# Single-Tooth Implants in the Esthetic Zone–Contemporary Concepts

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As discussed in earlier chapters, the placement of dental implants is now a mainstream procedure in esthetic and restorative dentistry. Because of currently available ceramics and technical expertise, the creation of an appropriate restoration that mimics the natural tooth in form, esthetics, and function is no longer considered the greatest challenge in implant dentistry. In cases where missing and failing teeth in the esthetic zone are to be restored, the dental implant restoration frequently is the first treatment modality considered. However, clinical experience and the literature indicate that the soft tissue esthetics remain a challenge, particularly with regard to maintenance of stability of labial soft tissue contours, the papillae between implants and teeth, and the inter-implant papillae.

Although clinicians now more fully understand the limitations in these areas, which leads to stronger treatment planning for implant restorations in the esthetic zone, many questions remain unanswered. The plethora of implant systems available today demands that treating clinicians have a clear appreciation and understanding of the response of the soft and hard tissues around various implant restorations, as there is no doubt that this response plays a key role in the esthetic outcome and determines the stability and predictability of the result over time. In the past, successful soft tissue esthetics in implant treatment were largely achieved by luck rather than by design. The contemporary approach to implant treatment planning anticipates the biologic response of the bone and the soft tissues once implants and prosthetic components are placed and uses this knowledge to attain optimal esthetic outcomes.

## Key Factors in Soft Tissue Esthetics

### Influences on the bone remodeling process

It is now generally accepted that bone and soft tissue remodeling occurs around all dental implant restorations, irrespective of the system used. This remodeling has been attributed to a number of factors, the most commonly accepted of which would seem to be the concept of the establishment of a biologic seal, described as a *biologic width*, between the free gingival margin and the crest of the peri-implant alveolar bone.[1–3] From a clinical perspective, this concept can be described as the three-dimensional remodeling of bone to create space for a connective tissue compartment between the bone and the epithelium. The extent of this remodeling is potentially influenced by several factors[2–16]:





- Three-dimensional position of the implant-abutment interface relative to the bone crest
- Presence of an inflammatory infiltrate in connective tissue adjacent to the microgap
- Design of the implant-abutment connection
- Repeated removal and replacement of prosthetic components
- Material of the transmucosal components (ie, titanium, alumina, zirconia, acrylic resin composite, gold, or porcelain)
- Shape and contours of the transmucosal components
- Thickness of the soft tissues
- Genetically predetermined normal wound healing in the individual host

Clinicians in contemporary clinical practice attempt to anticipate and compensate for the hard and soft tissue changes that result from this remodeling through proper treatment planning and procedures. Regardless of the reason for the remodeling, a certain dimension of soft tissue is required to house the necessary components of this biologic seal.

Traditionally, a great deal of emphasis has been placed on the volume of bone around implants in the esthetic zone. Some authors have advocated the creation of certain dimensions of peri-implant bone by means of extensive grafting procedures.[3,17] More recently, the tissue quality, tissue thickness, and tissue biotype have been given more credence.[9,18,19] The author believes that a paradigm shift needs to occur within the dental implant community in recognition that the relationship between bone and soft tissue is a more reciprocal one than previously thought—that is, bone is not the only key, but soft tissue quality and thickness influence bone remodeling and may even be more important than bone when it comes to long-term esthetics and stability of the peri-implant mucosa.

## Implant component design

New concepts for component designs have been proposed for the head of the implant, the implant-abutment connection, and the form of the transmucosal abutment contour levels.[13–15,20–23] These proposals mainly serve the same purpose of creating a transmucosal undercontour, which logically should increase the available volume of peri-implant soft tissue and effectively thicken the soft tissue cuff around the implant-abutment connection. Four main ideas are commonly suggested today:

1. Creation of vertical or, more commonly, horizontal offset (*platform switching*) to reduce the vertical remodeling of the bone and soft tissues
2. Use of an abutment connection that incorporates a conical seal, which may reduce the micromotion of the components and/or bacterial contamination at the microgap

3. Use of an undercontoured or concave transmucosal form for the abutment and prosthetic components
4. Placement of the final abutment at the time of surgery or within a short time frame before soft tissues fully heal, and subsequently not removing it again

It has not been demonstrated conclusively that any of these individual concepts holds the key to bone remodeling; more likely, it is a combination of factors relating to the bone, the soft tissue, and indeed the design of the components used in treatment. In addition, the clinician should always consider the individual biologic variability in host response.

However, the majority of the newer implant-abutment designs effectively narrow or undercontour the transmucosal components, thereby increasing the room available to create a thicker cuff of soft tissue around the neck of the transmucosal components. Certainly, this increased thickness of soft tissue could be key factor for successful esthetic results in terms of longer-term soft tissue stability. It is logical to presume that if 3 to 4 mm of tissue is required to house the dimension of the peri-implant tissues, then ensuring that this dimension of soft tissue is present at the time of implant abutment placement may preclude the need for bone to remodel vertically to create the necessary dimension for the biologic seal. This may also prevent the gingival recession that is commonly reported to follow restoration of single-tooth implants in the esthetic zone.

In recent years, immediate implant placement using flapless procedures has gained popularity, as these procedures offer a minimally invasive and often virtually atraumatic surgery. While this has obvious benefits for the patient in terms of the surgical experience and perhaps treatment acceptance, it may not be advantageous from the standpoint of long-term clinical outcome. Both gingival recession and labial bone volume loss are accepted risks when using this technique,[24–29] prompting many clinicians to advocate a number of additional surgical steps such as grafting of biomaterials and tissue grafting in an attempt to increase the predictability and stability of the soft tissue outcomes.[18,19,30–36]

The goal of any implant therapy in the esthetic zone is to produce a lasting restoration that blends inconspicuously into the patient's smile. Factors such as a high lip line, a thin gingival biotype, and the number of adjacent teeth to be replaced can present significant hurdles to achieving of a lasting esthetic outcome. It is commonly accepted that in most cases with a single missing or single failing tooth, this goal is more easily achieved than in cases that require the restoration of multiple adjacent missing or failing teeth.[37–39] Box 7-1 lists the key factors necessary to achieve optimal results with implants in the esthetic zone. The relationship between these key points and clinical management are demonstrated in the case presentations later in this chapter.





**Box 7-1 Key factors in the management of implants in the esthetic zone**

- Adequate stable bone volume and architecture
- Correct three-dimensional positioning of the implant
- Adequate soft tissue thickness
- Timing of final abutment connection
- Transmucosal material, form, and contours of the abutment and prosthesis
- Development and maintenance of appropriate soft tissue contours

## Single-Tooth Restorations in the Esthetic Zone

The single-tooth restoration in the esthetic zone is a common application of dental implant therapy and in many ways represents the most demanding clinical management, particularly when it comes to long-term soft tissue esthetics. There are generally two situations where implants are indicated in the restoration of a single tooth in the esthetic zone: *(1)* in an existing edentulous site, and *(2)* in the replacement of a failing tooth.

In terms of the healed edentulous site, a site that has a mature healed edentulous ridge with good remaining bone volume and adequate soft tissue thickness in a patient with a thick tissue biotype is significantly different from a site where there has been significant damage to bone, soft tissue, or both through infection or trauma, or where there has been a large amount bone resorption and the soft tissue quality and biotype are unfavorable. Established protocols are well documented and effective, and in the favorable sites, good results can be achieved relatively easily. The compromised sites pose a greater challenge,[39–41] especially when it comes to achieving stable soft tissue esthetics that stand the test of time.

Similarly, management of a failing tooth with healthy intact tissues and a thick biotype is vastly different from management of one with thin tissue and prominent roots or with significant damage to the tissues through infection or trauma. In the case of a failing tooth with potential for immediate implant placement or immediate provisionalization, the challenges relate mainly to the preservation and maintenance of the interdental papillae and, more significantly, the labial soft tissue volume and contours. Significant bone and tissue damage, however, invariably require delayed loading, socket preservation, or a regenerative approach.[34,40–42]

## Addressing the Clinical Challenge

The clinician should consider a few main factors that can be used to address the challenge to create or preserve and, more importantly, main-



tain the appropriate soft tissue contours around a restoration that allow them to blend inconspicuously with the patient's natural dentition and smile. First, it is necessary to have a stable bone scaffold to house the implant and support the soft tissue. In a healed edentulous site with adequate bone width, this is not a critical issue. In a site with inadequate bone, however, augmentation techniques must be employed to create a stable bone volume. Second, soft tissue procedures such as connective tissue grafts and rolled flaps may be necessary to augment the thickness of peri-implant soft tissue and establish the necessary 3 to 4 mm required for the biologic seal at the time of transmucosal component connection. Finally, soft tissue thickness in the transmucosal zone can be maximized through the use of biocompatible materials and, more importantly, components that possess the appropriate narrow contours (undercontours) near the implant level, with a concave form that flares late to the margin of the restoration.

## Bone augmentation

In more compromised sites, whether edentulous or with failing teeth, effective protocols are essential if one is to obtain predictable results. In the past, autogenous bone grafting often has been presented as the gold standard, either as a block graft prior to implant placement or as particulate graft in combination with guided bone regeneration techniques. Although these techniques have proved valuable in the creation of sufficient bone volume for correct implant placement, the longer-term esthetic results of such grafts are questionable.[43–46] Indeed, a lack of stability may create esthetic problems resulting from a flattened or thinned labial aspect of the implant restorations. This leads to labial tissue recession, discoloration, or dark shadowing of the tissue labial to the implant. Such outcomes are unacceptable to many of today's patients.

The current trend is to employ bone augmentation materials that better support and maintain volume to obtain stable soft tissue esthetics. Materials such as bovine anorganic bone mineral, used in conjunction with resorbable or nonresorbable membranes, seem to offer this benefit of greater volumetric stability because the graft material is incorporated into newly formed bone with less resorption.[46–51]

## Hard and soft tissue factors

As previously mentioned, the two key factors to consider in evaluation and management of a proposed implant site from the perspective of soft tissue esthetics are the interproximal and the labial hard and soft tissues. Generally, the interproximal bone level of the adjacent teeth, combined with the distance from the contact point to the bone crest, determines adequate papilla length. It is thought that this distance should





be 4.5 mm or less for a papilla to fill the space.[37,38,52] The literature also indicates that the distal papilla may be shorter than the mesial and that both papillae will improve with time if the prosthetic contours are appropriate.[53]

The literature has suggested that some labial recession of 1.0 to 1.5 mm should be expected after a definitive restoration has been placed.[1,8,54,55] However, much of the generally accepted data on this issue was published several years ago, and ideas have evolved since then. One of the greatest shortcomings in the literature pertaining to the labial soft tissue response is the tendency to attribute this response to a single factor (eg, the labial bone thickness or bone height). It has been said time and again that "the bone sets the tone," but this seems without doubt to be only a small part of the story. Contemporary thinking encompasses broader concepts, noting that the bone, the soft tissue quality and thickness, the implant, and the restorative components likely all influence the host biologic response and, therefore, the remodeling process of the tissues.

## Transmucosal elements

The shape and contours of the transmucosal components are also considered important factors that influence the biologic response and subsequent stability and form of the soft tissues. The component design, the type of implant-abutment connection, the transmucosal materials used (eg, zirconia, titanium, gold, or feldspathic porcelain), and the timing of the connection of the final abutment all play a role. The late 1990s and the early part of the 2000s saw a tendency for convex, broad transmucosal components to be used, in contrast to more contemporary concepts that suggest narrow, flat, or even concave labial transmucosal contours with the goal to create more space for the tissue and therefore allow increased soft tissue thickness on the labial side of the restoration. In the author's opinion, the latter approach is essential to attain and maintain soft tissue contours. Clinical experience has demonstrated that it leads to improved stability and esthetics. These concepts form the basis of the approach to implant restoration in the esthetic zone today.

The presence of labial bone is important, but it is questionable whether the thickness of this bone has any bearing on the soft tissue stability. Frankly, there is no evidence to suggest that the thickness of bone is maintained over time and, in fact, personal experience may even suggest that the bone continues to remodel despite implant placement. Implants can remain in healthy functional and esthetic situations with very thin labial bone or even a labial dehiscence. The often-cited paper by Spray et al,[17] which justifies the thinking that 2 mm of labial bone is required for stability, evaluates only short-term changes to bone



contours between implant placement and uncovering in a conventional two-stage approach. It does *not* provide any information on the behavior of the soft tissues over a long period of time, particularly subsequent to transmucosal restoration.

In fact, many clinicians and authors working in the esthetic zone advocate the use of bone grafting techniques that incorporate materials to improve the volume and stability of the labial contours over time, in addition to augmentation of the soft tissue thickness on the labial aspect of the restoration by means of connective tissue grafting or by a roll flap if the latter gives adequate soft tissue thickness. These protocols are considered routine and are an important factor in achieving adequate labial soft tissue thickness and stability. When combined with the use of narrow undercontoured or even concave transmucosal components that create increased room for labial soft tissue, these techniques result in a thicker labial connective tissue cuff that seems to be more resistant to recession over time. It is the contention of this author that the establishment of an adequate thickness of soft tissue at the time of transmucosal component connection, such that the biologic width of 3 to 4 mm is already established, may reduce the bone remodeling necessary to create the tissue required for a biologic seal.

The application of the factors described above are examined in the management of the following two challenging clinical cases, where all of these factors come into play and provide a better understanding of the key clinical steps. Box 7-2 summarizes the key steps to optimize the soft tissue esthetics of single-tooth implants in the esthetic zone.

**Box 7-2 Key steps to optimize soft tissue esthetics with implants in the esthetic zone**

1. Perform orthodontic extrusion prior to tooth extraction where possible.
2. If bone augmentation is required, use bovine anorganic bone mineral versus autogenous bone for better stability of volume and contours.
3. Position implant-abutment connection 3 mm apical and 2 mm palatal to final gingival margin.
4. Thicken labial tissues (ie, boost biotype through connective tissue graft or roll flap).
5. Use undercontoured or concave transmucosal components.
6. Use more biocompatible materials for the transmucosal components or abutment: zirconia, alumina, or titanium versus gold, feldspathic porcelain, or acrylic resin composite.
7. Avoid repeated disconnection and reconnection of abutments and components, ie, early or immediate placement of definitive abutment.
8. Develop contours with provisional restorations.
9. Control and remove cement excess at final cementation.





## Case 1: The Compromised Single-Tooth Site

Management of compromised sites, whether previously edentulous or with a failing tooth, is always a challenge, particularly if optimal esthetics are to be achieved.[41,56] While it must be stressed that the "perfect" result is not always achievable in these cases due to the compromised biology and damage to the site, nonetheless much can be learned and gained from the management of these cases. The clinician can subsequently apply this learning so as to provide better management and greater predictability for simpler cases that require implant treatment in the esthetic zone. The reader is encouraged to look into the articles referenced in this chapter for more information regarding the approaches to management of compromised sites.

### Presentation and evaluation

Case 1 provides a useful situation to demonstrate the key aspects in the management of implants in the esthetic zone. A 48-year-old man was referred to the practice in 2004 after the loss of his maxillary left central incisor (Figs 7-1a to 7-1g), which had been extracted about 2 months before his referral. The tooth had been endodontically treated and restored with a post crown. This had failed due to root fracture and was subsequently extracted after the patient's general dentist attempted antibiotic therapy of the infection. The patient was then provided with a removable partial denture.

Careful evaluation of the patient reveals a number of challenges and prognostic factors that may influence the likely outcome:



Fig 7-1a Case 1 at presentation. Note the compromised tissue esthetics.



Fig 7-1b Oblique view at presentation reveals the deficient tissue volume.




**Fig 7-1c** Preoperative anterior view. Note the thin tissue, triangular tooth form, blunt papillae, and unfavorable mesial angulation of the lateral incisor.



**Fig 7-1d** Analysis of some of the diagnostic and prognostic factors in this case.



**Fig 7-1e** Preoperative radiograph.



**Fig 7-1f** Close-up view of the compromised edentulous site.



**Fig 7-1g** Oblique view highlights the prominent root architecture and extent of the defect.

- Poor oral hygiene is evident.
- The patient has a high lip line (see Fig 7-1a).
- A thin scalloped biotype is combined with prominent roots and thin labial bone and tissue (see Figs 7-1c and 7-1g).
- A triangular tooth form (see Fig 7-1c) means the contact points are likely to be more coronal, therefore complete papilla fill is more difficult or unlikely to achieve, creating unless the crowns are recontoured a more apical contact point (see Fig 7-1d).
- The papilla on the mesial aspect of the left lateral incisor is already compromised. Due to the angulation of the tooth, the proximal bone level, and the tooth form, it is unlikely that an ideal distal papilla will be achievable on the future implant crown (see Fig 7-1d).
- A large volume of bone and soft tissue is missing, and there is significant damage to the site (see Figs 7-1b and 7-1f). The defect is a broad U shape rather than a narrow V shape (see Fig 7-1g).
- The state of the patient's mouth at presentation indicates an apparent lack of concern for ideal esthetics. The patient also stated that his primary concern was function and not optimal esthetics.

In a case like this, a clinician should expect to see a large defect in the bone and possibly an inadequate volume of keratinized gingiva and soft tissue. As mentioned above, assessment of the patient shows an unfavorable gingival biotype with a high scalloping, triangular tooth form and a low frenum attachment. The papilla on the distal aspect of the tooth to be restored is already deficient. This is partly due to some bone loss on the mesial aspect of the lateral incisor but also because the triangular tooth form is combined with a mesial tilt and rotation of the lateral incisor, thereby leading to inadequate proximal support of the soft tissues. These issues will affect the likely esthetic outcome and need to be discussed in detail with the patient. Ideally, considerations could include orthodontic treatment to upright the right lateral incisor or addition of some resin composite to the mesial aspects of the adjacent incisors, which would help create a contour that produces a less triangular tooth form and likely prevents black triangles in the final proximal embrasures. In this case, the patient did not wish to undergo orthodontic treatment, so a compromise was agreed upon whereby the distal papilla was expected to remain slightly deficient. Discussion of these types of issues with the patient ensures that expectations are realistic, particularly in heavily compromised cases such as this one.

Diagnostic study models and a wax-up allow for a better visualization and evaluation of the missing tissue contours (Fig 7-1h). In cases like this, it unlikely that any immediate provisionalization of the implant can be considered, so it is preferable to provide a fixed provisional restoration such as a Rochette bridge whenever possible. A Rochette bridge can be easily cemented with a resin-ionomer cement (Fuji II LC,



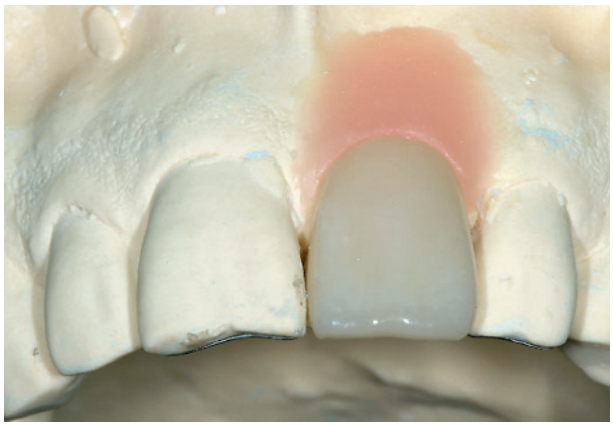


Fig 7-1h Diagnostic wax-up of tooth and tissue to restored.



Fig 7-1i Rochette provisional restoration.

GC America) (Fig 7-1i), which provides adequate retention without complex isolation or etching of the teeth, and allows for simple removal and replacement during the various stages of surgical treatment. The fit surface of the pontic can easily be hollowed and adjusted to fit over any healing abutment if necessary. If there is insufficient room in the occlusion to allow placement of the retentive wings, then a removable partial denture can be used. If this is done, it is important to ensure that the adjacent teeth support the prosthesis well; that is, the prosthesis should sit passively on the edentulous ridge, particularly after any ridge augmentation has been completed, and should not place inadvertent pressure on the area when the patient occludes.

## Decision-making in bone augmentation for ideal esthetics

Wherever a significant bone graft or regeneration is expected, a full thickness flap is raised using a sulcular incision around the adjacent teeth and at the palatal aspect of the ridge. This approach was used in this patient, and a large three-dimensional defect was revealed in the bone (Fig 7-1j). Periosteal releasing incisions, which allow easy advancement of the flap, were created early in the procedure to help reduce postoperative bleeding and swelling. Remote vertical releasing incisions, which allow the tissue to have sufficient mobility to cover any expanded volume created by grafting, also were made.

At this point, the clinician has two options to consider: *(1)* to complete bone grafting and augmentation at this stage and place the implant at a later stage after suitable healing; or *(2)* to place the implant in the ideal three-dimensional position if there is adequate stability and perform simultaneous bone augmentation. Both approaches have been advocated, but it should be stressed that the latter option is more demanding and requires a higher degree of surgical skill. Furthermore, consideration should be given to which bone grafting technique and



Fig 7-1j Osseous architecture after a flap is raised. Note the extent of the defect and the volume of missing bone.

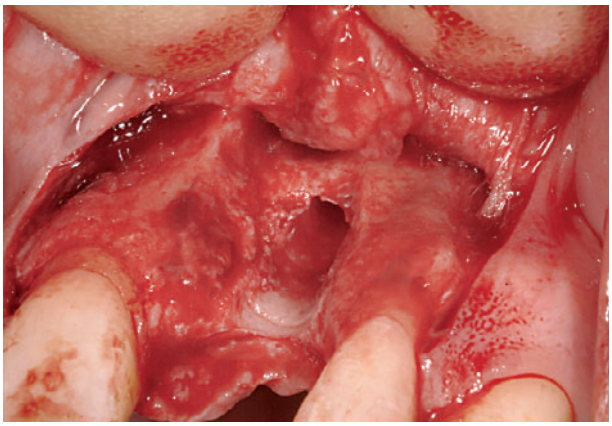


Fig 7-1k The prepared implant osteotomy.

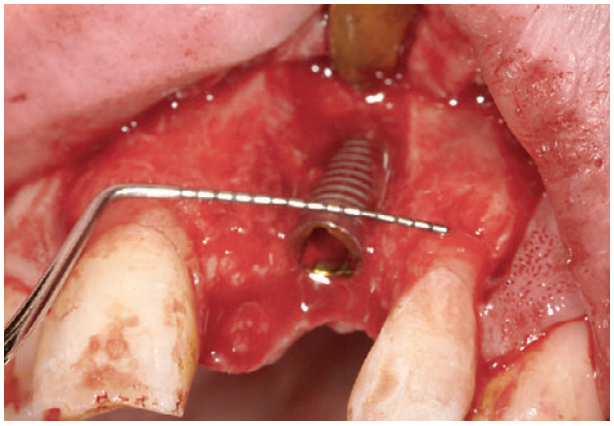


Fig 7-1l Ideal position of the implant is 3 mm apical and 2 mm palatal to the desired final gingival margin.

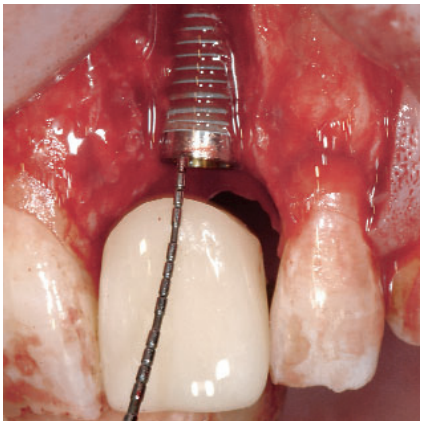


Fig 7-1m Verification of the implant head position against the provisional restoration.

material will be used. The current general trend leads away from autogenous block grafting and towards particulate grafts with biomaterials such as anorganic bovine bone material, which maintain better long-term volume. Ultimately, the goal is to create a volume of bone that produces a lasting result in terms of soft tissue contours and maintainable gingival esthetics.

Clinical experience would suggest that one approach may have advantages over the other in terms of results, and in the majority of cases the second option is the author's preference, as it produces consistent results that have stood the test of time. The premise of this concept is that the simultaneous implant placement reduces the volume of bone to be regenerated, because the implant itself occupies much of the space.

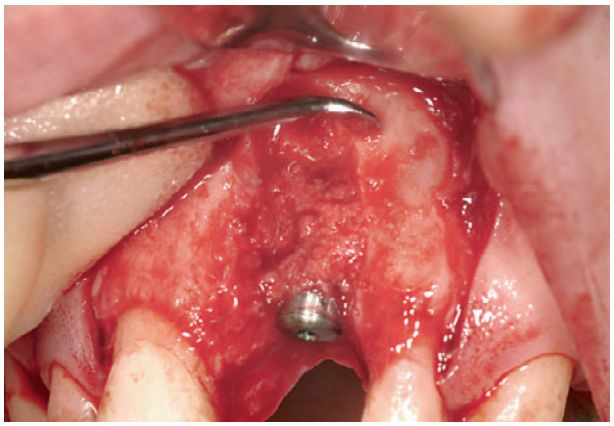


Fig 7-1n Autogenous bone scrapings are taken from the local site to cover the exposed threads.



Fig 7-1o Anorganic bone mineral grafted to fill the defect.

All bone grafting and regenerative techniques result in some degree of subsequent bone volume shrinkage during the bone remodeling process. Anorganic bovine bone mineral seems to demonstrate a smaller percentage of overall shrinkage than other materials. Therefore, it seems logical that earlier placement of the implant reduces the overall volume to be grafted and, subsequently, the total shrinkage, since the shrinkage only occurs in the small amount of regenerated bone covering the implant. For example, if 20% volume loss is expected, then shrinkage of 20% of 1 to 2 mm of bone (0.2 mm to 0.4 mm) has far less of an impact than 20% of 10 mm of bone (2 mm).[33,46–51]

Case 1 illustrates this concept well. In Figs 7-1k and 7-1l, a significant volume of bone would have to be regenerated if the implant is not placed. Simultaneous implant placement also shortens the overall treatment time, although this may not necessarily be a priority for the patient.

## Steps 1 and 2: Correct implant placement and bone augmentation

After the implant osteotomy was performed, it was established that an implant could be placed with adequate primary stability. The head of the implant must be placed in the ideal three-dimensional position, which is usually 3 mm apical and 2 mm palatal to the desired final gingival margin of the definitive restoration (see Figs 7-1l and 7-1m). In this type of case, where the implant is buried and bone augmentation is performed, it is always necessary to take a two-stage approach. The augmentation was completed using autogenous bone scrapings harvested from the apical aspect of the site, with a goal to bring some potential bone-forming cells close to the implant surface (Fig 7-1n). A layer of anorganic bovine bone mineral (Bio-Oss [Geistlich]) was placed over this (Fig 7-1o) and covered with resorbable collagen







Fig 7-1p Resorbable membranes are placed.



Fig 7-1q Good primary closure is achieved, and the flap is sutured using 6-0 monofilament polypropylene sutures.

membranes in two layers (Bio-Gide [Geistlich]). Care was taken to ensure the membranes did not come into contact with the adjacent roots (Fig 7-1p). In cases like this, the goal should be to have slightly more labial tissue volume than required to allow for some degree of inevitable shrinkage as the graft heals. In simpler cases, simultaneous connective tissue grafting can be considered. When bone grafting results in significant augmentation of bone volume, however, it is better to delay soft tissue grafting until later (before or possibly during stage 2 surgery when the implant or healing abutment is uncovered or abutment placement is performed) so that good primary closure of the wound can be achieved passively. In this patient, the flap was sutured using 6-0 monofilament polypropylene sutures, and the fixed partial denture was recemented after the pontic was adjusted to fit passively against the augmented ridge (Figs 7-1q and 7-1r).

## Step 3: Soft tissue augmentation

As expected, after 6 months the bone augmentation was sufficiently mature for reentry (Fig 7-1s). The site can be reopened with a sulcular incision on the adjacent teeth and a U-shaped incision on the palatal aspect of the implant that preserves the palatal blood supply to the papillae on both sides (Fig 7-1t). This can usually be done without vertical releasing incisions and with a split thickness flap that tunnels under the tissue labial to the implant and recipient site for creation of additional connective tissue. In Case 1, vertical releasing incisions were made so that the regenerated bone could be clearly visualized and the success of the graft confirmed.

It is suggested that at least 3 mm of tissue be retained coronal to the bone on the labial aspect of the implant to establish the necessary biologic seal, and a thicker tissue biotype will maintain a greater thick-



Fig 7-1r Provisional restoration is cemented with a resin-modified glass-ionomer cement. Note that the soft tissue contours are still inadequate.



Fig 7-1s Radiograph of the implant and graft in place shows good restoration of bone contours before stage 2 surgery.

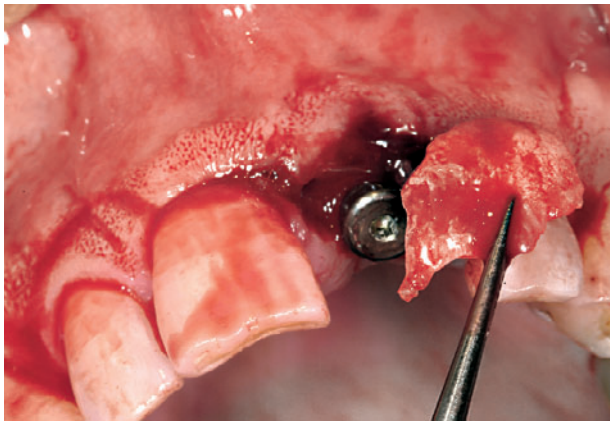


Fig 7-1t Stage 2 surgery 6 months later with healing abutment in place. A split-thickness dissection of labial flap creates the recipient site for a connective tissue graft, which will thicken the labial peri-implant tissue.

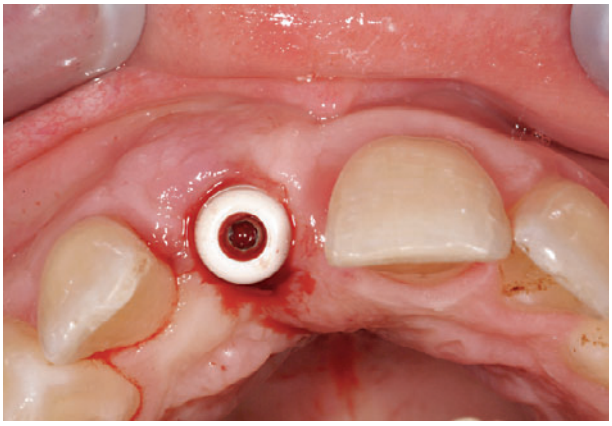


Fig 7-1u Example of an alternate approach where simple small roll flap at stage 2 surgery after a connective tissue graft has been completed at stage 1 surgery to thicken the tissue. A small U-shaped incision is made and the tissue surface is de-epitheliali-zed. The small tissue is then rolled under the labial gingival margin to increase the tissue volume labial to the healing abutment.

ness of peri-implant tissue (ie, the thicker the tissue, the less recession observed). Therefore, it is essential to augment the connective tissue.

It is often noted that at stage 2 surgery, the tissue overlying the regenerated bone is relatively thin. If the implant were to be uncovered and the transmucosal component placed at this stage, and if the tissue were only 1 mm thick, then the bone would have to remodel apically to establish the sufficient thickness to create the necessary biologic seal that comprises a sulcus, an area of junctional epithelium, and a connective tissue zone above the bone. However, the need is reduced for this remodeling (see Fig 7-1t) if an adequate volume of tissue is present at stage 2 surgery, created either by *(1)* connective tissue grafting at stage 2 surgery





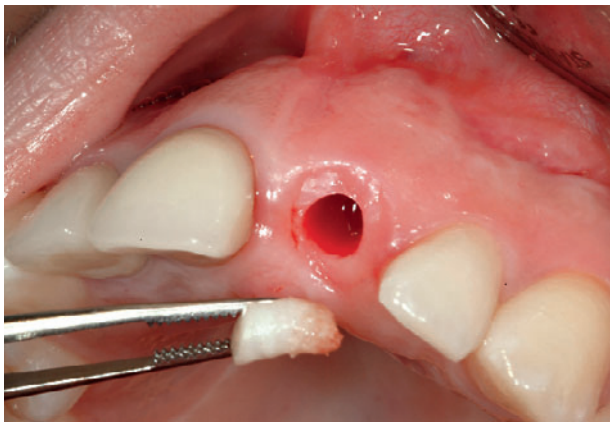


Fig 7-1v Example of a tissue punch procedure, which is appropriate only when the tissue thickness is sufficient, eg, when a previous graft has already been completed.

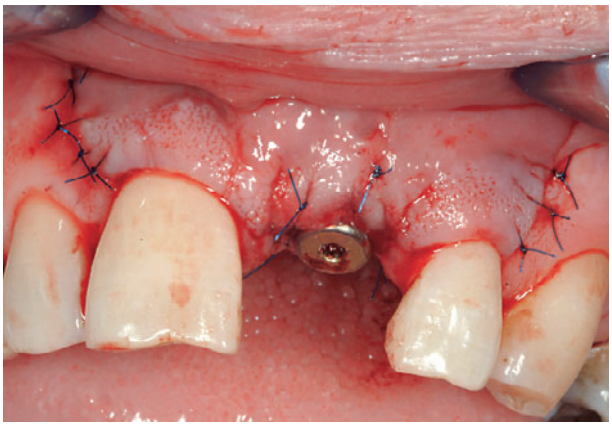


Fig 7-1w Flap and graft are sutured.

or *(2)* connective tissue grafting prior to uncovering of the implant followed by a simple roll flap (Fig 7-1u), or tissue punch procedure if the tissue over the implant already has sufficient thickness (Fig 7-1v). In any case, good passive adaptation of the tissues to the components and precise suturing of incisions is important to minimize creation of scars (Fig 7-1w).

## Step 4: Transmucosal component design and material

As discussed earlier, the transmucosal components should be kept narrow near the implant level with a concave form that flares late to the tooth contour. This will help to maximize the thickness of tissue around the neck of the implant restoration (Fig 7-1x). If a healing abutment is used, it should be narrow, and abutment placement should be followed by placement of narrow transfer impression copings (Figs 7-1y and 7-1z) to maintain the maximum tissue thickness on the labial aspect of the tooth.

Evidence increasingly suggests that zirconia offers advantages as the material of choice in the transmucosal zone (ie, for the abutment or for the transmucosal aspect of a screw-retained restoration) in terms of its color and influence on tissue color,[57] its biocompatibility, and its influence on tissue adaptation and health.[10–12]

## Step 5: Provisionalization

Ideally, a custom zirconia abutment is fabricated to allow for a crown margin that is positioned approximately 1 mm below the final desired gingival margin. The ideal transmucosal contours can be developed on the cast and then transferred to the mouth with a provisional crown that

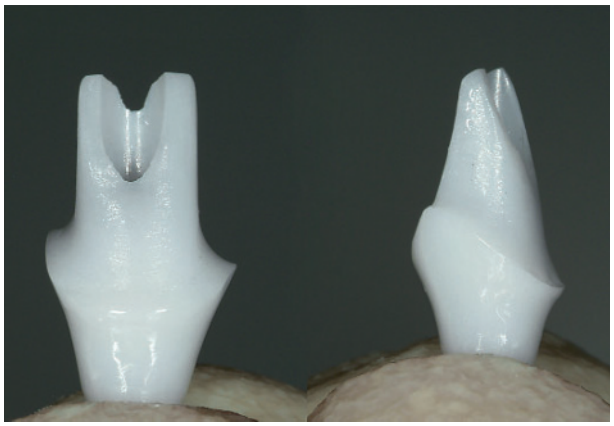


Fig 7-1x Example of the ideal contours for the abutment from the facial *(left)* and lateral *(right)* views highlights the maintenance of a narrow or undercontour at the level of the implant head that flares late to the full contour of the crown. This maximizes the available space for soft tissue.



Fig 7-1y Tissue healing at 3 months.



Fig 7-1z A narrow impression coping is used to transfer the implant position to the model.



Fig 7-1aa Custom zirconia abutment torqued into place.

can be modified as necessary to develop the appropriate soft tissue contours (Fig 7-1aa). A concave labial profile is maintained for the abutment as much as possible to allow for slight undercontour on the labial transmucosal area, which prevents apical migration of the tissue.

## Step 6: Careful cementation

The use of retraction cord during cementation of the crown (whether provisional or definitive) is essential to ensure that no excess cement travels into the submucosal area, because this can lead to peri-implantitis and therefore compromise the result.



Fig 7-1bb Definitive restoration at loading shows position of labial tissue and proximal tissue contours.



Fig 7-1cc Definitive restoration at 5 years postoperatively. Note the stability of the labial tissue, which is contrary to what is commonly anticipated and, if anything, is now in a more coronal position, while the papillae remain slightly deficient as expected.

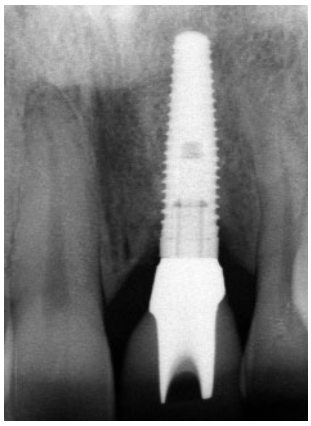


Fig 7-1dd Follow-up radiograph 3 years postoperatively.

Figure 7-1bb shows the final crown at cementation. The adjacent central incisor has been restored with resin composite. The patient was instructed to maintain optimal plaque control, and the clinician should explain that continued maturation of the tissues, particularly the papillae, will take place over time.

This case and others previously published by the author (see References) demonstrate that the approximately 1 mm of labial recession that is commonly reported can be avoided if clinicians follow the protocols described. The 3- and 5-year follow-ups (Figs 7-1cc and 7-1dd) shows that the labial gingival margin has not receded and, if anything, is now in a slightly more coronal position than at the crown placement. As expected, the papillae have somewhat improved, but because of the triangular form of the teeth and the various issues discussed in the evaluation of this case, the papillae are not complete. However, because there was no evidence of the original natural papillae positions, the end result may be as good as what was there previously.

## Case discussion

In review, the successful restoration of an implant in the esthetic zone is not reliant on any single feature but rather on a number of factors that combine and interact to create the desired result. The synergy of bone, soft tissue, and implant components, combined with a clear understanding of the key steps in the case management, are essential if stable esthetic outcomes are to be created, particularly in relation to the stability of the soft tissue contours.

## Case 2: Failing Teeth in the Esthetic Zone

While the overriding principles of clinical management of failing teeth remain largely the same as the management of the edentulous site, it is important to make some significant distinctions in the goal of the treatment. In the restoration of an edentulous site, the goal is to reconstruct and restore the appropriate soft tissue contours around the final crown. Management of the failing tooth, however, can be broken into two distinct kinds of cases: *(1)* the failing tooth where the bone and/or soft tissues are already significantly compromised; and *(2)* the failing tooth with intact labial and interproximal bone and an ideal or slightly compromised soft tissue contour. Case 2 presents a challenging example of the latter situation for possible implant treatment.

### Treatment approaches

In patients with significantly compromised tissues, a clinician is likely to perform either a delayed implant approach—where the tooth is extracted, soft tissues are allowed to heal, and the site is treated in more or less the same manner as the edentulous site above—or perhaps a socket preservation technique. Both approaches have been described in detail.[34,35,40,58] In patients with intact bone and intact or only slightly compromised soft tissues, the goal of treatment is to preserve the existing soft tissue contours or perhaps improve them if necessary. Typically, this slight compromise would be in the form of minor labial recession or discrepancy in the labial gingival margins.

Immediate implant placement using a flapless technique has been shown to offer a viable esthetic alternative for the replacement of failing maxillary anterior teeth in the esthetic zone. As previously mentioned, recession and labial volume loss are challenges that should be addressed in these cases, and additional treatment and surgical steps may be required (eg, orthodontic extrusion, grafting of biomaterials, and tissue grafting) to ensure the ideal soft tissue outcomes.[18,19,59–61] Orthodontic extrusion (see Chapter 6) is often recommended as a way to bring the labial gingival tissue to a more coronal position and then allow for remodeling to take place after the implant is placed at the correct level. However, the main drawback of this technique is that it is not always feasible to extrude a tooth—for example, if there is a failing endodontic treatment, vertical root fracture, or ankylosis. In addition, the technique may not be the best option for thin gingival biotypes. These additional steps require a higher degree of surgical skill and are by no means easy when working in a small site such as an extraction socket. In addition, it is not possible to say at this time that cases with a thin tissue biotype have reliable predictability. These cases certainly present a greater challenge, and the clinician may be wise to

take a more cautious route, using either a socket preservation or delayed implant placement approach.

From a biologic perspective, the challenge in these cases is the same as in the compromised site—ie, that the clinician needs to establish a stable bone contour, soft tissues of adequate thickness for the biologic seal, and final gingival contours that are stable and esthetically appropriate.

## Presentation and evaluation

A 33-year-old woman was referred to the practice with a failing maxillary left central incisor. Both central incisors had been crowned for years, and a recent attempt had been made to remake the crowns. The left central incisor, however, although asymptomatic, presented with a fracture that the referring clinician estimated extended some 5 mm subgingivally. The general dentist placed provisional restorations and subsequently referred the patient to us. The patient was extremely nervous and found it very difficult to undergo dental treatment.

Once again, the patient should be evaluated carefully to examine the main challenges and prognostic factors that may influence the likely outcome:

- The patient has a large smile and a high lip line (Fig 7-2a), and demands a high level of esthetics.
- The maxillary central incisors are prominent and dominate the smile.
- Thin tissue over the failing root is determined by the way the dark underlying tooth structure shows through in Figs 7-2a and 7-2b, and by the prominent root architecture (Fig 7-2c).
- The position of the labial gingival margin is slightly higher on the failing tooth than on the contralateral central incisor.
- The presence of a deep root fracture in the distal aspect of the tooth means probable loss of bone in the interproximal area. The papilla is puffy and inflamed on the distal aspect of the left central incisor (see Figs 7-2b and 7-2d).
- The radiograph shows that the interproximal bone between the central and lateral incisors is in a fairly apical position (Fig 7-2e). This may be due to the root proximity or to resorption because of the fracture. However, the interdental papilla here is in a markedly coronal position (see Fig 7-2a), well outside of the Tarnow 5 mm rule (see Chapter 6), so it is unlikely that an ideal distal papilla can be achieved on the future implant restoration.
- The central incisors are a little long relative to the lateral incisors. There is evidence of altered passive eruption on the lateral incisors, as the gingival margins are in a more coronal position than is desirable (see Fig 7-2a).





Fig 7-2a Case 2 at presentation. Note high lip line on the smile and discoloration of gingival tissue above the failing incisor.



Fig 7-2b Anterior view of the teeth at presentation.



Fig 7-2c Oblique view highlights the prominent root architecture and vestibular concavity.



Fig 7-2d Occlusal view shows the inflamed tissue distal to the left central incisor.

In this case, it would be ideal to complete some orthodontic extrusion of the failing root. This would improve the level of the labial gingiva (although not the thickness) and may bring the interproximal bone crest to a more coronal position to help create a "perfect" papilla on the distal aspect of the failing incisor. However, as is often the case, there was concern about the extent of the root fracture and possible increased bone loss from infection.

An impression was made of the right central incisor to make an immediate provisional restoration in the form of a cantilevered fixed partial denture with a hollow pontic for the failing tooth. This type of provisional restoration is useful because it allows the clinician to extract the failing tooth and decide whether to place an immediate implant once a clear view of the socket is gained and the situation can be appropriately assessed. In some cases it may be feasible to place a provisional restoration



Fig 7-2e Preoperative radiograph shows the apical position of the bone distal to the failing incisor.





on the implant at the time of immediate placement. In this type of situation, however, the possibility of immediate placement is never certain because of the risk that important labial bone has been damaged by infection. It is important to have an alternate provisional restoration in the event that the clinician is unable to place the implant or feels that immediate provisionalization of the implant is not possible or advisable. This "backup" restoration can either be a Rochette-type partial denture, a fixed partial denture (used here), or a removable partial denture.

The basic principles in the management of Case 2 are very similar to those in Case 1. The application may vary slightly with the individual case parameters, nevertheless the concept remains the same.

## Step 1: Careful extraction and evaluation of the site

After the crown was removed, the extent of the fracture could be fully realized (Figs 7-2f to 7-2h). It is important to remove the tooth in a manner that minimizes trauma to the bone and tissues. The use of magnification is particularly helpful in these cases, and the author routinely uses 4.8× magnification loupes. Once the tooth is successfully removed, the socket is carefully debrided under magnification, and the bone is evaluated to ensure that the labial plate is intact. Patients are given prophylactic antibiotics (eg, penicillin V 250 mg 4 times a day, cephalexin 500 mg 2 times a day, or clindamycin 150 mg 4 times a day) for 5 days, with the initial dose given just prior to surgery.

Figures 7-2i and 7-2j show the socket immediately after tooth removal. The distal aspect reveals the inflammation and ingrowth of tissue and the likely bone loss in this area. At this point, a decision must be made whether to continue with an immediate implant placement or to pursue a delayed approach of some kind.

The main complication here is the loss of distal proximal bone. However, it is important to realize that regardless of the treatment plan chosen, it is unlikely that complete maintenance of the distal papilla can be achieved on this tooth. To date there are no techniques available that can guarantee complete regeneration of this proximal bone. In fact, the flapless approach may better maintain the integrity and blood supply to the papilla and thereby offer the best possible result considering the circumstances. This is done through careful degranulation of the tissue below the bone level (or at least where the bone should be) while maintaining the superficial papilla integrity, grafting the area with anorganic bone mineral, and applying some enamel matrix protein (Emdogain, Straumann) to the adjacent root exposed by bone loss below the gingival tissues.



Fig 7-2f The extent of the fractures is evident after removal of the provisional crowns.



Fig 7-2g Occlusal view of fractured tooth.



Fig 7-2h The extent of the vertical fracture can be seen on the distal aspect of the root of the extracted tooth.

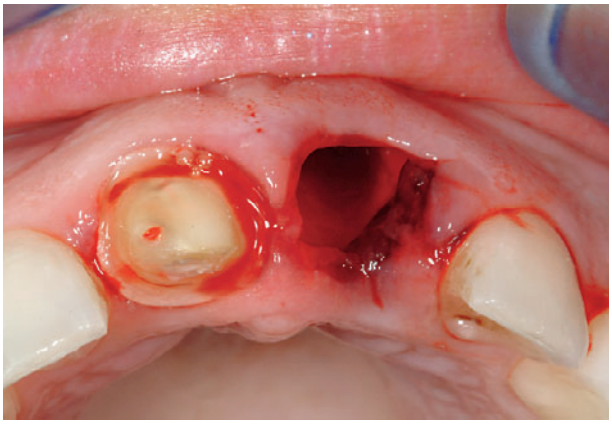


Fig 7-2i Occlusal view of the extraction socket. Note the inflammation and invagination of tissue on the distal aspect of the socket.



Fig 7-2j Anterior view of socket.

## Step 2: Correct implant placement

The next step in a case like this is to place the implant using commonly accepted protocols. The pilot hole should be prepared in the palatal wall of the apical third of the socket and the osteotomy performed so that implants are placed in the palatal aspect of the socket and lined up with the incisal edge. Any apical granuloma or defect should be thoroughly curetted and debrided through the socket. The implant is usually placed palatal to any apical defect, and depending on the size of the defect, it can be either left to heal spontaneously or packed through the socket with anorganic bone mineral (Bio-Oss) prior to implant placement. The implant head should be placed 3 mm apical and 2 mm palatal to the desired final gingival margin of the final restoration. A transfer impression of the implant can then be made for the laboratory to fabricate the abutment and provisional restoration, and a narrow healing abutment should be seated on the implant.

## Steps 3 and 4: Bone augmentation and soft tissue augmentation

Although there will be some remodeling of the bone contours regardless of what is done, the key is to reduce this as much as possible and compensate for the bone flattening by means of soft tissue augmentation. A space of approximately 2 mm should be left labial to the implant in the sockets, and anorganic bone mineral (Bio-Oss) or nonresorbable bone substitute should be packed firmly into the void between the implant and the labial bone to the level of the implant head (Fig 7-2k). This is necessary to minimize the shrinkage of labial bone volume during subsequent remodeling and helps to optimize the esthetic outcome. Because augmentation of the connective tissue is an extremely important step both to establish the necessary biologic seal and to maintain a greater thickness of peri-implant tissue, a labial connective tissue graft is then harvested from the palate and sandwiched between the healing abutment or the abutment and labial gingiva. This can be placed into a pouch produced by careful tunneling under the labial gingiva or, more commonly, between the abutment and labial tissue. The inner aspect of the labial tissue should be de-epithelialized and the graft secured into position with 6-0 or 7-0 monofilament polypropylene sutures (Figs 7-2l and 7-2m).

At this stage, the provisional restoration is tried in, and the pontic is adjusted, relined, and adapted to the healing abutment using provisional fixed partial denture material and flowable resin composite to create the appropriate contours to support the interproximal tissues (Fig7-2n). The fixed partial denture is provisionally cemented on the adjacent incisor and sits passively on the healing abutment. It is slightly undercontoured and short on the labial aspect to allow space for the soft tissue graft (Fig 7-2o).

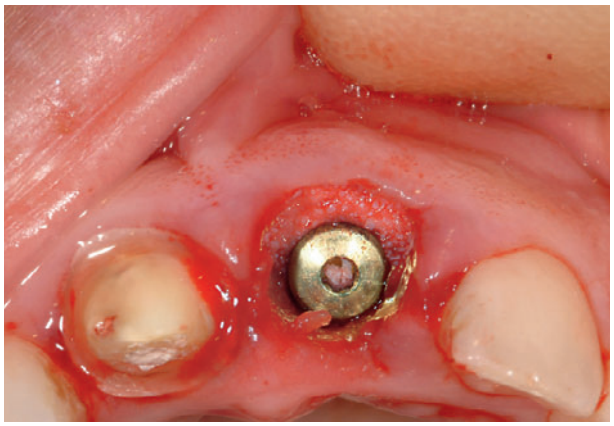


Fig 7-2k Implant correctly placed with space for the graft material, which is packed into the labial socket space between the implant and labial bone. A narrow healing abutment is placed.

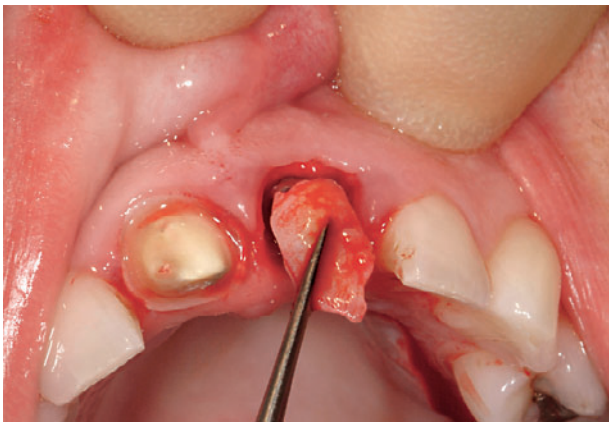


Fig 7-2l A connective tissue graft is harvested from the palate to be placed between the healing abutment and the labial tissue after de-epithelialization of the inner aspect of the labial tissue.

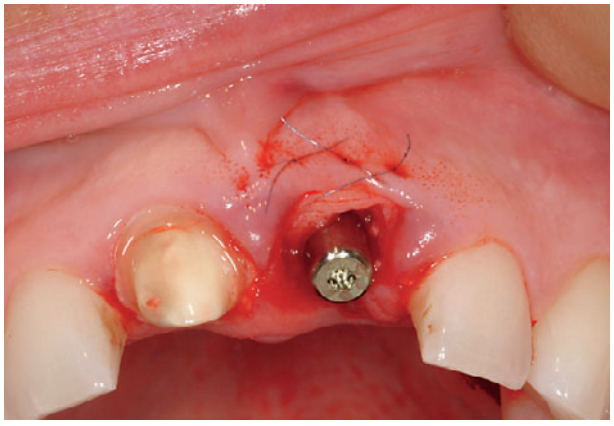


Fig 7-2m The graft is sutured precisely into place.



Fig 7-2n The provisional restoration shows how the pontic will adapt to the healing abutment.



Fig 7-2o Provisional restoration cemented in position immediately after surgery. Note the undercontour to allow space for soft tissue.

The patient was seen a 1 week postoperatively for suture removal (Fig 7-2p). The postoperative radiograph (Fig 7-2q) shows a narrow (or, in this case, platform-switched) healing abutment, and one can see the graft material attempting to regenerate as much as possible the lost bone on the distal aspect of the implant.

## Step 5: Transmucosal component design and material

The labial aspects of the abutment and restoration should be undercontoured in the transmucosal area to allow additional room for thicker soft tissue. If the implant is stable enough, then the abutment and provisional restoration can be placed a few weeks or even a few days after surgery. If the primary stability of the implant is uncertain, it is better to wait for at least 6 weeks. In Case 2, the abutment and provisional crowns were fitted at 3 months. The final abutment is preferably a custom zirconia abutment that is shaped to the appropriate contours as previously discussed (Fig 7-2r).

## Step 6: Provisionalization

The provisional crown is cemented with provisional cement at the same time as placement of the final abutment. It is imperative that retraction cord be placed prior to cementation to facilitate complete removal of excess cement and ensure that no cement is trapped in the subgingival area of the implant. Crown lengthening of the adjacent lateral incisors was performed by means of a simple gingivoplasty to determine the correct gingival contours (Fig 7-2s). The labial bone on these teeth was recontoured to establish the correct biologic width and labial contours, using a simple tunneling technique to gain access to the bone without the need to raise a flap. The tissues were left to mature and remodel, and the provisional crowns were refined over the next few months until the desired result was achieved (Fig 7-2t). At this stage, final impressions of the tooth and the abutment are made using conventional crown impression techniques.

## Step 7: Careful cementation

After impressions have been taken, the definitive restorations can then be fabricated using the appropriate bisque try-ins and adjustments until the desired outcome is achieved. Once again, retraction cord is essential when the crown is cemented on the implant to ensure that no excess cement travels into the submucosal area, especially where the concave form of the abutment would make removal difficult.



Fig 7-2p Healing 1 week postoperatively. Note the volume of tissue now present, although there is still some swelling.

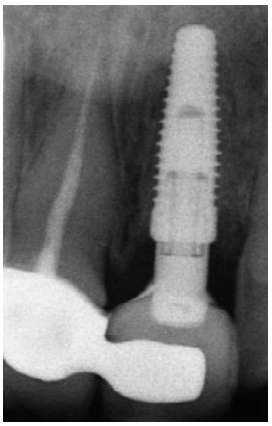


Fig 7-2q Postoperative radiograph of implant shows the bone graft filling any voids and the narrow platform-switched abutment.



Fig 7-2r Custom zirconia abutment is fitted; the healed tissue is well adapted to the abutment.



Fig 7-2s Provisional crowns in place and crown lengthening of the lateral incisors.



Fig 7-2t Maturation of tissue after 3 months.







Fig 7-2u Definitive crowns at 1 year.

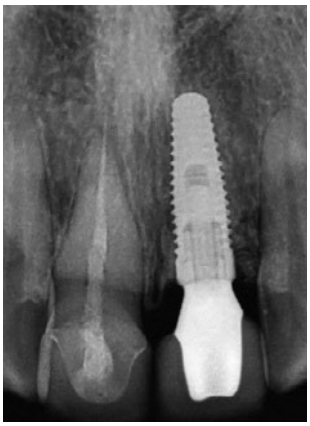


Fig 7-2v Follow-up radiograph at 1 year demonstrates the undercontoured abutment used with the platform switching technique. Note the good bone levels and the apparent regeneration of bone in the distal proximal area.



Fig 7-2w Close-up at 1 year demonstrates excellent stability of the labial tissue and slightly compromised distal papilla.

## Case discussion

Figures 7-2u to 7-2w show the final crowns at approximately 1 year postoperatively. As expected, the distal papilla is not ideal, but the radiograph (see Fig 7-2v) reveals good apparent regeneration of the bone in this area. Since maturation and remodeling of the papilla continues for as long as 3 years, further improvement of the papilla should be expected over time.

This case reinforces the author's view that the reported 1 mm or so of labial recession seen in the first year after implant restoration can indeed be avoided, even in immediate placement cases, by following the protocols described.

## Conclusion

Contemporary implant dentistry aims not only to restore function but also to create a lasting esthetic outcome. This is particularly important in the esthetic zone, where single-tooth replacement is frequently indicated. While optimal results can be accomplished predictably in simple cases, the achievement of ideal results is difficult in complex cases, which usually present with significant obstacles. Nevertheless, the protocols described in this chapter serve to highlight contemporary concepts that can maximize the outcomes in these cases. These principles, and the key steps described, form a sound basis for the successful restoration of single teeth with implants in the esthetic zone.

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