal view.

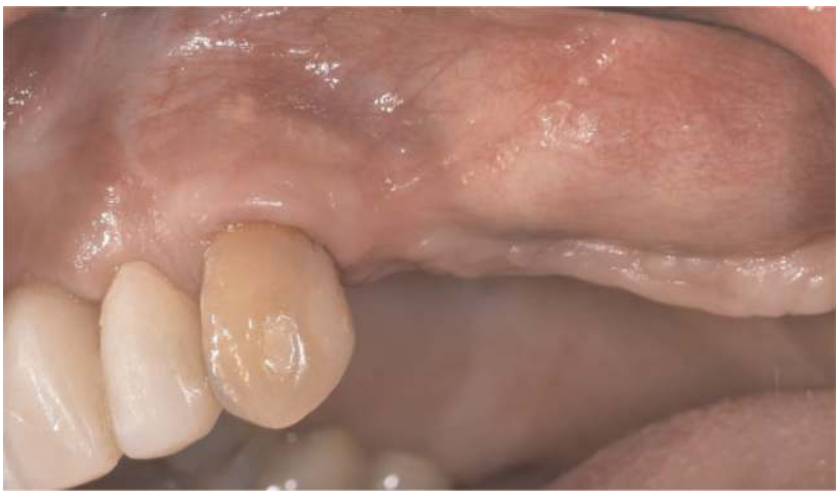

Figure 47.
Four months after the GBR, the palatal displacement of the mucogingival line is evident. Lateral view.

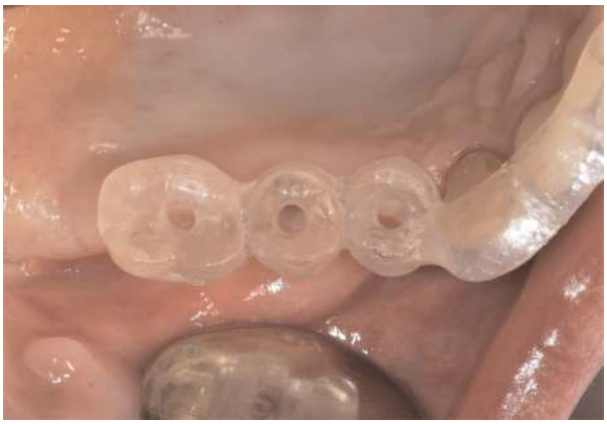

Figure 48.
The surgical stent was used to determine the dimensions of the flap.

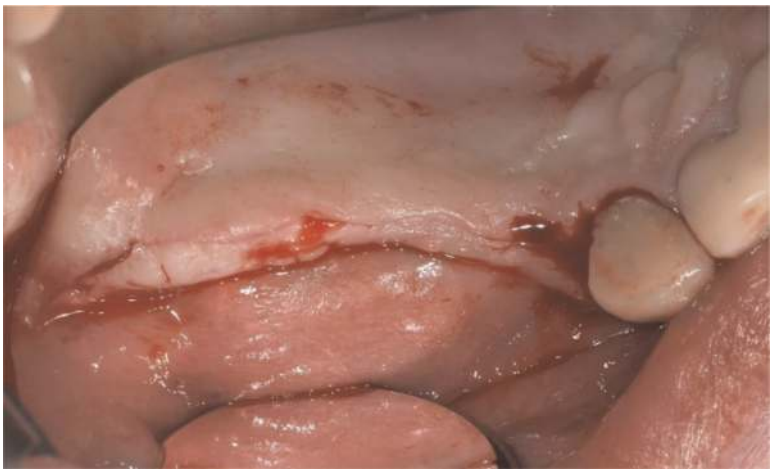

Figure 49.
The flap incision is made not at the mucogingival junction but 4 mm within the keratinized mucosa, therefore the buccal split-thickness flap will include a band of keratinized mucosa which is 4 mm wide.

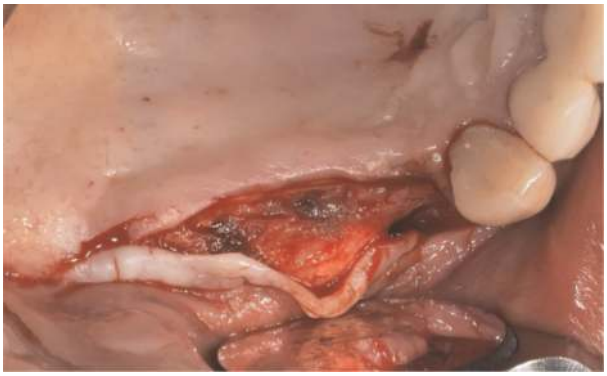

Figure 50.
Finalized preparation of the buccal split-thickness flap. The most coronal part of the partial-thickness flap consists of keratinized mucosa.

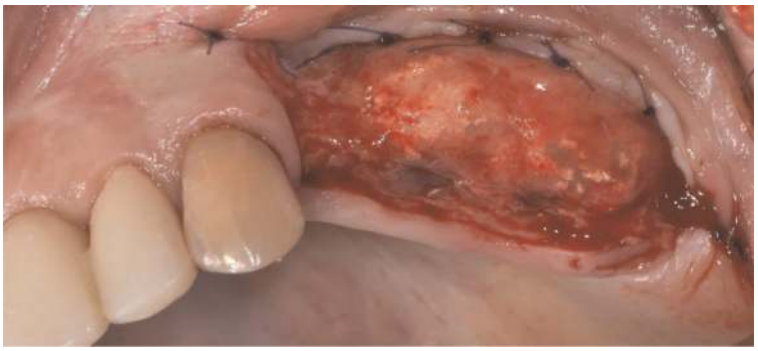

Figure 51.
Apically positioned flap—Stabilization of the buccal partial-thickness flap in the new apical position. The exposed periosteal surface is completely surrounded by keratinized mucosa.

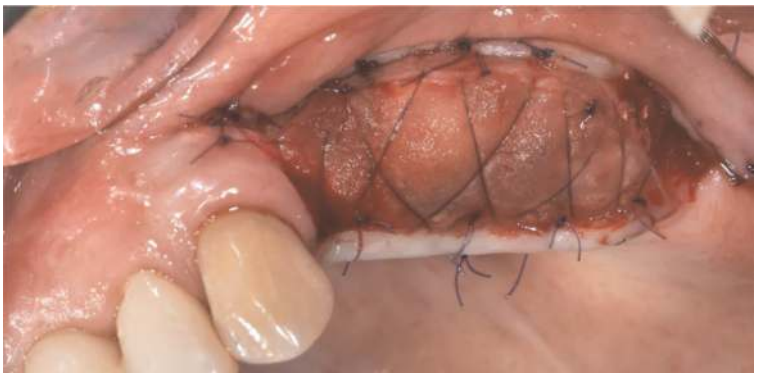

Figure 52.
The exposed periosteal surface is covered with xenogenic collagen matrix (Mucoderm, Botiss gmbh, Berlin).

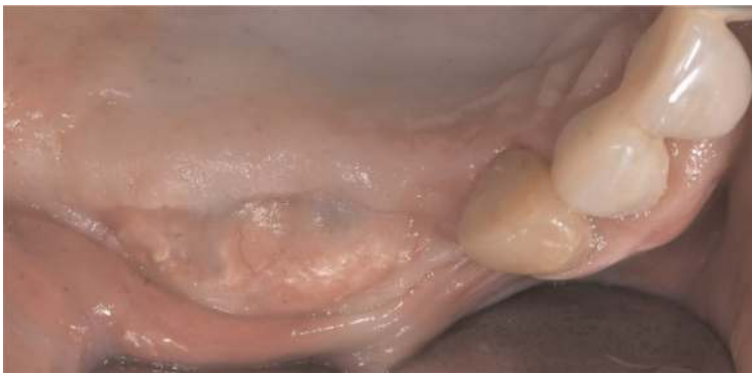

Figure 53.
Healing two months after the keratinized mucosa widening procedure. The gain of the keratinized mucosa is evident but the thickness of the gained tissue is unsatisfactory. Occlusal view.

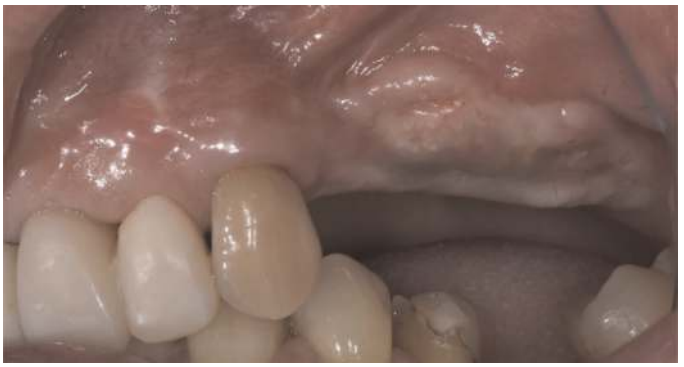

Figure 54.
Healing two months after the keratinized mucosa widening procedure. The gain of the keratinized mucosa is evident but the thickness of the gained tissue is unsatisfactory. Lateral view.

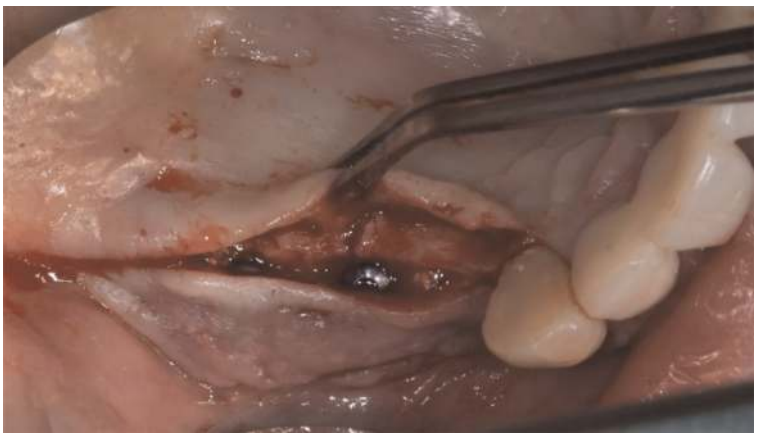

Figure 55.
During the implant uncovering procedure, a primary flap was prepared on the palatal side. The minimal thickness of 1.5 mm of the primary flap was respected, and the connective tissue was exposed.

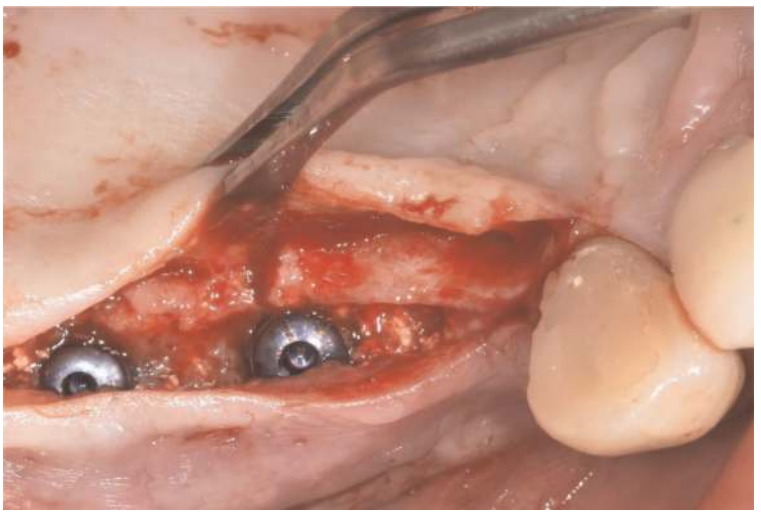

Figure 56.
Mesial, distal and apical incisions were made inside the connective tissue graft in order to completely dissect the CTG from the rest of the adjacent soft tissue.

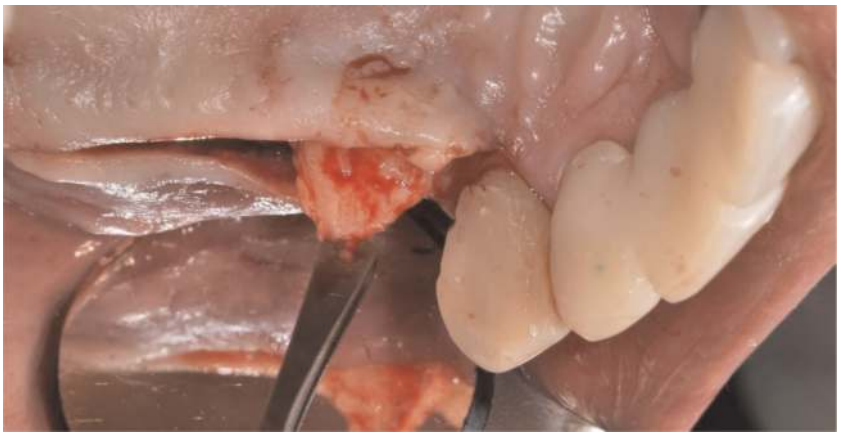

Figure 57.
The CTG is completely dissected from the rest of the adjacent soft tissue.

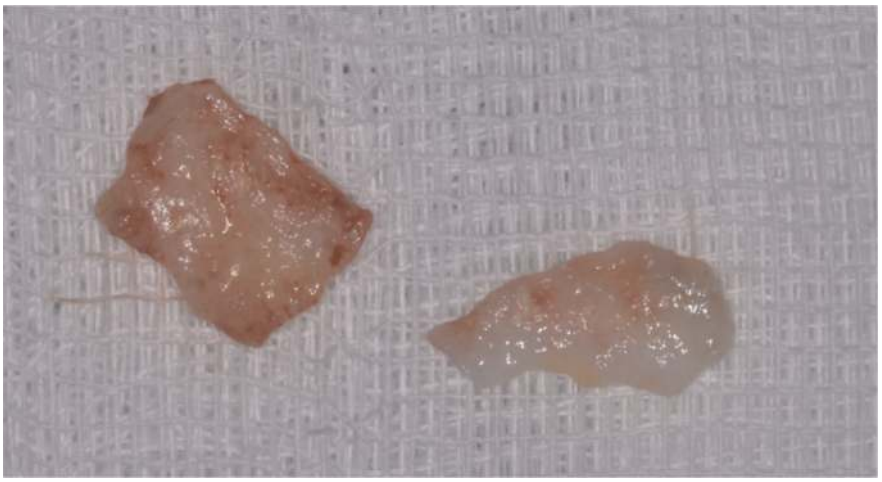

Figure 58.
On the left: CTG harvested from the palate (the harvesting procedure was displayed on the previous pictures), on the right additional CTG harvested from the tuberosity on the same side.

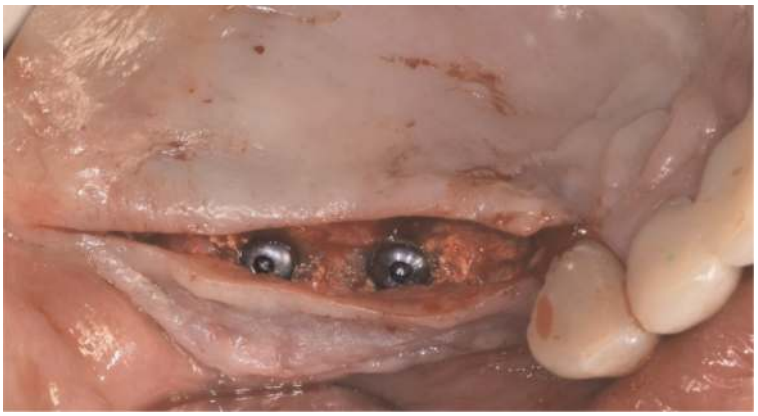

Figure 59.
Appearance of the palatal and tuber donor site after CTG harvesting.

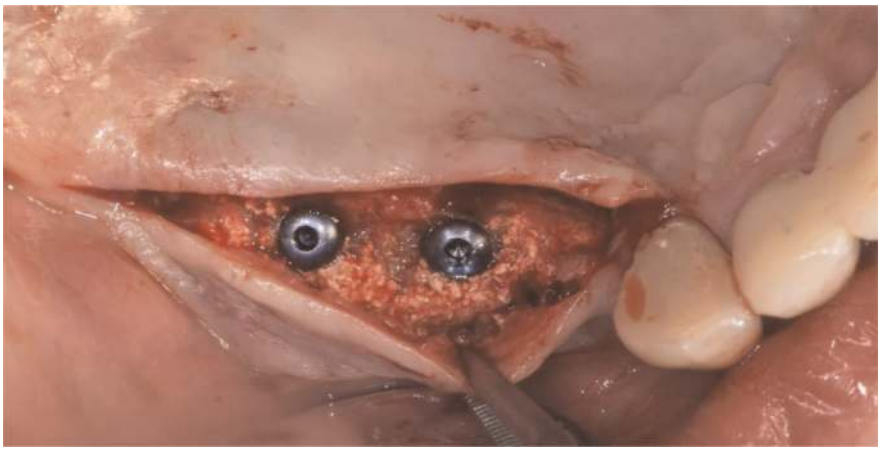

Figure 60.
Appearance of the regenerated bone on the buccal side of the implants.

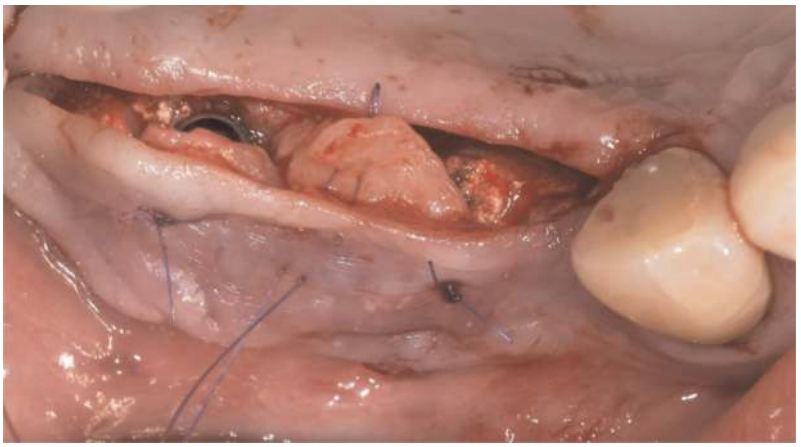

Figure 61.
Both of the CTG grafts were stabilized with sutures to the buccal flap.

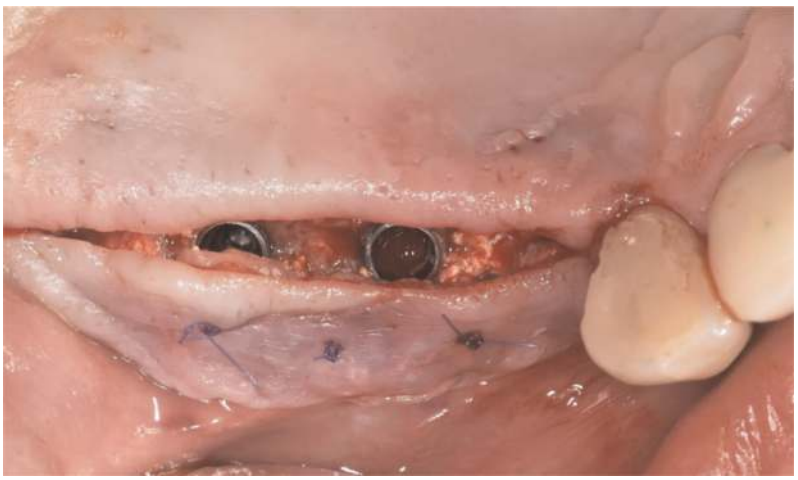

Figure 62.
Final stabilization of the CTG grafts to the inner aspect of the buccal flap.

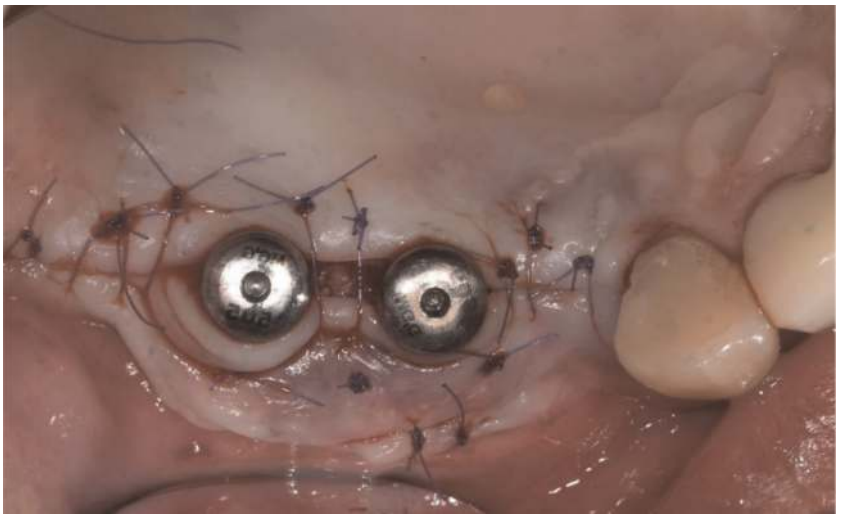

Figure 63.
Final suturing of the flap.

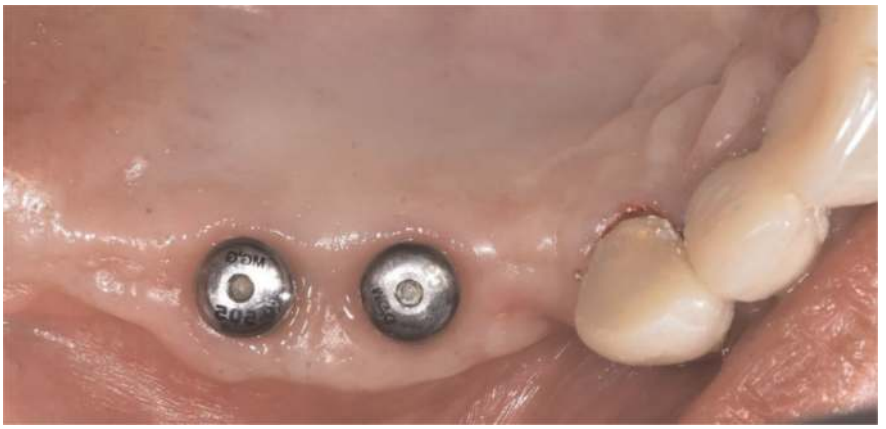

Figure 64.
After 2 months of healing adequate quantity (soft tissue thickness) and quality (width of keratinized mucosa) of soft tissue surrounding the healing abutments.

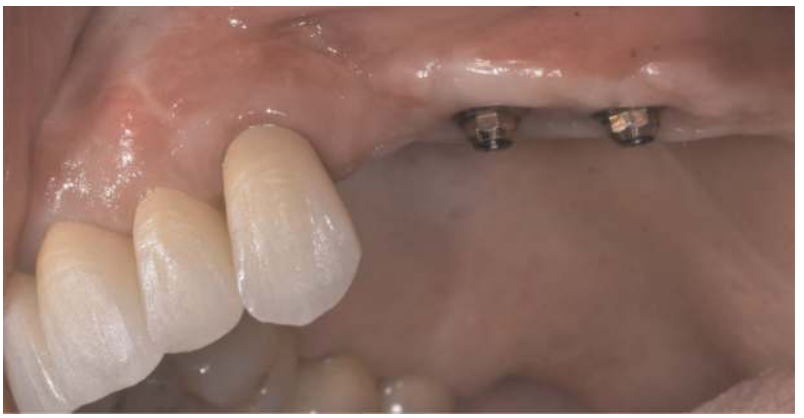

Figure 65.
Screw retained abutments.

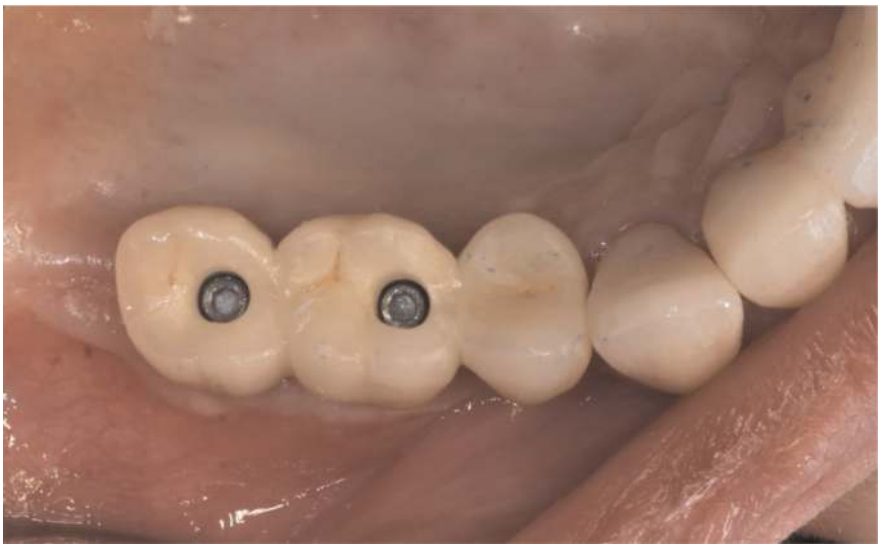

Figure 66.
Three units screw-retained bridge.

7. Conclusion

PIS augmentation procedure has become an integral part of implant-prosthetic rehabilitation. The aim of PIS augmentation is adequate quality and quantity of PIS—at least 2 mm of the width of peri-implant KM and 2 mm or more, of the thickness of PIS. These dimensions of PIS will result in stable peri-implant hard and soft tissue, better esthetical outcome and facilitate oral hygiene maintenance around the implant.

The use of autogenous soft tissue graft for PIS augmentation is considered the gold standard. FGG is primarily used for increasing the KM width and CTG for increasing the thickness of PIS. Different techniques have been developed for the harvesting of the CTG graft. The grafting technique and the choice of the donor site can influence different aspects of the procedure, from patient discomfort in the postoperative period to the quality and dimension of the graft. The choice of the grafting technique should be addressed individually based on the parameters of the specific clinical case (patient desire for decreased morbidity, anatomical limitations of the donor site, dimensions, and quality of the required graft).

The use of substitutional soft tissue grafts has different advantages—reduced length, the complexity of the procedure and patient morbidity, availability of the unlimited amount of the graft, and better patient acceptance. At the moment, the results of the use of substitutional grafts are inferior compared to soft tissue autografts. There is a lack of published long-term results of PIS augmentation with substitutional soft tissue grafts. Therefore, they should be used in cases where patient denial for soft tissue autografts would lead to rejection of the PIS augmentation procedure. In all other cases, priority should be given to soft tissue autografts.

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