Received: 8 May 2022 | Revised: 24 June 2022 | Accepted: 26 July 2022

DOI: 10.1111/prd.12470

Periodontology 2000 WILEY

REVIEW ARTICLE

# Complications and treatment errors in peri-implant soft tissue management

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## 1 | INTRODUCTION

The soft tissue surrounding dental implants is called peri-implant mucosa. The characteristics of peri-implant mucosa are established during the wound healing process following implant placement or after connecting the prosthetic components. It is believed that the formation of a soft tissue seal around the implant ("transmucosal attachment") prevents toxic products from the oral cavity from reaching the bone tissue, therefore ensuring osseointegration and rigid fixation of the implant. This concept is the basis of current dental implantology, which is progressively becoming more oriented towards correct management of the soft tissues.[1–3]

Surgical soft tissue management can be carried out at different times during implant rehabilitation and can have different objectives based on the site in which the implant will be positioned.

The surgical techniques can be divided into two main categories: those that aim to increase the keratinized tissue height and those that aim to increase the thickness/volume of the tissues.

- The goal of keratinized tissue augmentation techniques is to obtain a band of keratinized tissue attached to the periosteum that increases the depth of the vestibular fornix and improves patient home care and plaque control.[4–7] This technique is commonly performed in the posterior area where aesthetics is not usually a concern.
- The goal of soft tissue thickness augmentation techniques is to create or restore the peri-implant supracrestal soft tissues by increasing their thickness and height from the bone crest to the mucosal margin; those tissues are crucial to obtain a natural emergence profile of the prosthetic restoration and to ensure a satisfying aesthetic result. These techniques are commonly performed in the anterior area.[8–10]

Predominantly, three main time points may be considered for soft tissue management: before implant placement, simultaneous to implant placement, and during second-stage surgery.

Complications are defined as "unexpected intercurrences happening during or after the execution of a treatment procedure that have the potential of modifying or jeopardizing the wound healing process and the anticipated effect of treatment". The effects of the complications are often evident only at the end of the therapy, but the error can be traced back to different phases of the treatment.

A medical error is a preventable adverse effect of care ("iatrogenesis"), whether or not it is evident or harmful to the patient. This might include an inaccurate or incomplete diagnosis or treatment of a disease, injury, syndrome, behavior, infection, or other ailment.

The aim of this article is to describe treatment errors and complications related to soft tissue management and suggest possible clinical solutions.

[Correction added on August 10, 2023, after first online publication: The affiliation for the author Giovanni Zucchelli has been updated.]

## 2 | COMPLICATIONS CAUSED BY DIAGNOSTIC ERRORS IN SOFT TISSUE MANAGEMENT THAT OCCURRED BEFORE IMPLANT PLACEMENT

"Diagnostic errors" mainly concern the lack of a correct presurgical soft-tissue evaluation of the implant surgical site. Before implant placement, in addition to the radiographic examination of the hard tissues, a clinical evaluation of the soft tissues is mandatory. If this assessment is not properly carried out, it follows that the surgical techniques for compensating the lack of soft tissues will not be performed, most likely resulting in a quantitative and/or qualitative soft tissue deficiency.

### 2.1 | Inadequate keratinized mucosa

In the last few decades, one of the most debated topics has been the role of keratinized mucosa around implants. According to the literature, the quantity of keratinized mucosa can be considered as present and adequate (≥ 2 mm), present and inadequate (< 2 mm), or absent (0 mm).[11,12]

For implants, as occurs with natural dentition, the absence of keratinized tissue in patients with good oral hygiene is compatible with peri-implant tissue health.[13,14]

Systematic reviews and meta-analyses on the role of keratinized mucosa in the maintenance of implant health have found a statistically significant difference only in the gingival index parameter, but not in the probing pocket depth or bleeding on probing.[2,15] Even if this partial evidence does not necessarily support the absolute indication for increasing keratinized mucosa, it suggests selective indications. For example, a typical scenario is when the lack of keratinized mucosa is associated with a reduced vestibular depth. This anatomic condition hampers proper hygienic maneuvers, thus leading to plaque accumulation, which in turn induces an inflammatory process.

Moreover, the complete absence of keratinized mucosa during implant surgery interferes with proper management of the flap incision, elevation, and closure.

The most suitable surgical technique to increase keratinized mucosa before implant placement is the free gingival graft.[16–18]

#### 2.1.1 | Case 1: A lack of keratinized tissue caused by a diagnostic error in the presurgical evaluation

In this clinical case (Figure 1), an implant in position #36 with reduced vestibular depth and complete absence of keratinized tissue presented recurrent episodes of mucositis. In such a situation, a free gingival graft[19,20] is recommended to improve patient home care and plaque control. Before the surgical procedure, a nonsurgical etiological therapy aimed at resolving the inflammatory condition was performed. At the same time the crown was removed and a healing abutment was placed to improve vascular supply to the soft tissues and to simplify access during the surgical procedure. The recipient bed was prepared by elevating a trapezoidal flap with a deep split-thickness incision, detaching the muscles from the periosteum. The epithelial-connective tissue graft was harvested from the palate: the apico-coronal dimension was related to the required entity of vestibular depth and the thickness was around 1.5 mm. The graft was sutured at the base of the anatomic papillae in the recipient site, then it was tightly adapted with a number of single interrupted sutures in the peripheral aspects and with compressive sutures anchored to the periosteum in the central portion. One month after surgery, the healing abutment was replaced with the preexisting crown. At 1 year, the increase in both depth of the vestibule and attached keratinized mucosa allows for good plaque control with no recurrence of mucositis.

### 2.2 | Horizontal and/or vertical soft tissue deficiencies

Obtaining an ideal soft tissue integration that mimics a perfect gingival contour in the interproximal area is of paramount importance when dealing with aesthetic concerns.[21,22]

Following tooth extraction, the soft tissue volume in the edentulous area is often inadequate when compared with the adjacent teeth.

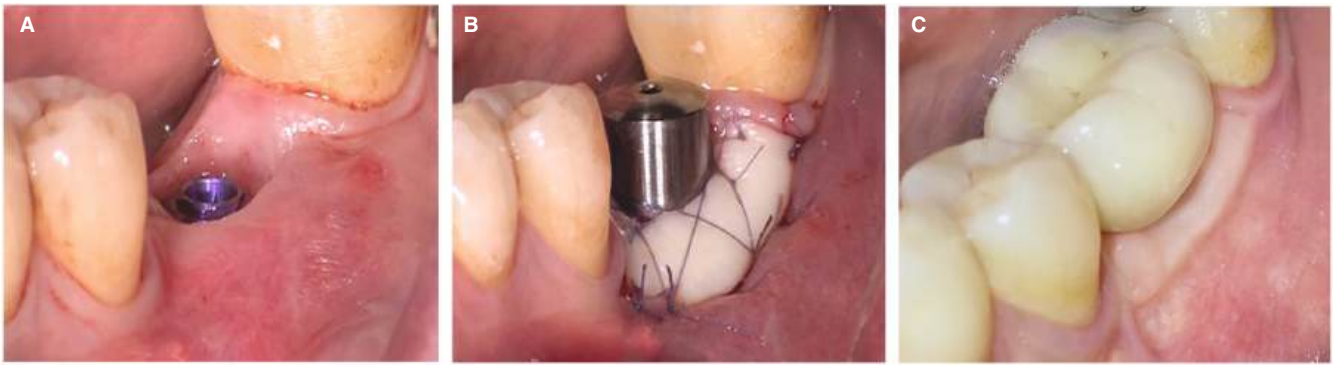


FIGURE 1 Lack of keratinized tissue. A, Mucositis caused by reduced vestibule depth and absence of keratinized tissue. B, Free gingival graft fixation. C, Clinical situation 1 year after treatment. Note the increased vestibule depth and increased keratinized tissue width

Placing an implant in supracrestal soft tissues with a volumetric deficiency can cause two types of soft tissue aesthetic complications:

- A vertical deficiency leading to misalignment of the facial gingival margins and/or a lack of papilla height.
- A horizontal deficiency leading to a grayish discoloration of the mucosa and/or an inadequate emergence profile.

According to the recent classification of facial peri-implant soft tissue dehiscence/deficiencies at single implant sites in the aesthetic zone,[23] these soft tissue defects can present alone or in combination and can be divided into four classes and three subclasses. The classes are based on the amount of apical displacement of the mucosal margin and on the implant-supported crown/implant head position, while the subclasses depend on the papilla height.

### 2.2.1 | Case 1: Horizontal soft tissue deficiency caused by a diagnostic error in presurgical soft tissue evaluation

In this clinical case (Figure 2), the level of the gingival margin at the implant-supported crown in the maxillary right lateral incisor position corresponded to that of the homologous contralateral tooth, but a horizontal bucco-lingual deficiency was present (Class 1) with interproximal papillae height greater than 3 mm (Subclass A).[23] This horizontal tissue deficiency led to an incorrect emergence profile of the crown and caused the visibility of the grayish implant components by transparency. To increase the thickness, a connective tissue graft was applied and covered by a coronally advanced flap.[24,25] At 1 year, the increase in soft tissue thickness enabled masking the underlying implant structures and improved the emergence profile of the implant-supported crown, leading to a satisfactory aesthetic appearance.

### 2.2.2 | Case 2: Horizontal and vertical soft tissue dehiscence caused by a diagnostic error in presurgical soft tissue evaluation

When apical displacement of the buccal mucosal margin is associated with shallow interproximal papillae dimension (height < 3 mm, Class 3, Subclass B),[23] a combined surgical prosthetic approach is indicated (Figure 3).[26–28] The preexisting, implant-supported crown in the maxillary left central incisor position was removed and an abutment with reduced mesio-distal dimensions was placed along with a short provisional crown. This phase, lasting about 3-4 months, allowed soft tissue maturation and thus provided a wider recipient bed for both the connective tissue graft and for adaptation of the surgical papillae. A coronally advanced flap of trapezoidal design,[29] covering a connective tissue graft, was performed. After flap closure, the crown provisional was modified, to avoid any contact with the soft tissues allowing undisturbed healing and maturation. At the end of this phase, when the healing was considered complete (3-4 months after surgery), a second prosthetic phase of tissue conditioning with a new screwed retained provisional crown was carried out. The goal of this phase was to scallop the marginal soft tissues to make it as similar as possible to the gingival margin of the natural

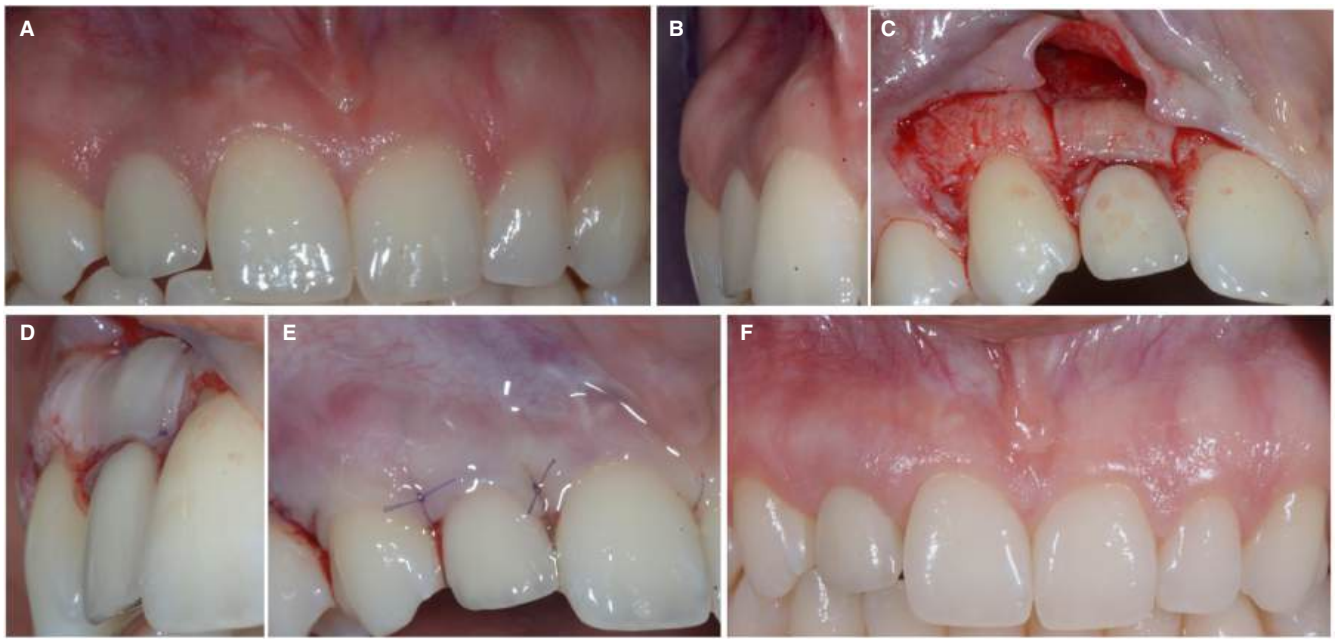


**FIGURE 2** Horizontal soft tissue deficiency. A, Vestibular aspect of the soft tissues around the implant in position 1.2. B, Profile view showing the horizontal deficiency. C and D, Connective tissue graft compensating the horizontal gap. E, Coronally advanced flap completely covering the graft. F, One-year healing

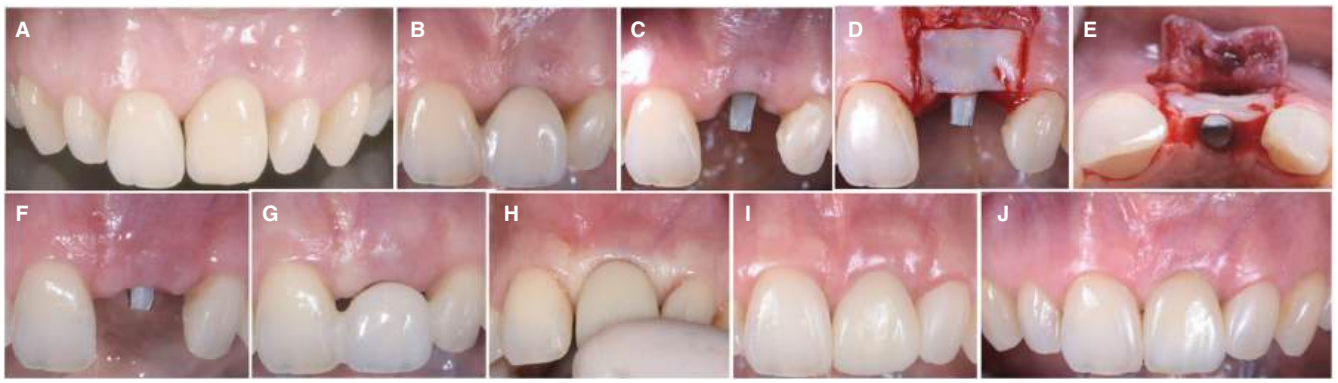


FIGURE 3 Vertical soft tissue dehiscence. A, Vestibular aspect of the soft tissues around the implant in position 2.1. B and C, Soft tissues appearance after 4 months with short provisional crown and modified abutment. D and E, Connective tissue graft sutured at the base of the increased interproximal soft tissues. F and G, Soft tissues at suture removal and after 4 months of healing. H, Soft tissue conditioning. I, Soft tissues aspect at the end of the conditioning phase. J, Definitive restoration and aesthetic appearance after 3 years

homologous tooth and to promote the coronal growth of the papillae through modifications of the profiles of the provisional crown. The final restoration was delivered when the position of the buccal mucosal margin was aligned with that of the target tooth (ie, the 1.1) and when papillae filled the interproximal spaces completely. At 3 years, complete dehiscence coverage was achieved, leading to correct alignment of the gingival margins in the frontal area and to a successful aesthetic result.

### 2.2.3 | Case 3: Horizontal and vertical soft tissue dehiscence with a lack of papillae caused by a diagnostic error in presurgical soft tissue evaluation

When apical displacement of the buccal mucosal margin is associated with severe interproximal papillae loss, or complete lack thereof (Class 3, Subclass C),[23] a soft tissue augmentation procedure with submerged healing is recommended (Figure 4).

Only a limited number of studies have described the treatment approach to reconstruct interdental papilla between an implant and a periodontally compromised tooth. One of these studies recently described a novel approach to restore a buccal soft tissue dehiscence combined with loss of peri-implant papillae and periodontal attachment on the adjacent teeth.[30]

Briefly, before surgery, the implant crown was removed, the abutment was replaced with a cover screw, and a temporary Maryland bridge was placed. The clinical plan was to treat the implant site as if it was an edentulous area, using a modification of the connective tissue platform technique[31–34] to solve the horizontal and the vertical component of the peri-implant soft tissue defect. The wide mesial and distal peri-implant papillae were de-epithelialized on the supracrestal surface, acting as a "partial" platform, unto which the connective tissue grafts could be sutured. This surgical approach allows not only an improvement in the level of the buccal soft tissues, but also an augmentation of the interproximal tissue height and volume, thus leading to a successful aesthetic result.

## 3 | SOFT TISSUE COMPLICATIONS CAUSED BY TREATMENT ERRORS THAT OCCURRED DURING IMPLANT PLACEMENT

Incorrect implant placement is the main causal factor for the occurrence of peri-implant soft tissue defects. In fact, proper implant planning and positioning are crucial aspects for keeping an ideal and harmonic soft tissue appearance over time.[35] In recent years, specific software programs have become available for planning implant surgery. Combining the cone beam computed tomography images with an intra-oral digital scan makes it possible to plan the ideal implant position virtually, while considering the surrounding vital anatomic structures and future prosthetic needs.[36,37] Recent systematic reviews concluded that, in comparison with manual implant insertion, guided implant placement leads to greater positioning accuracy.[38,39] In particular, the data analyzed concerned the angular and three-dimensional bodily deviation between the planned and final implant positions. The observed angular deviation values were generally greater in free-handed implant placement (6.90 ± 4.40 to 9.92 ± 6.01°) in comparison with partially guided (3.50 ± 1.60 to 8.43 ± 5.10°) and computer-aided (2.20 ± 1.10 to 5.95 ± 0.87°) modalities. The three-dimensional bodily deviations exhibited a less drastic but similar pattern between free-handed (coronal: 1.25 ± 0.62 to 2.77 ± 1.54 mm; apical: 2.10 ± 1.00 to 2.91 ± 1.52 mm), partially guided (coronal: 1.12 ± 0.10 to 2.97 ± 1.41 mm; apical: 1.43 ± 0.18 to 3.40 ± 1.68 mm), and computer-aided (coronal: 0.54 ± 0.33 to 2.34 ± 1.01 mm; apical: 0.90 ± 0.43 to 2.53 ± 1.11 mm) implant placement.[38] This means that the main predisposing factor for peri-implant dehiscence occurrences is related to incorrect implant positioning in any of the three dimensions.[40,41]

The rules commonly applied to plan the ideal implant position are extrapolated from a few prospective studies and case series[42–47] and include four spatial parameters. The angulation and buccolingual position are determined in relation to the future restoration. Ideally, the projection of the longitudinal implant axis should be slightly palatal to the incisal edge of the future restoration.[46,47] The

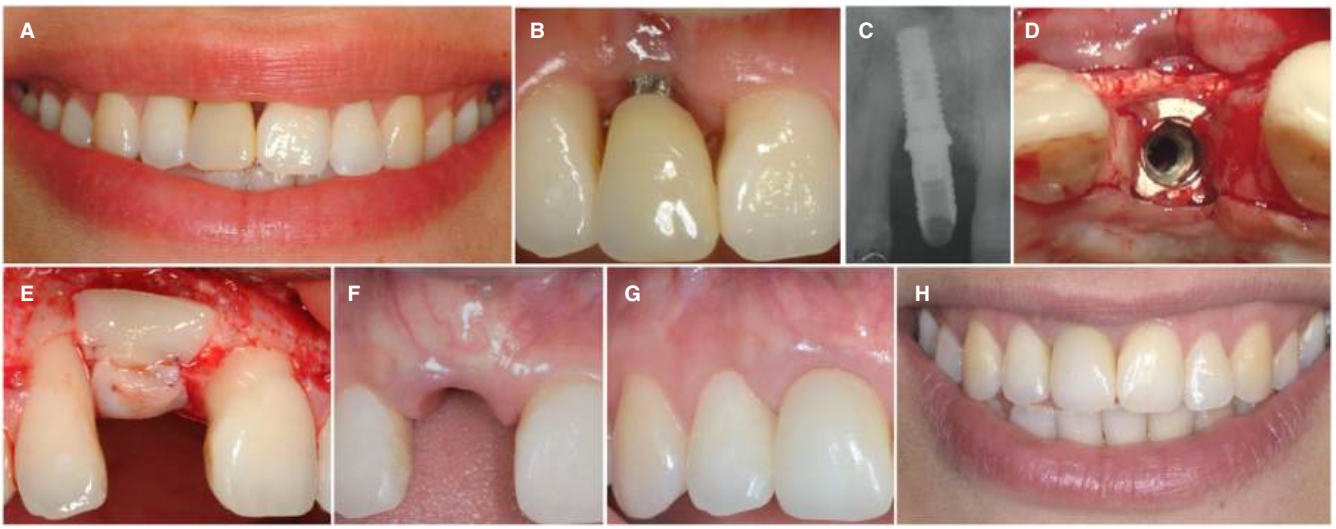


**FIGURE 4** Horizontal deficiency and vertical dehiscence with a lack of papilla. A–C, Smile of the patient and clinical and radiographic pictures showing the baseline situation. D, Occlusal view of the connective platform. E, Connective tissue grafts sutured buccally and above the platform compensating for both the horizontal and vertical defect. F and G, One-year healing. H, Smile of the patient after 3 years

mesio-distal position[42,43] should ensure a safe distance of at least 1.5 mm between the implant and the adjacent teeth and 3 to 4 mm between the implants. Respecting these parameters not only prevents damage to the adjacent root structures but also aids in the preservation of interproximal peri-implant bone and soft tissue volume.[40,48] The apico-coronal position[42,44–46] in aesthetic areas should be established in relation to the position of the gingival margin of adjacent teeth. Ideally, the osteo-integratable implant surface should be positioned between 3.5 and 4 mm apical to the ideal position of the gingival margin.

## 3.1 | Errors in angulation and buccal position

In many clinical situations, incorrect implant angulation leads to a soft tissue defect.[49,50] Errors in angular position are defined as the angular discrepancy (measured in degrees) between the actual and ideal implant positions with respect to the center of the implant body. Clinically, the angulation error is the value of the angle comprised between an impression coping placed on the implant (acting as a direction indicator) and the ideal final position of the abutment. Regarding treatment, the primary aspect to be considered is the entity of the angulation error, which can be corrected up to a certain extent with the use of angulated abutments. If angle correction allows the abutment axis to have an acceptable inclination for an adequate emergence profile of the prosthetic element, then the soft tissue defect can be treated surgically.

Apart from the angulation, malposition can also concern the body of the implant (ie, three-dimensional bodily deviation). This error is defined as metric discrepancy (measured in millimeters) between the actual and ideal implant position in the bucco-lingual plane relative to the coronal and apical-most regions of the implant body.[38]

Both of the aforementioned errors can cause an incorrect emergence profile of the crown, which is why the restoration should be removed to allow adequate evaluation of the implant head's position. After this assessment, the treatment approach is planned in relation to the interproximal soft tissue dimensions.

### 3.1.1 | Case 1: Soft tissue dehiscence and fenestration caused by errors in angulation (< 40 degrees) and buccal position

In this clinical case (Figure 5), a soft tissue dehiscence was caused by a very buccal implant position (Class 4) associated with a fenestration resulting from a severe angulation error. The papilla height, measured as the distance between the tip of the papilla and the ideal position of the mucosal margin, was less than 3 mm (Subclass B).[23] This complication can be managed with a two-step procedure: soft tissue augmentation with submerged healing to treat the soft tissue defect, and a second uncovering surgery with the placement of an angulated abutment to correct misangulation. The goal of the submerged healing surgery was to increase the thickness of the vestibular soft tissues while also closing the fenestration. A trapezoidal flap was designed and after its elevation a connective tissue graft was placed above the cover screw and extending 2-3 mm apically over the buccal bone. The flap was coronally advanced and sutured to the occlusal connective tissue platform.[31–33]

The second surgery was performed 3-4 months after healing. A buccal incision, aiming to maintain at least 2 mm of soft tissue thickness at the buccal flap, allowed access to the implant head. Once the cover screw was removed, a new digitally planned custom-made, angulated welded implant abutment was inserted: its function was to compensate for the incorrect implant axis and to relocate the screw channel access in a more coronal position; flap closure was performed. This new system is custom designed based on the required angular correction and consists of two milled titanium components welded together, and an angulated screw. It is able to provide a correction

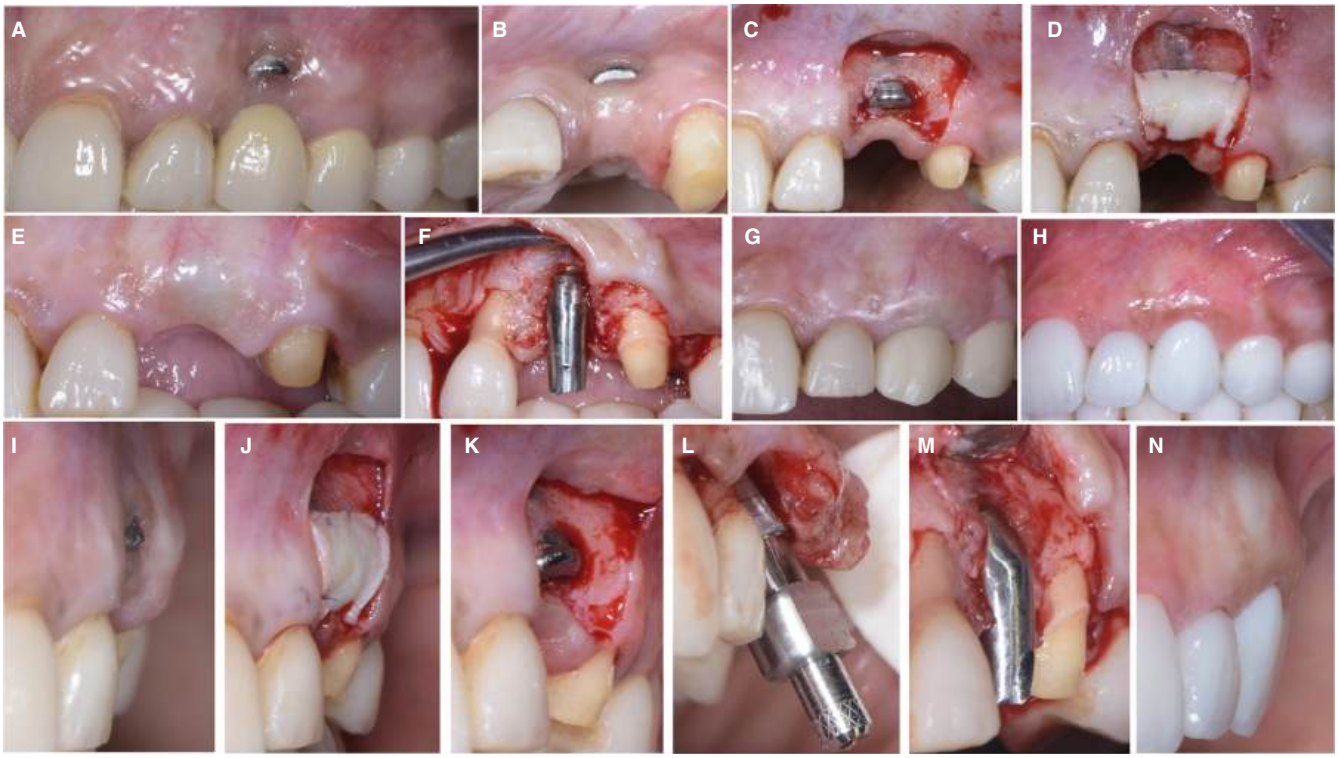


**FIGURE 5** Soft tissue dehiscence and fenestration caused by errors in angulation and the buccal position. A and B, Baseline clinical situation showing soft tissue dehiscence and fenestration. C, Flap elevation. D, Connective tissue graft fixation. E, Four months of healing. F, Second surgery and welded abutment positioning. G, Conditioning phase. H, Final restoration. I–N, Profile pictures showing baseline, graft, reopening, angulation correction, and the final result

of up to 40 degrees, along with the modification of the access to the screw channel, providing a surface on the vestibular aspect of the abutment that allows placement of a suitable prosthetic restoration.

After soft tissue healing and conditioning, an ideal position of the mucosal margin was achieved and definitive restoration with a correct emergence profile was delivered.

### 3.1.2 | Case 2: Soft tissue dehiscence caused by errors in angulation (> 40 degrees) and buccal position

When a soft tissue dehiscence is caused by buccal malposition in addition to an angulation error greater than 40 degrees, regardless of the interproximal soft tissue conditions, it is not possible to improve aesthetics by means of mucogingival procedures without removing the implant because there are currently no abutments capable of compensating for this amount of malposition (Figure 6).

### 3.1.3 | Case 3: Soft tissue dehiscence with a lack of papillae height caused by an error in the buccal position

When buccal implant malposition is associated with the loss of peri-implant papillae (the papilla tip is at the same level or apical to the ideal position of the soft tissue margin of the implant-supported crown), there is no possibility of improving the aesthetic situation with mucogingival techniques (Class 4, Subclass C) (Figure 7).

## 3.2 | Errors in the mesio-distal position

Root proximity to the implant site should be carefully evaluated. A minimum of 1.5 mm of bone between teeth and implants is required because if implants impinge on this distance, the residual thin bone could resorb, resulting in reduced support for the overlying soft tissues.[40] However, when evaluating an interproximal soft-tissue defect caused by a mesio-distal malposition, the amount of space for the soft tissues between tooth and implant determines the possibility for correction. Radiographic evaluation in the anterior areas does not represent a reliable diagnostic tool because of the curvature of the dental arch, which precludes an accurate linear measurement of the distance between the tooth and the implant. This space must be evaluated clinically by removing the crown and abutment and measuring the distance between the implant head and the adjacent tooth with a periodontal probe. At least 1.5 mm of interproximal soft tissue width must be present to ensure adequate support for soft tissue reconstruction; if the remaining space is narrower, the defect cannot be corrected with mucogingival surgery.

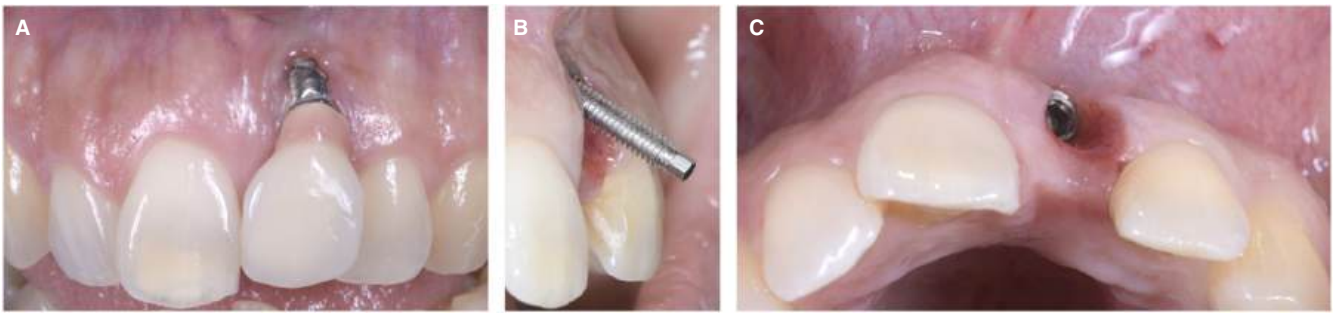


**FIGURE 6** Soft tissue dehiscence caused by errors in angulation and the buccal position. A, Buccal view showing the apical displacement of the mucosal margin. B, Evaluation of the angulation error after crown removal. C, Occlusal view of the buccal malposition

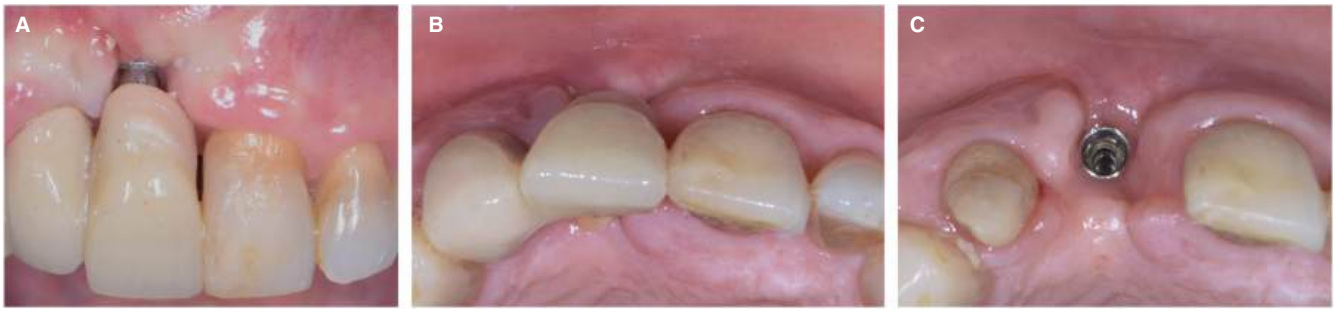


**FIGURE 7** Soft tissue dehiscence caused by an error in the buccal position. A, Buccal picture showing the soft tissue dehiscence with an absence of interproximal papillae. B and C, Occlusal view with the crown and after removal showing the buccal malposition

### 3.2.1 | Case 1: Soft tissue dehiscence with a lack of papillae height caused by an error in the mesio-distal position

In this clinical case (Figure 8), a buccal soft tissue dehiscence affecting the implant in the maxillary right central incisor position with lack of distal papilla height (Class 3, Subclass C)[23] associated with an error in mesio-distal positioning was present.

The close proximity between the implant and the lateral incisor did not allow the soft tissues to adequately fill the interproximal space, resulting in unacceptable aesthetics. However, after crown removal, the distance between the tooth and the implant, measured clinically, was greater than 1.5 mm. This consented performing a soft tissue augmentation procedure with submerged healing to correct the soft tissue defect. The first step involved removal of the crown and abutment and placement of a cover screw to promote soft tissue regrowth. A temporary Maryland bridge was placed without soft tissue contact. After 3 months of tissue maturation, the connective tissue platform surgical technique was performed. In the edentulous area, two parallel horizontal crestal incisions were designed. These incisions, connecting the line angles of the central and the lateral incisors on the vestibular and on the palatal aspect, delimited an area of soft tissue called "platform". The occlusal aspect of the platform was de-epithelialized so that the exposed connective tissue could be used for anchoring the connective tissue graft. The graft was placed on top of the cover screw and stabilized with internal mattress sutures anchored to the occlusal surface of the distal portion of the connective tissue platform. This first graft was used to compensate for the apico-coronal difference in levels between the cover screw and the occlusal surface of the platform. A second graft was applied buccally, covering the exposed implant surface, and was fixed with single interrupted sutures at the vestibular aspect of the connective tissue platform. Primary intention flap closure was accomplished with submerged implant healing. After a 4-month healing phase, the implant was uncovered with a flapless "punch" procedure. Soft tissue conditioning was performed with a screwed-retained provisional crown. The final goal was to contour the marginal soft tissue in order to make it as similar as possible to the gingival margin of the natural homologous tooth and to promote the coronal growth of the papillae through modifications of the interproximal profiles of the provisional crown and the coronal displacement of the contact points.[30] At 1 year after final restoration placement, complete root coverage of the lateral incisor along with resolution of the implant's soft tissue dehiscence and a satisfactory interproximal soft tissue filling of the distal implant papilla were obtained.

### 3.2.2 | Case 2: Soft tissue dehiscence with a lack of papillae height caused by an error in the mesio-distal position

In this case (Figure 9), there is a deficiency of interproximal soft tissues between the implant and the central incisor, which also exhibit distal attachment loss. The reduced mesio-distal dimension of the

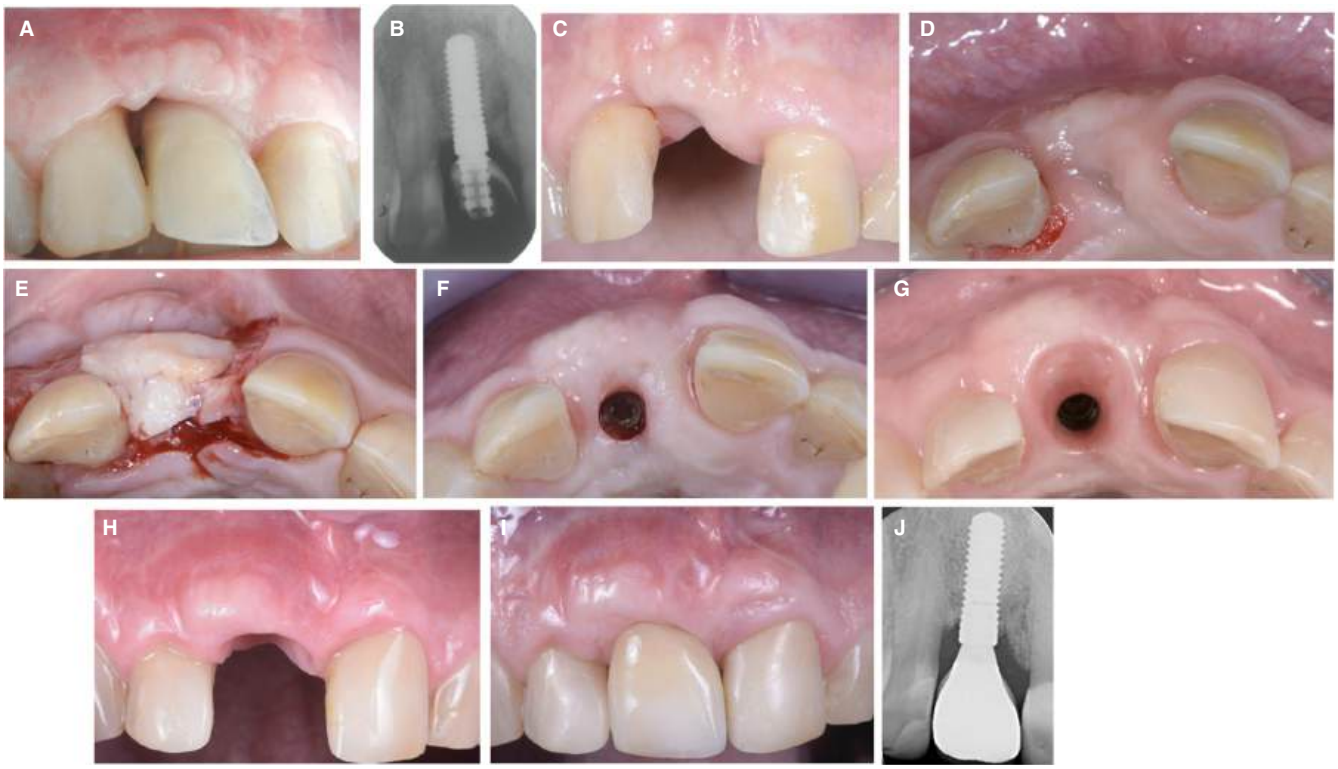


**FIGURE 8** Soft tissue dehiscence. A, Buccal view showing the soft tissue dehiscence with a lack of the distal papilla. B, Baseline radiographic situation. C and D, Soft tissue maturation after crown and abutment removal. E, Connective tissue graft sutured at the connective platform. F, Four months of healing and exposure of the head of the implant. G and H, Soft tissue healing after conditioning. I, Final restoration delivery. J, Radiographic control

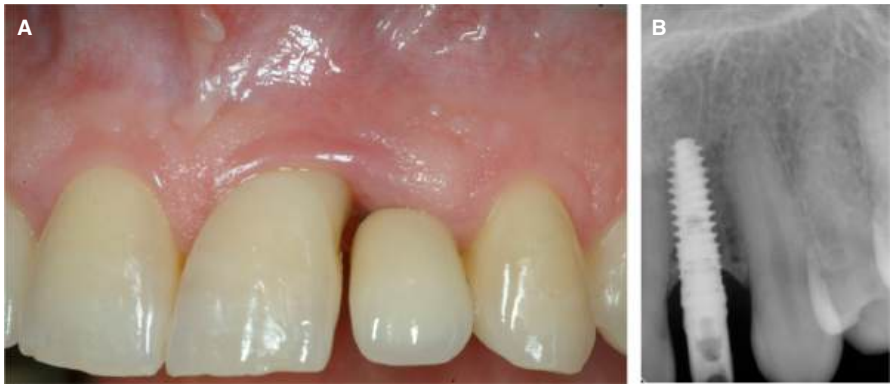


**FIGURE 9** Soft tissue dehiscence. A and B, Clinical and radiographic pictures showing a soft tissue dehiscence with a lack of papilla height and reduced (< 1.5 mm) mesio-distal dimension

interproximal soft tissues (< 1.5 mm) did not allow for a papilla reconstruction technique.

## 3.3 | Errors in the corono-apical position

Treatment options are based on the amount of coronal malposition. Because of the peculiar nature of this malposition and the clinical aspects involved, each case should be assessed individually. As a general rule, if the implant head is more coronal than the ideal position of the homologous natural tooth's gingival margin, then there is no space to allow for proper soft tissue/prosthetic reconstruction.

### 3.3.1 | Case 1: Soft tissue dehiscence caused by an error in the coronal position

One of the reasons for a very coronal implant position can be the unintentional contact with the root of the adjacent tooth, as in the case shown (Figure 10). Nevertheless, the implant head was at the level of the gingival margin of the homologous tooth. The implant's coronal placement led to clinical exposure of the implant platform, both buccally and distally, in association with a lack of radiographic osseointegration along the most coronal implant threads. It must be clearly stated that the lack of osseointegration in the most coronal aspect of the implant was not related to bone

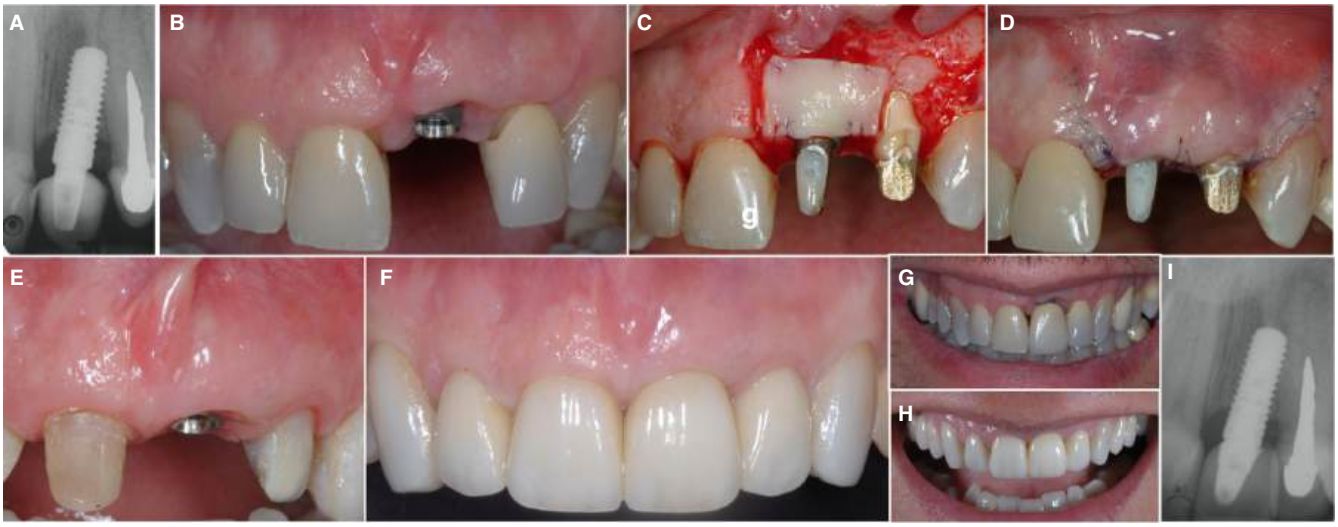


**FIGURE 10** Soft tissue dehiscence. A and B, Clinical and radiographic pictures showing the position of the implant head at the level of the central incisor gingival margin. C and D, Connective tissue graft and flap suture. E, After 4 months of soft tissue healing. F, Final restoration delivery. G and H, Smile of the patient before and after treatment. I, Radiographic control after final restoration delivery

resorption or peri-implantitis. Clinically, there were no signs of inflammation (suppuration or bleeding) or pathologic pocket probing depths.[51] The present soft tissue dehiscence can be classified as Class 3 Subclass B and a combined prosthetic-surgical approach is recommended.[23]

After a presurgical prosthetic phase with the aim of increasing the interproximal soft tissues, the surgical technique consisted of a coronally advanced flap of trapezoidal design with an underlying connective tissue graft.[26]

The flap design was extended to include the adjacent lateral incisor, which was also affected by gingival recession if compared with the contralateral tooth. After complete connective tissue coverage by the flap, a provisional crown was applied avoiding any contact with the buccal and interproximal soft tissue, so as not to interfere with soft tissue healing. Soft tissue maturation was left undisturbed for 4 months. At the end of the maturation phase, the conditioning phase with new temporary restorations was started and lasted for approximately 3 months, when the definitive restorations were delivered. Complete coverage of the buccal and distal peri-implant soft tissue dehiscence was achieved and papillae mesial and distal to the implant crown filled the interproximal spaces entirely.

### 3.3.2 | Case 2: Soft tissue dehiscence caused by an error in the coronal position

Altered passive eruption is a situation in which the gingival margin in the adult is located incisal to the physiologic position (ie, 1 mm coronal to the cemento-enamel junction). Undiagnosed altered passive eruption can result in an implant placement error (Figure 11). In fact, considering a coronally displaced margin as a reference point can lead to excessive coronal implant positioning, especially in cases of an immediate postextraction flapless implant.[52–54]

After implant placement, the mucosal margin, in absence of the support provided by the tooth enamel, healed, repositioning itself in a more apical level than at the adjacent teeth, thus resulting in what we define as a "pseudo-dehiscence". Moreover, because of predisposing factors such as deficiencies in supracrestal soft tissue thickness and inflammation caused by plaque accumulation, the pseudo-dehiscence further progressed into a dehiscence.[55]

Treatment was aimed at improving alignment of the gingival margins according to aesthetic criteria by covering the dehiscence in association with the correction of altered passive eruption on the natural adjacent teeth. A crown-lengthening procedure with paramarginal, scalloped incisions was performed at the teeth, while a coronally advanced flap plus connective tissue graft was used to treat the implant dehiscence. At 1 year, the increase in soft-tissue thickness along with the treatment of the altered passive eruption showed a harmonic, aesthetic alignment of the gingival margins.

### 3.3.3 | Case 3: Soft tissue dehiscence caused by an error in the apical position

A soft tissue dehiscence (Class 4, Subclass A) associated with an apical implant placement and altered passive eruption on adjacent teeth caused an unesthetic appearance. In this clinical case (Figure 12), the presence of altered passive eruption facilitates the resolution of the dehiscence as it reduces the amount of coronal displacement needed for its treatment. Two "opposing" techniques were used to obtain a realignment of the gingival margins: on one hand, crown-lengthening surgery was performed at the teeth to restore the correct dimensions of the clinical crowns,[53,56] and on the other hand, a coronal displacement of the mucosal margin at the implant-supported crown associated with a combined surgical-prosthetic approach was performed.[26] The increase in supracrestal

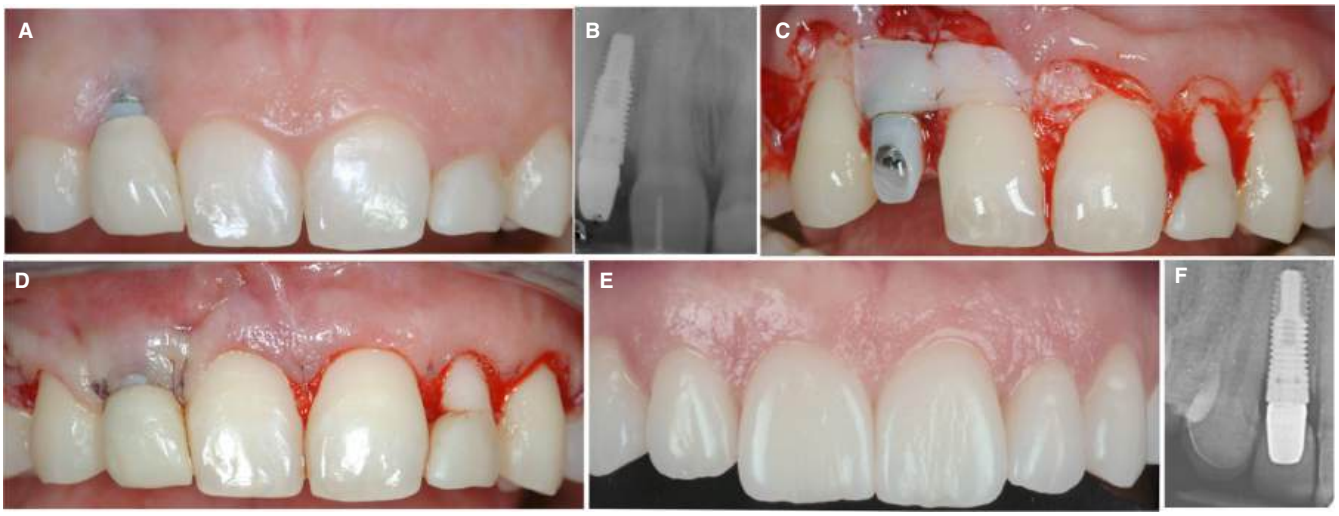


**FIGURE 11** Soft tissue dehiscence associated with altered passive eruption. A, Clinical picture showing the soft tissue dehiscence at implant level and the altered passive eruption at teeth level. B, Intra-oral x-ray with a guttapercha cone measuring the entity of the passive eruption. C, Connective tissue graft sutured and intrasurgical osseous remodeling. D, Flap closure showing the different position of the gingival margin: coronally placed at the implant site and apically positioned at the teeth level. E and F, Clinical and radiographic results

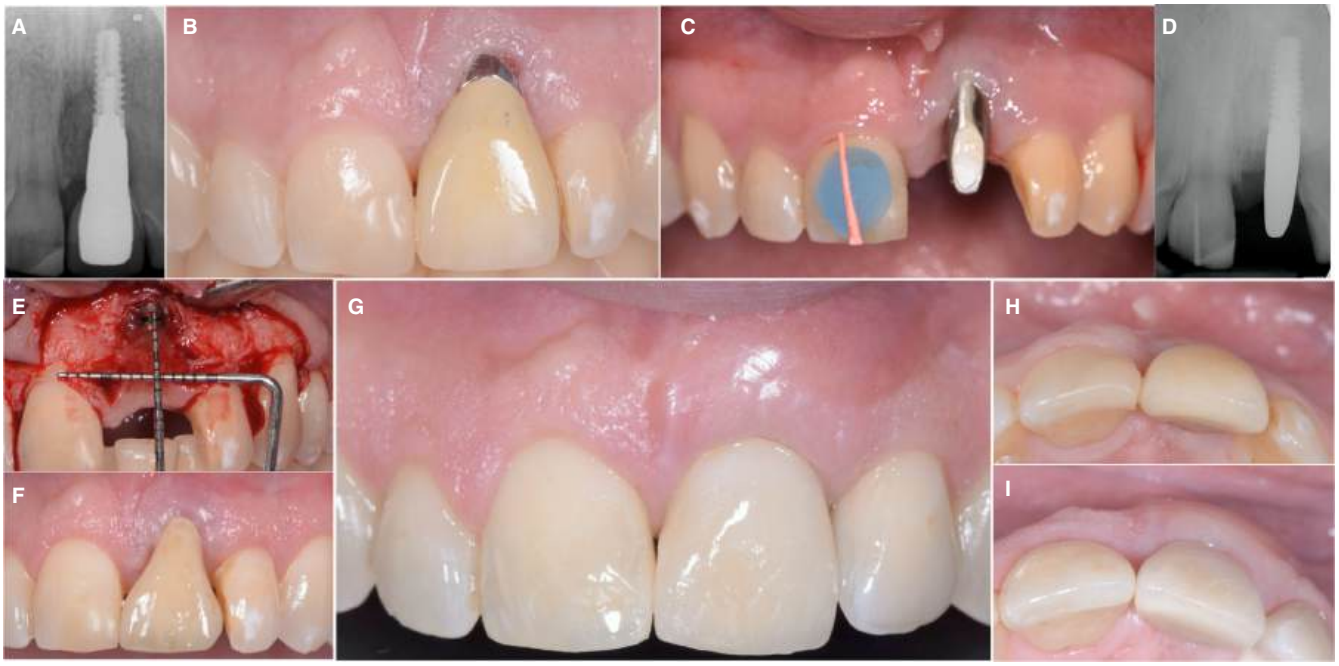


**FIGURE 12** Soft tissue dehiscence. A and B, Radiographic and clinical pictures showing the baseline situation. C and D, Clinical and radiographic diagnosis of the soft tissue dehiscence affecting the implant in position 21 associated with altered passive eruption at the adjacent teeth. E, Crown-lengthening procedure for the altered passive eruption treatment. Note the excessive apical position of the implant. F, Three-month healing and aspect of the soft tissue after the presurgical prosthetic phase. G, Final result showing the realignment of the gingival margins. H and I, Occlusal view before and after the surgical treatment showing the increase in soft tissue thickness

soft tissue thickness allowed the mucosal margin to remain in the correct and aesthetically acceptable position. However, this entails the creation of a long trans-mucosal channel related to the extent of the apical malposition, which represents a risk factor for bacterial plaque accumulation and the possible onset of mucositis. This condition represents an indication to include the patient in a strict hygiene recall program.

## 4 | COMPLICATIONS CAUSED BY SURGICAL SOFT TISSUE MANAGEMENT ERRORS MADE DURING IMPLANT PLACEMENT OR STAGE II SURGERY

As happens in mucogingival surgery around teeth, the most common complications that can occur because of inaccuracies in the execution

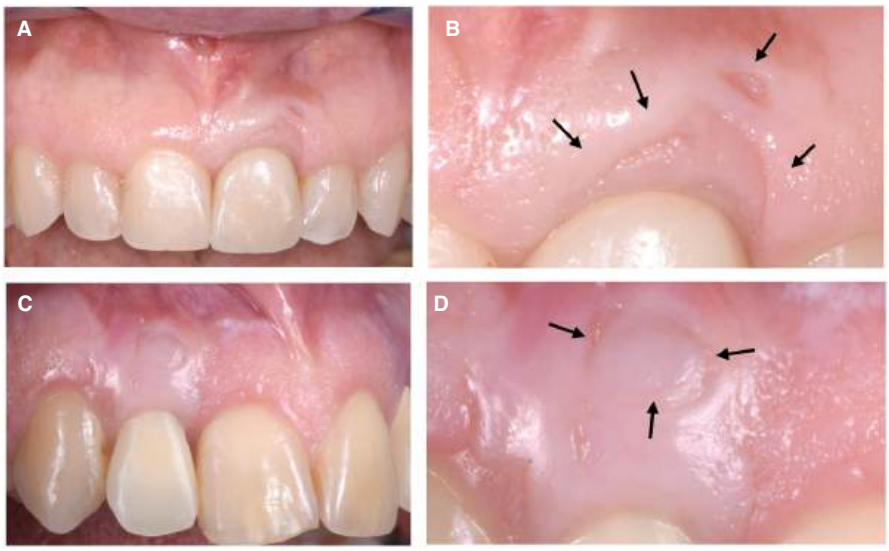


**FIGURE 13** Graft exposures. A, Clinical picture showing a graft exposure caused by shrinkage of the primary flap. B, Detail of the peri-implant soft tissue margin. Note the margin of the covering shrunken flap (arrows). C, Clinical picture showing a graft exposure caused by perforation of the covering flap during surgery. D, Detail of the exposure. Note the "island" of the exposed graft resulting from the reopening of the perforation during the healing phase

of the surgical technique are scar formation, graft exposure, excessive soft tissue thickness, and soft tissue discoloration resulting from the shine-through effect of the underlying metallic structures.

## 4.1 | Keloid-like scar formation

The critical step involves the execution of the vertical releasing incision. Flap elevation in this area must be performed keeping the blade at a 45° angle, thus creating a beveled plane without cutting into the periosteum. This is done to create the widest possible contact surface between the flap and the receiving bed at the time of flap closure. In general, the vertical releasing incision should be confined as much as possible in keratinized tissue, where there is a lower rate of scar formation. A recent in vitro study dealing with oral mucosa and gingival cell cultures[57] suggested that a different regulation of autophagy pathways after injury can activate myofibroblast differentiation, a process that mediates collagen deposition and scar formation. The authors demonstrated that in oral mucosa, characterized by a partially fibrotic outcome during repair, the activation of the autophagy pathway determined an increase in myofibroblast activity (alpha smooth muscle actin) and, subsequently, collagen type 1 production. Conversely, wound healing did not stimulate autophagy in attached gingiva, which meant that no increase in myofibroblast differentiation and collagen deposition could be seen, justifying its scarless outcome.

## 4.2 | Graft exposure

Inadequate passivation of the flap, excessive coronal connective tissue graft placement, and flap perforation are the main common errors that can lead to graft exposure (Figure 13).

The stability of the flap depends on its capability to maintain the position achieved at the end of the surgery. Passivation can be considered adequate when, during surgery, the flap margin is able to reach a level coronal to the cemento-enamel junction even without sutures and this allows it to maintain its position throughout the healing process. These findings have been confirmed in a randomized clinical trial comparing the coronally advanced flap with or without tension before suturing. It was reported that minimal flap tension favored a higher percentage of root coverage, while higher tension of the flap was associated with a lower percentage of root coverage.[58] It has been demonstrated that the position of the gingival margin in relation to the cemento-enamel junction at the end of the surgery is also an important factor in achieving complete root coverage. A clinical study suggests locating the gingival margin 1 or 2 mm coronally to the cemento-enamel junction to compensate for postsurgical shrinkage.[59] These concepts deriving from mucogingival procedures around teeth can be extrapolated to the soft tissue management around implants.

Passive flap advancement requires two split-thickness incisions: a deep incision keeping the blade parallel to the bone, to detach the muscles from the periosteum; and a superficial incision keeping the blade parallel to the external tissues, to detach the muscles from the alveolar mucosa. In this step, wrong blade inclination can result in flap perforation. The dimension of the perforation can lead to different scenarios. A small perforation can be easily sutured and heal uneventfully, while a larger perforation can induce flap necrosis. In the latter situation it is recommended to place a connective tissue graft to protect the underlying tissues or implant components in case the sutures loosen. Still, the opening of the perforation can result in exposure of the underlying graft, creating an area of different color and texture in comparison with the adjacent tissues.

## 4.3 | Excessive soft tissue thickness and grayish discoloration

Excessive soft tissue thickness and grayish discoloration are mainly a consequence of inadequate thickness or poor quality of the grafted

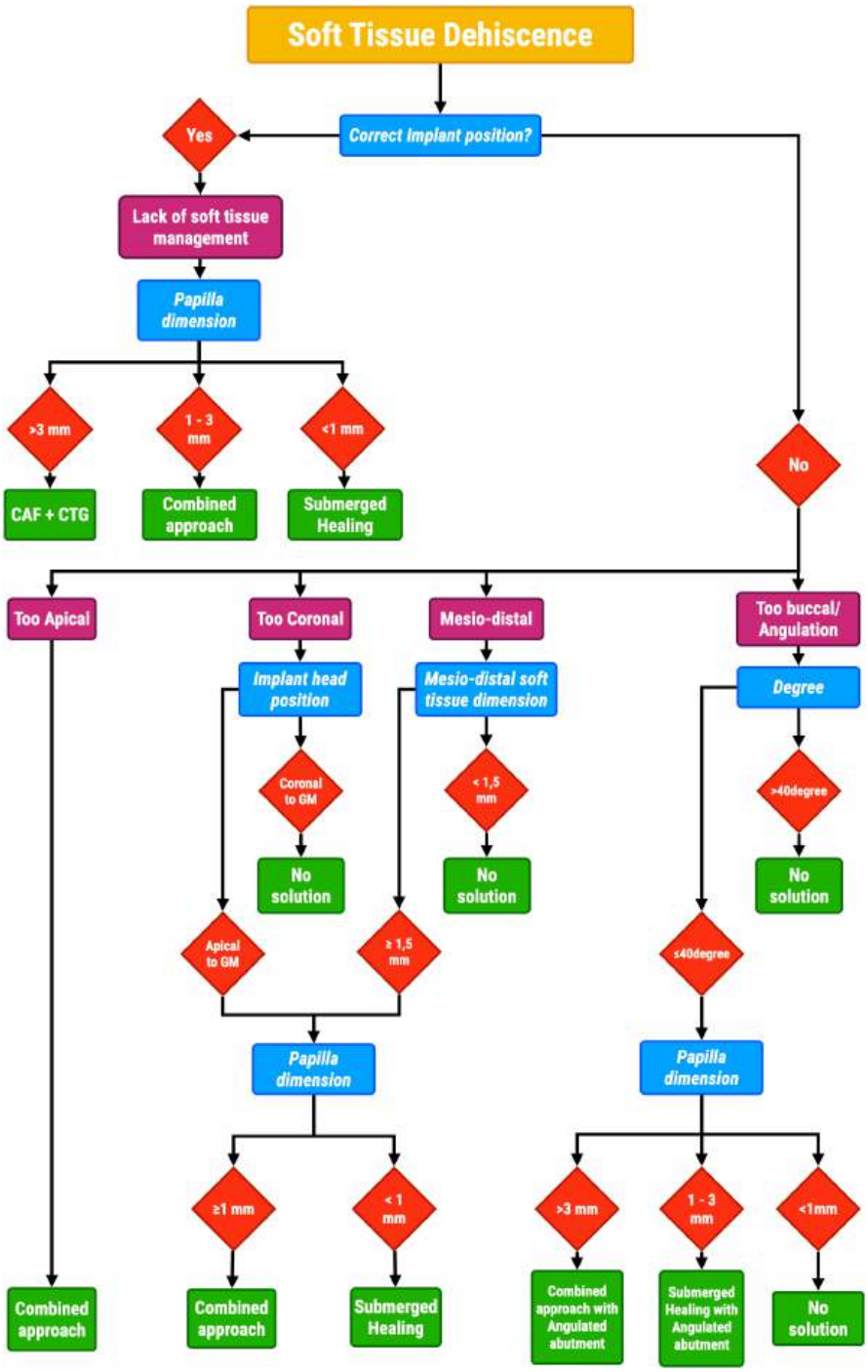


**FIGURE 14** Decision-making process for the correction of peri-implant soft tissue defects. CAF, coronally advanced flap; CTG, connective tissue graft; GM, gingival margin

connective tissue. The size and thickness of the connective tissue graft play an important role in overall soft tissue appearance after healing. If too thin, they can cause transparency of the prosthetic/implant components; if too thick, they can cause flap shrinkage, with consequent graft exposure or the appearance of excessive tissue thickness. The ideal graft thickness is related to the flap: the aim is to obtain approximately 2 mm of buccal tissue thickness at the end of the surgical procedure. This dimension is able to prevent mucosal margin recession in the presence of inflammation, considering that the size of the inflammatory infiltrate is about 1.5 mm.[60] Moreover, mucosa thickness is a crucial factor in terms of discoloration caused by different restorative materials: the thicker the mucosa, the lesser the chances of tissue discoloration.[61]

In addition to the dimension, the quality of the harvested tissues can also influence healing from an aesthetic point of view. The graft should be made of dense connective tissue and deprived of adipose or glandular tissue, as the one deriving from the posterior palate, to reduce the amount of resorption. However, connective tissue taken from the tuberosity can also be considered undesirable, as it not only shows dimensional stability, but also a tendency for hyperplastic reactions.[62] For these reasons, the dense connective tissue harvested with the epithelial-connective

tissue technique in the molar area represents the technique of choice. The drawback of this technique is the need to completely remove all the epithelium from the free gingival graft. The persistence of epithelial cells can cause the formation of epithelial cysts and/or pseudo pockets.[63–65]

Besides the intrapatient variability related to the donor site area, different interpatient healing patterns have also been reported.[62,66,67] For reasons that are still unclear, in some patients the connective tissue graft shows an increased tendency to develop hyperplastic/hypertrophic reactions.

## 5 | DECISION-MAKING PROCESS ON PERI-IMPLANT SOFT TISSUE DEHISCENCE

A decision-making scheme has been designed (Figure 14) to guide the choices of the clinician who is faced with a dehiscence of the peri-implant soft tissues. The first aspect to take into consideration is the implant position, which can result in two main scenarios:

1. Implant in a correct position (ie, the soft tissue dehiscence is caused by a lack of soft tissue management prior to implant positioning). In this case, the feature to value is the dimension of the peri-implant papillae. On that basis, various surgical and/or prosthetic treatments are proposed.
2. Implant in an incorrect position (ie, the soft tissue dehiscence is caused by an error that occurred during implant placement). First, it is necessary to identify the type of misplacement (apical/coronal, mesial/distal, angulation); second, the size of the peri-implant papillae should be assessed. Based on these parameters, different surgical and/or prosthetic approaches are proposed as well.

## 6 | CONCLUSIONS

Peri-implant soft tissue complications can arise from a combination of factors that can be summarized by two categories: diagnostic errors, and treatment errors that occurred during the planning-surgical phase. The former can be avoided by performing an adequate presurgical evaluation and guided implant placement; the latter by standardizing every step of the surgical procedure and mastering the learning curve.

Nevertheless, most of the complications can be corrected with adequate soft tissue management to give the patient an aesthetically pleasing outcome.

The critical factor for the success of the mucogingival procedures employed to correct the aforementioned complications—even more so than implant positioning, which nowadays can be corrected with angulated abutments—is the presence of interproximal soft tissues. Knowledge of the limitations of these techniques is fundamental for preventing additional failures that can increase patient morbidity and frustration.

### DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no dataset were generated or analysed during the current study".

### ACKNOWLEDGMENT

Open Access Funding provided by Universita degli Studi di Bologna within the CRUI-CARE Agreement.

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**How to cite this article:** Stefanini M, Marzadori M, Sangiorgi M, Rendon A, Testori T, Zucchelli G. Complications and treatment errors in peri-implant soft tissue management. *Periodontol 2000*. 2023;92:263-277. doi: 10.1111/prd.12470