CHAPTER 29

Techniques of Soft Tissue Grafting in Implant Dentistry

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Introduction

A rich history of soft tissue management surrounding natural teeth along with advents in comprehension of wound healing have allowed adaptation and application of surgical techniques to be developed for teeth to implants. Since the development of dental implants, the standards for what was considered a successful implant have changed and become more stringent with advances in techniques and materials used in implant dentistry. The most basic criteria for implant success are those of function, but with implants role in esthetic dentistry new standards for success include form, function, and esthetics. Albrektsson proposed criteria for success that was defined by lack of mobility, the absence of peri-implant radiolucency, and a less than 0.2 mm annual bone loss [1,2]. Since Albrektsson, there have been other means of measuring implant success, namely the esthetic achievement. These new parameters included the pink ssthetic score, an assessment of papilla height, the pink and white esthetic score in a gingival display, and all the esthetic parameters reviewed in the previous chapter and contributes to the new assessment of dental implant success [3–7]. Today's clinicians must balance biology, functionality, and esthetics when treatment planning and executing implants. This and the following chapter will discuss manipulation and/or augmentation of existing soft tissue, rather than prosthetic gingiva, in combination with implant-supported crowns, to achieve an ideal esthetic result.

Implant failures can either be esthetic or functional. Failures that compromise the health of an implant fixture are inflammatory in nature and include peri-implantitis and peri-implant mucositis. While the result of these pathologic changes is often unesthetic, the underlying cause of the disease must first be addressed before steps can be made to restore the esthetics. When an implant is healthy but the result of the surgical and prosthetic placement is unsatisfactory to both the patient and clinician immediate steps can be taken to achieve a more desirable esthetic result. As with all dental treatment, the disease process and pathology must be eliminated or controlled before steps can be taken to repair the damage that it has caused. It is best to take measures to prevent both infectious and esthetic implant failures through proper planning and surgical execution. Techniques to both prevent and correct implant positioning failures in the early stages before prosthetic delivery will be covered with this chapter focusing on surgical management and prevention and the following chapter will be a discussion of corrections and treatment of failed cases.

Some common esthetic failures are loss of interdental papilla with "black triangles", mid-facial gingival recession, a non-harmonious gingival margin, buccal concavities, and translucency of the implant body or prosthetic margins. There are steps that can be taken to avoid these failures during the planning and surgical execution of implant placement, including augmentation prior to implant placement, flap design during placement, and soft tissue management during second stage. The existing hard and soft tissue should be assessed prior to implant placement in order to determine if there is a need for augmentation prior to placement. Bone height and thickness are major determinants of soft tissue contours while implant placement, tooth morphology, contact point, and tissue quality also play a role [8,9]. The shape and dimension of the osseous crest and the three-dimensional placement of the implant within the osseous tissue affects how the soft tissue will appear surrounding an implant restoration. In order to achieve optimal esthetic and functional results as well as prevent translucency of the implant, a 1.5–2 mm of osseous structure is needed buccal to the fixture [9]. The angulation of the implant relative to its buccal lingual position affects the emergence profile of future restoration. For example, if the fixture is too palatal a buccal ridge lap-style restoration may be necessary, but if the fixture is at 45-degree angle to the occlusal plane optimal esthetics is easier to achieve [10]. This dimension of placement is of particular importance when placing implants in the maxillary anterior region due to the buccolingual and cervicoapical resorption pattern of the anterior maxilla following extraction [11]. The apicocoronal position of a fixture plays a role in determining the height of the gingival margin on the future restoration and is important in achieving a harmonious gingival margin between the implant restoration and the natural teeth. The vertical level of the bony crest around the implant should be approximately 3.0 mm apical to the CEJ of the adjacent teeth and the planned restoration [12].

Papilla fill is dependent on many factors, including biotype, contact, tooth morphology, height of the osseous crest, and adjacent dentition. The morphology of the teeth will determine the location of the contact point, with square teeth having a more cervical contact point and triangular teeth a more incisal contact point. In natural teeth, the distance between the osseous crest and the contact point affects the papilla as the distance beyond 5 mm increases the chances of complete papilla fill decreases [13]. Kan and Kois noted that the biotype also plays a role in the papilla fill as well as the distance from the contact point to bone, noting that in order to

Horizontal Alveolar Ridge Augmentation in Implant Dentistry: A Surgical Manual, First Edition. Edited by Len Tolstunov.

achieve papilla fill a thick biotype needs 4.2 mm and a thin biotype can only tolerate 3.76 mm [14]. When a single implant is placed between two natural teeth, Choquet found that the distance between the osseous crest and the contact point also should not exceed 5 mm to have a complete papilla fill [15]. Grunder found that papilla presence is dependent on the attachment level of the adjacent tooth, noting that one has to account for the 1.5 mm of crestal bone loss around a dental implant in the vertical direction, which should be added to the distance from the contact point to that level [16].

Another factor affecting interpoximal tissue is the distance between the dental implant and either the adjacent natural teeth or adjacent implant. A minimum distance of 1.5 mm is necessary between an implant and natural teeth to prevent interproximal bone loss and a distance of 3.0 mm is needed between adjacent implants [17,18]. When proper space cannot be achieved one should consider cantilevers or fixed bridges for a more esthetic result. "Peri-implant plastic surgery focuses on harmonizing peri-implant structures by means of hard tissue engineering and soft tissue engineering, and includes: bone structure enhancement; soft tissue enhancement; precision in implant placement; and quality of the prosthetic restoration." The decision to augment an area prior to implant placement should be based on established protocols and prognosis. Large defects in hard and soft tissue are best corrected prior to implant placement and moderate defects in soft tissue can be addressed during the placement or second stage. Three-dimensional soft tissue defects with vertical and horizontal components should be corrected prior to or at the time of implant placement because stability and vascularization is difficult at any other stage, while faciopalatal (horizontal only) deformities can be more easily corrected at any time through modified soft tissue flap design, soft tissue onlay grafts, and free autogenous subepithelial connective tissue grafts [19]. Once a final prosthesis is in place options and successful outcomes of soft tissue grafting become more limited and difficult to achieve. One way to prevent esthetic and physiologic complication is to insure adequate attached keratinized tissue at a planned site and if there is not enough at the time of placement consider grafting during a second stage procedure. However, even when there is adequate hard and soft tissue, one must be aware that surgical trauma delivered to soft and hard tissues during implant placement can influence the future esthetic result and care should be taken to minimize this trauma during surgery [20]. Flap design during implant placement and management of the soft tissue during initial and secondary stage surgery has an influence on the final outcome. Even if there is adequate crestal bone height prior to implant placement the flap design can affect the amount of crestal bone resorption following placement. Crestal bone loss is of practical importance and statistically significant when comparing two flap designs, one including the surrounding tissue of adjacent teeth and one preserving them, called "limited flap design". Less bone loss was noticed following the use of a "limited flap design" versus a "widely mobilized flap procedure", where the bone loss was 0.29 mm with the limited design versus 0.79 mm in the wide flap design.

Too often abutment placement is performed using a tissue punch technique. Clinicians need to be aware of the importance of second stage surgery and appreciate that it is an opportunity to either improve or correct soft tissue surrounding implants. Second stage surgery is a chance to manipulate the soft tissue around implants and enhance the esthetic and health outcome around dental implants to be restored, leading to a soft tissue architecture similar to that around natural teeth [16]. Many techniques have been described in the literature during second stage surgery.

Techniques

Techniques to create contour, thickness, and increase keratinized tissue

Roll technique

A roll flap procedure was developed by Abrams in 1980 as a means of correcting small Seibert class I ridge defects that result in a buccal concavity. This technique is useful in correcting a ridge defect at a future site for a pontic, or a small buccal concavity present in the area where an implant has been placed. If there is an implant present in the site, this technique can be used in combination with the uncovery procedure. This technique employs a pedicle connective tissue graft that is harvested from the palate and then folded under into a pouch created on the buccal. The augmentation provided by the pedicle is meant to match the root eminences of the adjacent teeth; therefore, if the edentulous span is greater than one tooth multiple pedicle grafts may be prepared.

The roll technique presented here is a *modification* to the roll technique introduced by Scharf and Tarnow in 1992 [21] and will be illustrated in the series of figures (see Figures 29.1 to 29.5). It begins with making three measurements. The first measure is from the crest of the ridge or the anticipated gingival margin of the future crown to the most apical extent of the concavity, the second measure is the apical width 1 mm from the mesial side of each adjacent apex of the adjacent teeth, and the third measure is the interproximal distance between the adjacent teeth coronally accounting for the papillary-like tissue to be left on the side of each tooth. Those lines of measurements will form a trapezoid shape. These measurements will determine the size of the pedicle that needs to be harvested from the palatal area. The buccal limit of the donor site is the mid-crest of the pontic site preparation or above the middle of the cover screw for implants. This delineates the donor site with incisions extending to the underlying bone in all areas except the crestal limit, which will serve as the base of the pedicle. Once the site is delineated, it is important to de-epithelialize that area and sharply elevate the connective tissue pedicle to a full-thickness flap, leaving exposed bone on the palate. Some authors

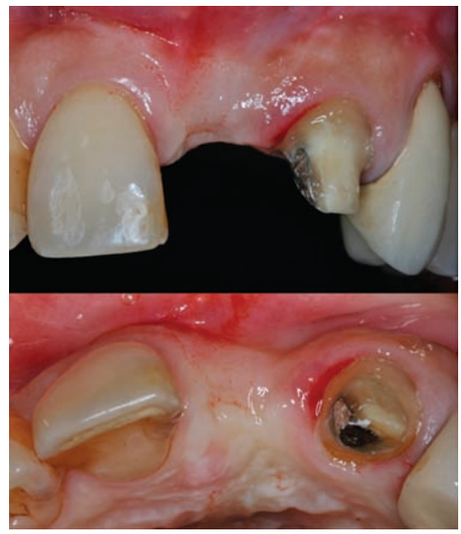

Figure 29.1 Buccal and occlusal view prior to initiating the modified roll technique during the second stage. The modified role technique was used in the case to fill the ridge concavity that can be seen in the area of implant 9.

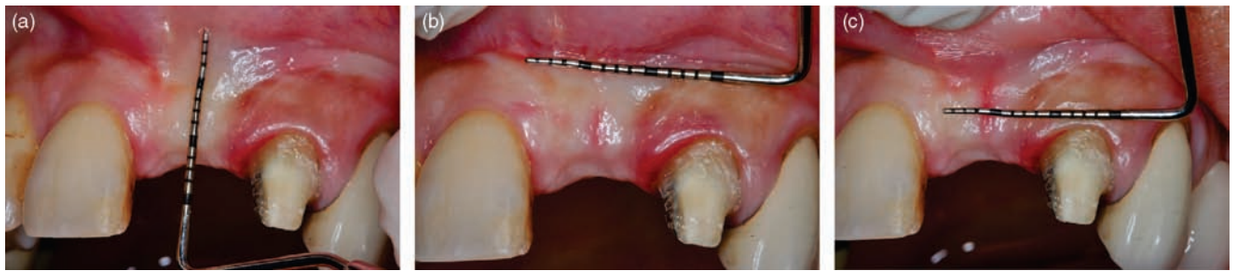

Figure 29.2 Portrayal of the three pre-operative measurements used to determine the size of the trapezoid shaped donor pedicle from the palate. **(a)** Measurement from the crest of the ridge or the anticipated gingival margin of the future crown to the most apical extent of the concavity. **(b)** Distance of the apical width 1 mm from the mesial side of each adjacent apex of the adjacent teeth. **(c)** The interproximal distance between the adjacent teeth coronally accounting for the papillary-like tissue to be left on the side of each tooth.

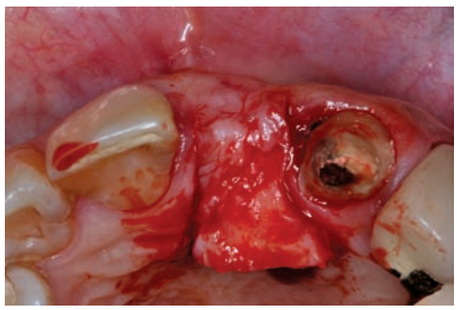

Figure 29.3 Full-thickness flap elevation of the trapezoidal area of donor tissue on the palate as well as creation of a full-thickness buccal pouch.

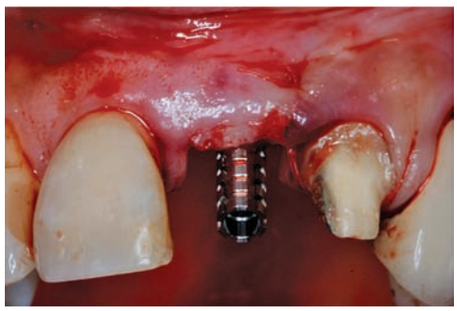

Figure 29.4 The palatal flap is rolled and tucked into the buccal pouch. This folded flap is held in place in part by the provisional cylinder or a healing abutment and is also sutured into place.

suggested dissecting the pedicle graft and leaving behind the periosteum, but doing so risks severing the supraperiosteal capillary bed, which may lead to flap necrosis and jeopardize the end result. Full thickness elevation also reduces the risk of perforation of the pedicle flap, allows for a thicker graft, and maintains the supraperiosteal blood supply to the graft. Once the pedicle is elevated to the buccal transition area, create a full thickness pouch in the area of the defect on the buccal following the planned trapezoidal architecture. After elevation of the pouch, roll the pedicle graft into the area of the buccal defect. At this time the pedicle may be trimmed and adjusted to fit. Once the graft is in place, place two stabilizing sutures apically on either side of the trapezoid and two on the coronal area through the neighboring tissue. At this point, the healing abutment can be placed and any periosteum or any osseous structure over the implant cover screw should be removed.

Apically repositioned flap

When there is an inadequate band of keratinized tissue in the anticipated buccal area of the dental implant, of at least 2.0 mm, an apically repositioned flap can be employed on the buccal side of the site. Begin with an envelope flap design (H design), placing a crestal incision lingual to the cover screw(s) with a minimum 2.0 mm band of keratinized tissue. Displace this tissue apically using two cross arch incisions, which extend vertically avoiding the papilla-like tissue on the proximal side of the adjacent teeth. Elevate the flap to full thickness and apical position it with the edge of the keratinized band buccal of the now exposed implant fixture(s). Switch all cover screws to healing abutments and begin to stabilize the apically repositioned flap through suturing. First suture the apical end of the buccal vertical incisions followed by affixing the coronal part of the flap to the adjacent tissue. If there are multiple implants in a row, suture the buccal flap to the lingual. The caveat of this technique will leave an area of interimplant crestal bone to heal in a second intentional manner (see Figures 29.6 to 29.8).

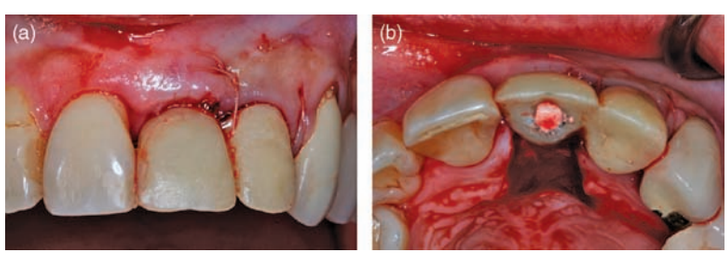

Figure 29.5 Immediately post-operative **(a)** buccal and **(b)** lingual views of the modified roll technique with provisionalization. Note the exposed osseous structure on the palate from raising a full-thickness flap.

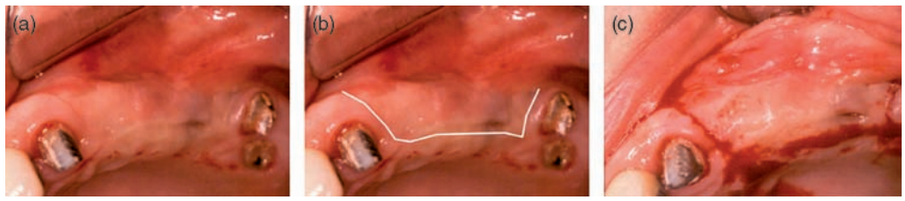

Figure 29.6 **(a)** Three implants are to be uncovered in the maxillary posterior employing an apically repositioned flap to increase the zone of keratinized tissue. **(b)** The flap outline with a papilla sparing design is depicted. **(c)** The flap with a papilla sparing incision is depicted.

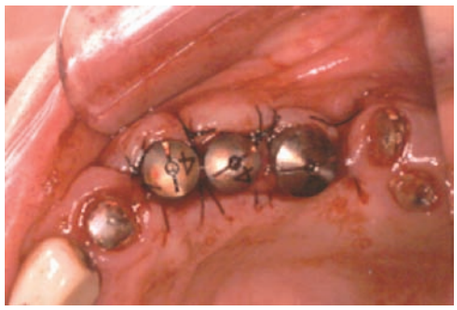

Figure 29.7 The healing abutments are placed and the flap is sutured apically. Note the exposed osseous structure when the buccal and lingual flaps are sutured together between the implants. This results in healing by secondary intention and flattened interimplant papilla, a major drawback of using this technique with more than one implant in a row.

Auto subepitelial connective tissue graft (CTG) or a free gingival graft (FGG)

In case of a lack of keratinized tissue surrounding the implant fixture or in case there is not enough tissue present to be displaced apically or rolled buccaly, a free gingival graft (FGG) or an auto connective tissue graft (CTG) may be employed. Connective tissue grafts can be used to increase tissue thickness and/or to increase attached keratinized tissue in areas of esthetic concern. A free gingival graft can also be used to increase a zone of keratinized tissue but will heal with a more blanched looking tissue and it is not advised in areas of esthetic concern. The main advantage of using a connective tissue graft is the color match with the surrounding tissue compared with the free gingival graft. These techniques are easiest to perform at the time of the second stage surgery or implant placement, but can be done with a prosthesis in place if necessary, although that would require a more diligent and refined execution.

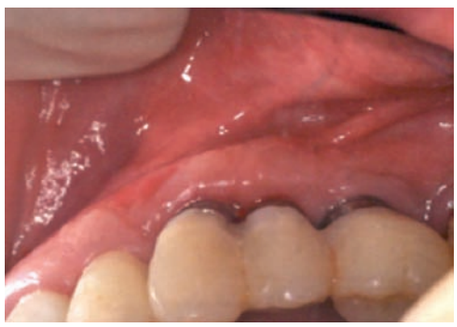

Figure 29.8 After healing with the final prosthesis in place. Note the deep vestibule for ease of hygiene and the large zone of keratined tissue on the buccal.

Free gingival graft (FGG)

This technique (see Figures 29.9 to 29.12) is mainly used to increase the amount of keratinized tissue while preserving the marginal gingiva. A beveled incision is made in the gingival margin extending past the alveolar crest of bone and the extent of the incision depends on the extent of the area to be treated. At the margins of this area place either two vertical incisions or extend the incisions curving apically.

Flap design should reflect an abilty to reposition the flap apically following split thickness reflection. Apically reposition the tissue and secure the position wih vicryl 5.0 absorbable sutures. Once the flap is secured measure the recipient area to determine the amount of tissue that needs to be harvested from the palate. Next, harvest a full thickness graft from the palate to place in the area of deficient tissue. The donor tissue should be taken at least 2 mm from the palatal gingival margin as tissue contraction occurs during healing and recession may occur as a result of the wound edge being too close to teeth. The shape of the donor tissue is outlined with a scalpel at right angles to the palate at the desired depth, which can be gauged by the bevel on a 15C scalpel blade (approximately 1 mm). The blade is then turned parallel to the palate and a graft of the desired uniform thickness is removed by sharp dissection from the palate.

The donor tissue is transferred to the recipient site to check the fit and modified if needed.

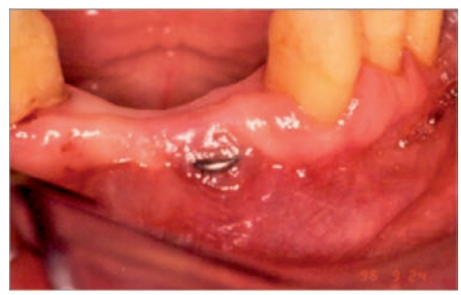

Figure 29.9 Free gingival graft placement at the time of the second stage. Note that the exposed edge of the mandibular left implant cover screw is surrounded by mucosa. Use of a tissue punch in this case would result in a prosthesis surrounded by mucosa rather than keratinized tissue on the buccal. A free gingival graft was used in this case rather than an apically repositioned flap because there is not enough keratinized tissue present to reposition.

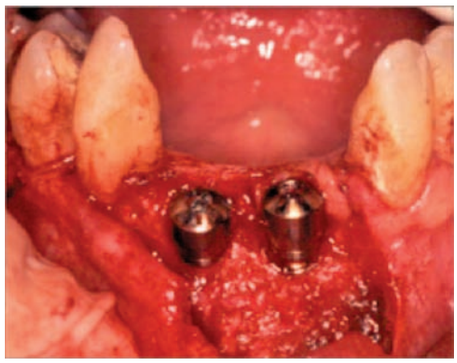

Figure 29.10 Full-thickness flap elevation and placement of the healing abutments.

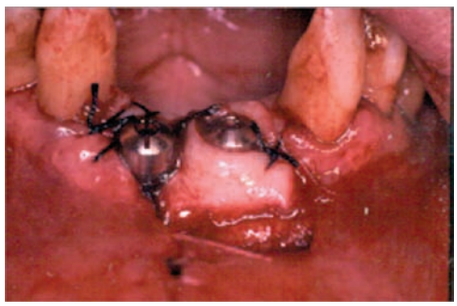

Figure 29.11 The free gingival graft is sutured in place.

Suturing techniques vary widely, but stabilization of the graft is the most important principle and can be accomplished using stabilizing structures adjacent to the surgical site such as interproximal tissue or a sling suture placed around the teeth or the implant crowns. The apical muscle group and the periosteum can be used to stabilize the graft using 5–0 Vicryl absorbable sutures. Reducing graft mobility and dead spaces between tissues will improve the graft success and after an average of 8 weeks the donor and recipient sites are healed. This technique does give a high discomfort at the palate site reported by most patients regardless of which kind of cover is used over the donor site and does not provide a high esthetic result due to the color mismatch.

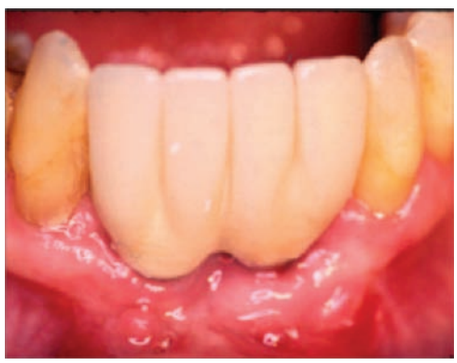

Figure 29.12 Here the final prosthesis is in place. Note the wide band of keratinized gingiva along the entire buccal limit of the prosthesis.

Connective tissue grafts (CTG)

Following the development and use of free gingival grafts, Langer and Calagna in 1980 described the subepithelial connective tissue graft for root coverage and ridge augmentation as the second major type of free soft tissue autograft [22]. The esthetics advantages, healing period, and superior color match of CTG verses FGG make CTG the most widely used soft tissue autograft technique used in periodontal plastic surgery [23]. A connective tissue graft used under a pedicle flap yields to mean root coverage of 89.3% around natural teeth [24].

When the palatal masticatory mucosa is used as an autogenous donor material for a connective tissue graft it is important to control the thickness of the graft harvested. Harvesting a thick graft aids in vascularity and ease of manipulation of the donor tissue but delays the healing period, while use of a thin graft decreases the healing time but often results in graft shrinkage or early necrosis [25,26]. Therefore surgeons should have a thorough knowledge of the anatomy of the palatal masticatory mucosa and different anatomical landmarks used to harvest an adequate graft. The thickness of the palatal masticatory mucosa was measured through various means such as direct bone sounding with a periodontal probe, ultrasonic devices, and computed tomography, which was shown to range from 1.0 to 12.0 mm [19,27–31]. Histological analysis of the mucosa by Yu et al. showed that the thickness of the lamina propria decreased toward the posterior palatal area and mid-palatal suture, while that of the submucosa increased [32]. Yu's results suggest that the most appropriate donor site is the region 3–9 mm below the CEJ between the distal surface of the canine and the mid-line surface of the first molar. When harvesting from this area also keep in mind the anatomical landmarks of the palate. The greater and lesser palatine foramina are located apical to the third molar at the junction of the vertical and horizontal components of the palate. The greater and lesser palatine vessels and nerves lie in a bony groove, the greater palatine groove, which traverses the palate anteriorly at the junction of the horizontal and vertical palate.

It is important to avoid the nerves and vessels located along this neurovascular line [19]. The location of this line relative to the CEJ varies with the palatal vault depth. In shallow palatal vaults the average distance between the neurovascular line and the CEJ is 7 mm, whereas in high vaults the maximum average distance is 17 mm. In an average vault there is about a distance of 12 mm from the neurovascular line to the CEJ [33]. Major problems can occur when the surgeon violates the neurovascular area, such as paresthesia and excessive bleeding. Paresthesia of the anterior palate is more noticeable to the patient during speech due to the phonetic impact of an absence of feeling in this area. This paresthesia is generally temporary and often dissipates over the span of 6 to 12 months due to regeneration of nerve fibers. Bleeding can be a major problem in the palate but most bleeding can be controlled by pressure, increasing the amount of sutures, and the use of chemical or electrical coagulants. Taking into account an incision started 2 to 3 mm from the free gingival margin and ending 2 mm prior to the neurovascular line then the maximum width of donor tissue will vary from 3 mm in the shallow vault to 13 mm in the high vault, with an average width of 8 mm in the average vault. If the average amount of donor tissue needed for a site is 5–9 mm, this means that harvesting a graft from an individual with a shallow palatal vault may not be adequate and doing so could risk neurovascular damage. In these cases a clinician should consider allogeneic grafting as the best treatment option [33].

A connective tissue allograft can be used in two differenct ways. One is to increase the bulk of tissue in the area of a small concavity or thin mucosa and the other is to increase the zone of keratinized tissue. If the intention is to increase the zone of keratinized tissue one should employ a free connective tissue graft, while if tissue thickness needs to be increased a classical connective tissue graft procedure should be applied. These two connective tissue grafting techniques will be presented separately.

A free connective tissue graft

A free connective tissue graft is pre-formed in the same manner as a free gingival graft at the recipient site and the harvesting from the palate is perfomed by dissecting the connective tissue rather than harvesting a full thickness graft. When harvesting connective tissue from the palate begin by doing a single horizontal incision 2 mm apical to the gingival margins, especially at the first molar without vertical incisions, and then elevate a full thickness envelope flap from which connective tissue is dissected out and the remaining flap epithelium cover is left attached to the remaining palatal tissue. Once the graft has been removed, the remaining flap will be sutured to the adjacent immobile palatal tissue.

Covered connective tissue graft

A conventional connective tissue graft is usefull in areas where one needs to increase the thickness of the buccal tissue around an implant or in areas where it is necessary to improve the quality of the tissue. In a covered connective tissue graft the flap created at the donor site is placed over the graft and positioned apically. A coronally advanced flap covering a connective tissue graft increases the graft survival and success and the overlaying flap also adds to the thickness of the grafted area [34]. Two different manners of executing a connective graft will be described below, one using a tunneling technique and one another with an open flap.

Coronally advanced flap with CTG *(Figures 29.13 to 29.16)*

1 Begin with preparation of the recipient bed: lay a full-thickness envelope flap exposing the bone in the area that needs augmentation. Use intrasulcular incisions on the coronal portion of the flap in areas of surrounding natural teeth and use a submarginal incision sparing a 1 mm band of keratinized tissue in the area of the implant. All interproximal papilla should be sliced (de-epitheliarized), exposing the underlying connective tissue and leaving the base intact and attached to the underlying bone. If any elements of the implant fixture is exposed following flap elevation, these areas should be disinfected following the clinician's chosen protocol. No vertical incisions will be done, which allows a better blood supply to the flap and more predictable stability to the graft.
2 As done in previous techniques, measure the area of the defect and harvest a connective tissue graft from the palate.

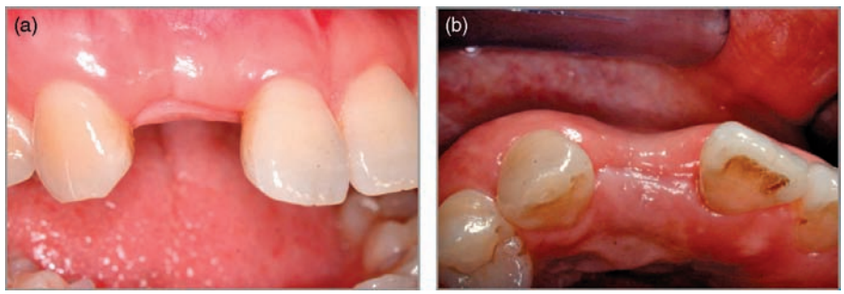

Figure 29.13 In this case there is a buccal concavity visible in the area of implant 7 and a connective tissue graft was employed during the second stage to add bulk to the ridge.

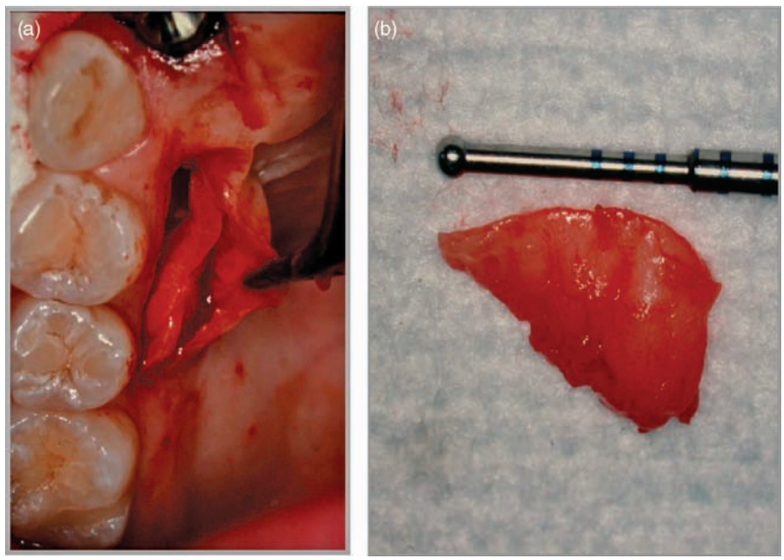

Figure 29.14 Depict harvesting of the connective tissue from the palate.

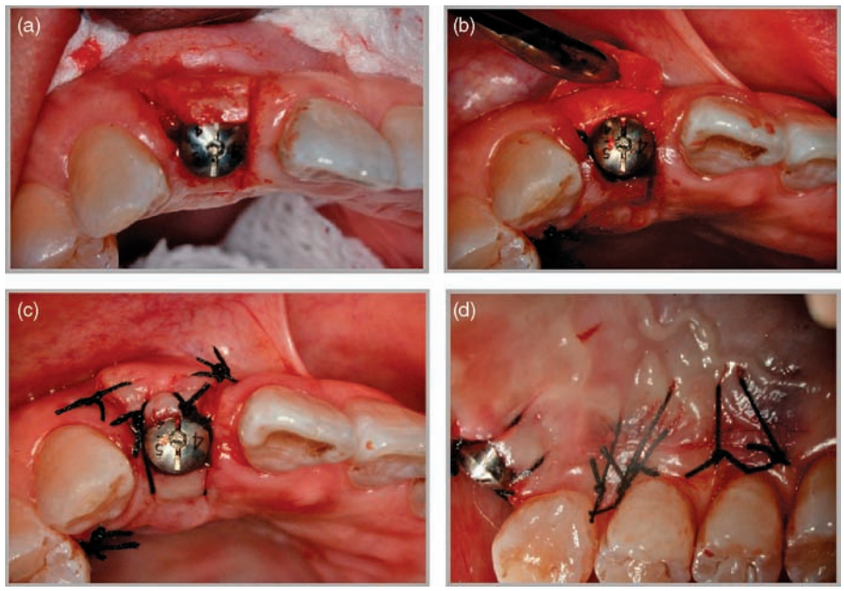

Figure 29.15 **(a)** A full-thickness flap with a papilla sparing design is elevated to both create the recipient bed for the connective tissue graft and expose the implant cover screw. **(b)** A healing abutment and the donor tissue is put in place. **(c)** The flap is secured over the donor tissue and the healing abutment is left in place. **(d)** The donor tissue is also sutured.

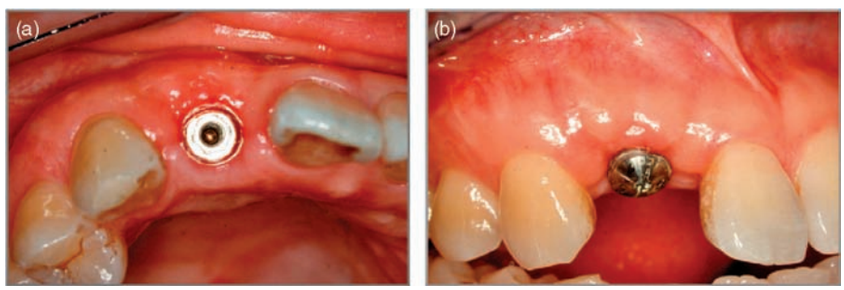

Figure 29.16 Post-operative images. Note the fill in the area of the buccal concavity and the re-established continuity of the ridge.

3 Place the CTG into the opened flap and suture it to the interproximal papilla with interrupted sutures using polypropylene 6.0 sutures.
4 Stretch the elevated flap and cover the now stabilized graft. Affix the overlaying flap using single sling 5.0 vicryl sutures.
5 If the overlying tissue is mainly from mucosa another step may be done following healing where the mucosa is split to expose the underlying matured tissue.

Tunnel technique *(Figures 29.17 and 29.18)*
The tunnel technique allows for placement of a connective tissue graft without reflection of a conventional flap. A tunnel flap is in essence an alteration of a pedicle flap as it maintains blood supply from the papillary and the mucogingival aspects. This increase in blood supply as compared to a conventional flap aids in graft stability and circulation [19]. A full-thickness dissection prepares the donor site to receive the connective tissue graft. This style of flap

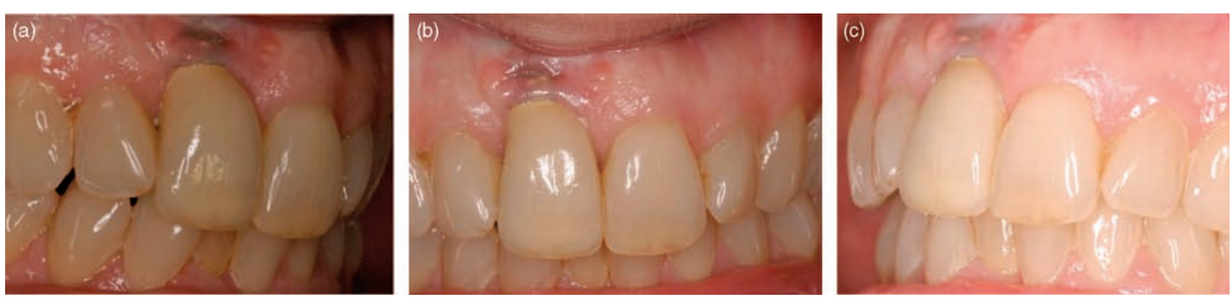

Figure 29.17 In this case the tunnel technique with a connective tissue graft was employed to increase the tissue thickness in the area of implant 8.

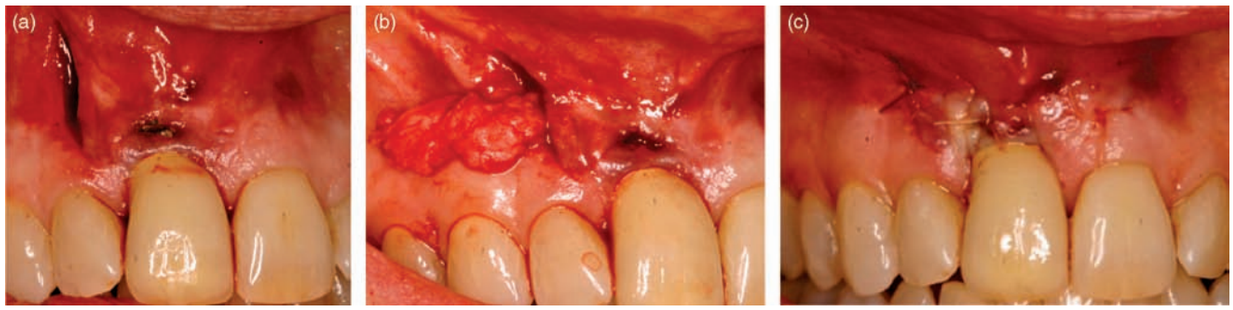

Figure 29.18 **(a)** A vertical incision is made distal to the defect and a tunnel-like pouch is elevated to full thickness. **(b)** The harvested connective tissue is passed into the tunnel pouch. **(c)** The donor tissue is sutured in place.

is difficult and time consuming when compared to a conventional flap. This technique of reflection should only be undertaken after many conventional flaps have been reflected and a working knowledge of the anatomy is learned. This technique has many advantages as it allows for increased blood supply, graft stability, and a more rapid healing due to the nature of the tunnel flap [35–38].

1 In a tunnel technique, the recipient bed is a tunneled full-thickness pouch spanning the area of the defect. Once the defect area is identified, create two vertical incisions aproximately the height of the defect spanning the mucogingival junction and not extending the free gingival margin. The incisions should be at the depth of the osseous structure as a full-thickness pouch is to be disected in the plane of the incision.
2 Elevate the tissue with a tunnel technique in the area of the defect without opening the flap at the gingival crest. Ensure the instrument tip is resting underlying the osseous structure and with a gentle back and forth pushing motion develop and dissect a full-thickness pouch under the tissue. Extend the plane of disection close to but not breaking the free gingival margin.
3 Harvest the connective tissue graft from the palate as previously described. In this case after orienting the connective tissue graft over the defect affix a suture to one end of the graft and then thread the suture through the created pouch positioning your graft.
4 Once the graft is satisfactoraly placed into the defect area suture it into place through the flap while coronally elevating the flap using a continous sling suture. The vertical incisions can be closed with interrupted sutures.

Allograft dermis

While autografts such as connective tissue and free gingival grafts have been considered the gold standard for soft tissue grafting, improvement in processing mechanisms and development of soft tissue allografts have made them a predicable alternative to autografts [39,40]. There are many different acellular dermises available on the market, each type differing in processing and sterilization techniques, but all serve a sterile acellular collagen matrix that acts as a scaffold for ingrowth of surrounding tissue [41,42]. The current processing technique involves complete removal of the epithelium by uncoupling the bond with the dermis, ensuring no damage to the dermal structure, and maintaining the basement membrane. The dermal cells are removed with low molecular weight non-denaturing detergents, whereas the matrix is stabilized through the inhibition of metalloproteinases. The tissue is freeze-dried without damaging components essential for revascularization and repopulation by the recipient's normal cells. This process renders the dermal matrix free from cellular components, while the graft still contains blood vessel channels, collagen, elastin, and proteoglycans [43]. Using an acellular dermal matrix allows for a more organized and rapid healing response due to the biologic scaffold for normal tissue remodeling. The acellular dermal matrix allograft is in the thin to medium range of graft thickness (0.75–1.4 mm) [42,44].

Allografts should be selected in instances where a patient☒s own tissue cannot overcome a defect or a clinician feels a patient cannot tolerate harvesting of an autograft. The use of an acellular dermal matrix is technique sensitive and its success is highly dependent on case seletion. Highly vascularized areas with limited surgical scarring best serve soft tissue allografts as an adequate blood supply will aid with healing and less fibrous tissue will allow for the primary closure necessary for use of soft tissue allografts. The use of platelet-derived growth factor concominent with acellular dermal matrix products can aid in accelerating the healing process [45]. Allograft dermis cannot be predictably used as a free graft due to the rate of necrosis and delay in vascularization when not covered by a flap. The major advantages of this technique are the unlimited amount of donor material available and the lack of post-operative complications related to the palatal wound. It is recommended that the allograft dermis be completely covered by the patient☒s tissue for a successful result and can therefore only be used in place of an autograft in some of the techniques presented above. Allograft dermis in the implant therapy can be used in place of connective tissue in the tunnel and open flap. However, connective tissue grafts heal an average of 2 to 3 weeks faster, with more keratinized soft tissue than the acellular dermal matrix grafts [38,39] (see Figures 29.19 to 29.21).

Techniques for papilla management

Second stage surgery or soft tissue augmentation in sites with multiple implants in a row presents a very specific challenge, which is managing the interproximal implant tissue. When using the roll technique, apically repositioned flaps, free gingival, or connective tissue grafts during the second stage around multiple implants, the interproximal areas are left exposed to heal through secondary intention. This type of healing can lead to interimplant crestal bone loss and the formation of flat or even inverted inteimplant papilla tissue. All of these outcomes are of extreme esthetic detriment and prevent adequate embrasure space fill following final restoration. Fortunately there are techniques to manage soft tissue in a way to correct or minimize this set-back.

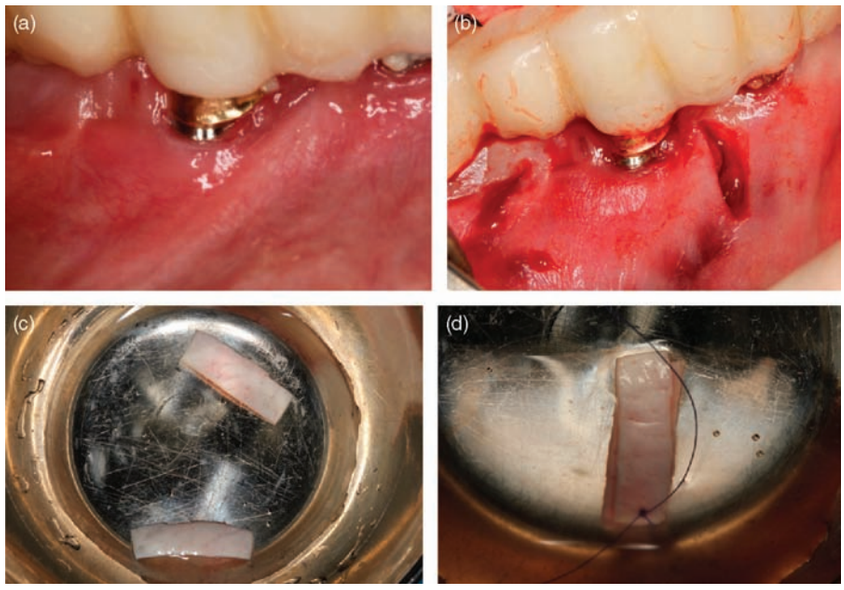

Figure 29.19 **(a)** There is thin tissue and a shallow vestibule in the area of this mandibular implant. A tunnel technique to place the allograft dermis was used to thicken the tissue and deepen the vestibule. **(b)** Two vertical incisions are made and a full-thickness tunnel flap is elevated. **(c)** The allograft dermis is hydrated. **(d)** The allograft dermis is doubled and a suture is placed on one end to aid in pulling the allograft dermis through the tunnel.

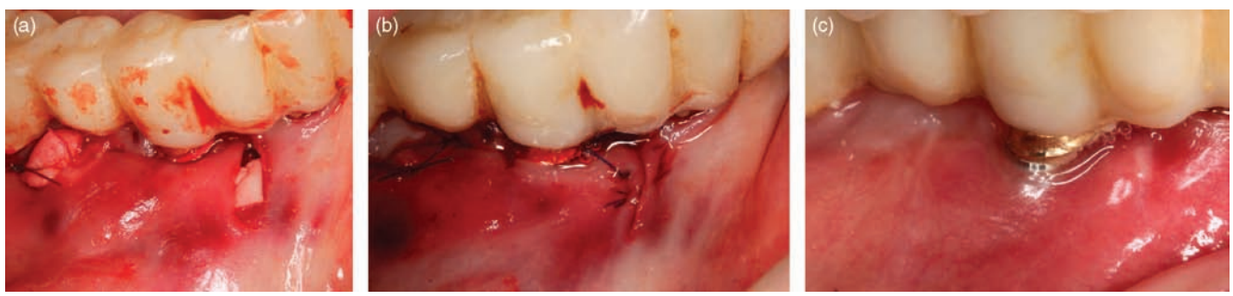

Figure 29.20 **(a)** The allograft dermis is passed through the tunnel. **(b)** The allograft dermis is sutured in place and the vertical incisions are closed.

Rotated eediculated marginal tissue (Palacci)

Palacci in 1995 described a technique to create papilla-like formation. The attached gingiva is displaced buccally beginning with a crestal incision in line with the palatal or lingual limits of the implant cover screws, two vertical releasing incisions, and a full thickness flap. The flap is elevated and pushed buccally while the healing abutments are placed to hold the flap buccally. The excess buccal tissue is dissected into pedicles that are then rotated into the interproximal spaces. Dissection and rotation is done with semilunar incisions, starting from the distal and rotation of the pedicle at 90° in the palatal direction. The pedicles should be sutured without tension or engagement of the pedicles; an eight-shape figure suture is suggested to hold them in place [46].

Rotated pediculated lingual marginal tissue (El Chaar)

A major modification to the Palacci technique takes advantage of the abundance of soft tissue on the palate while reducing the risk of buccal gingival recession, which can be caused by use of the buccal as a donor site. In this modification the attached gingiva is displaced buccally beginning with a crestal incision either directly over the center of the implant cover screws or shifted slightly buccally. Two vertical releasing incisions, sparing the papilla-like tissue at the proximal of adjacent teeth, are placed and a full-thickness flap is elevated. The elevated flap is displaced buccally and is held in place by the healing abutments. The excess palatal tissue is then dissected into pedicles with semilunar incisions beginning distally. These pedicles are then rotated into the interproximal spaces. Contrary to the Palacci technique, the pedicles are created from the palatal tissue and rotated forward rather than from the buccal. This is advantageous because no buccal keratinized tissue is sacrificed. Here areas of the palate can be left to heal through secondary intention without fear of creating visible recession and pedicles can be harvested without risk of a deficient width of buccal keratinized tissue. The rotated pediculated papilla-like tissue is sutured to the buccal flap using horizontal mattress sutures. The sutures started from the buccal flap, allowing the pediculated papilla to cover the interproximal boneand lie passively in the interproximal space, which is a very important variant to the Palacci technique, securing the rotated pedicle more and accelerating the revascularization between the two joining tissues. This technique can be utilized anywhere including the anterior area. In cases where the two sides right and left are both involved, one might end up having two rotated papillae

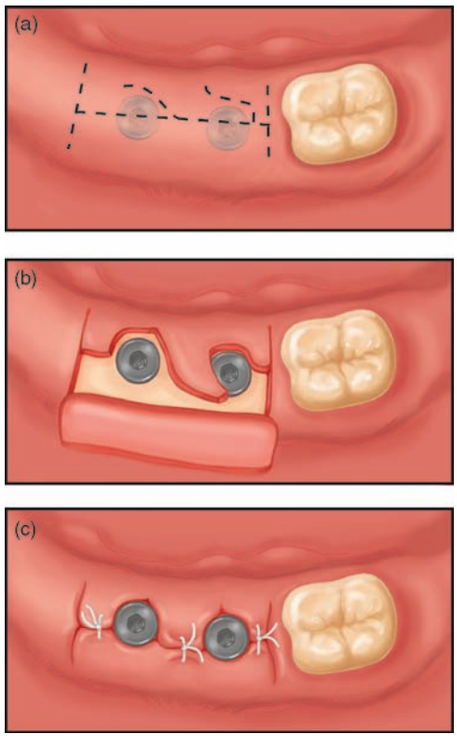

Figure 29.21 **(a)** A crestal H incision is made, sparing the papilla-like tissue at the proximal of adjacent teeth. A full thickness flap is elevated. **(b)** The elevated flap is displaced buccally and is held in place by the healing abutments. A semilunar incision is made in the excess palatal tissue in the mesiodistal direction, as shown in (a), dotted lines. **(c)** The pedicle is then rotated into the interproximal space and sutured to the buccal flap. Contrary to the Pallaci technique, the pedicle is created from the palatal tissue and rotated forward rather than from the buccal. The pedicle is sutured with a vertical mattress.

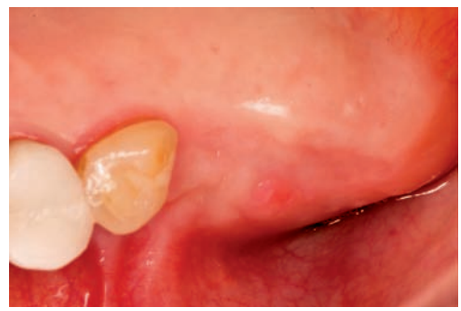

Figure 29.22 Maxillary posterior prior to placement of two adjacent implants and closure using the rotated pediculated lingual marginal tissue the El Chaar technique. This technique can be used at the time of the single stage implant placement or during implant uncovering of adjacent implants. Note the adequate keratinized tissue on the buccal.

in the mid-line or interimplant in positions 8 and 9. Before committing the two sides, one has to measure the interimplant space. If the mid-line interproximal space is 3 mm then one side's (right or left) rotated pedicle should fill the space. If that space exceeds 4 mm, then the two pedicles from both sides right and left should be rotated to fill the space. If needed, those two pedicles can be affixed together via 6.0 polypropylene sutures. (Figures 29.22 to 29.24).

Conclusion

This chapter presented an overview of how to apply the biology and esthetic considerations (presented in the previous chapter) to prevent soft and hard tissue defects surrounding planned implants. It also presents information that aids the clinician in deciding the best time during treatment to correct any identified deformities. This chapter outlines multiple techniques that can be used to both prevent and manage the soft tissue surrounding implant fixtures,

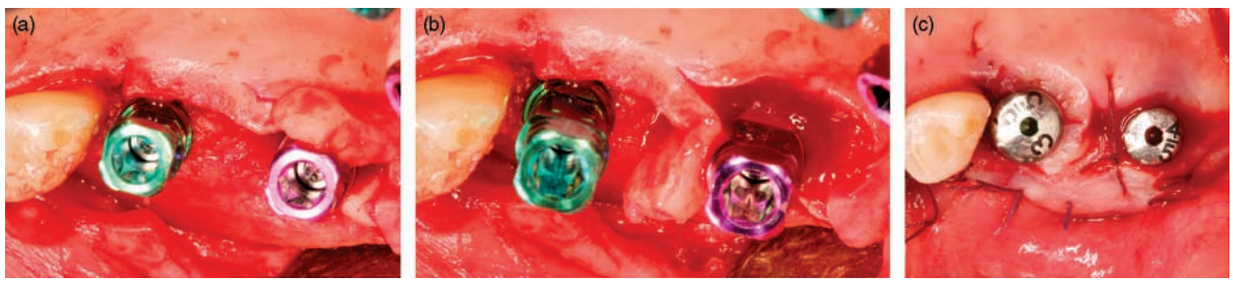

Figure 29.23 **(a)** A full-thickness flap is elevated, exposing the area. **(b)** After the implants are placed a pedicule is dissected out of the lingual tissue and rotated to the interproximal position. **(c)** The healing abutments are placed and the pedicle is sutured into place.

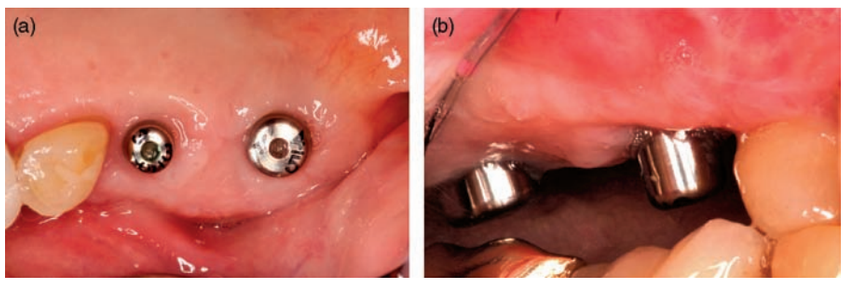

Figure 29.24 Note the abundant soft tissue height and papilla-like structure present between the two healing abutments most visible in the buccal view.

such as: connective tissue grafts, free gingival grafts, acellular dermal matrix grafting, and rotated pedicle grafts. While this chapter does distinctly present surgical techniques, it is not simply a manual. The indications as well as the pros and cons of each approach are also reviewed in order to help a clinician make the best choice for each specific case he/she may encounter. The methods presented here can be applied to correction and prevention of a wide variety of soft and hard tissue defects, ranging from buccal concavities, lack of keratinized tissue, and deficient papilla between implant fixtures. The biologic rationale and surgical indications provided alongside these techniques will aid in proper treatment planning and execution of successful surgical procedures.

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